Assessing Digitization Readiness in Public Organizations:
A Case Study of Kenya National Examinations Council

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Abstract

An education system geared towards critical thinking, problem solving and lifelong learning is a critical part of the innovation ecosystem in any country. The examination process is an important indicator of learning outcomes. In Kenya, Kenya National Examination Council (KNEC), which manages examinations, is required to provide accurate and timely information on national examinations to education stakeholders. However this role is hampered by the fact that most of information held by the agency is in hardcopy hence challenges of access, retrieval, analysis and dissemination. This paper reports on a study carried out to develop a digitization readiness model for assessing the preparedness of KNEC and by extension other public organizations to undertake successful digitization projects. After reviewing theories, the study developed a digitization readiness assessment model (DRAM) known as Comprehensive Digitization Assessment Model which includes organizational, IT governance, competency, technology and ICT security readiness indicators. The model was then validated through a survey at KNEC. Through a quantitative survey, the study sought to establish the preparedness of KNEC to carry out digitization using the Comprehensive Digitization Assessment Model. Using a purposive sampling targeting a population of 100 respondents' data was collected by use of a questionnaire. Data was analyzed through frequencies, descriptive analysis and Principal Component Analysis. The analysis established an aggregation of success factors along three components; most critical, which address governance of ICT projects, critical that address control measures, and less critical are supportive components. The emergent digitization index for KNEC was 2.88, on a scale of 1 to 4, where 2.5 is the minimum expected level of readiness. DRAM is useful for decision-making and recommends sector wide approach towards digitization as a way to optimize resources.

Introduction

An education system geared towards critical thinking, problem solving and lifelong learning is an important part of the innovation ecosystem. The examination process is an important indicator of learning outcomes. In Kenya, Kenya National Examination Council (KNEC), which manages examinations, is required to provide accurate and timely information on national examinations to education stakeholders.

Like most other Government institutions, there is need for KNEC to transit to provision of public services online. This will lead to a more transparent relationship with the citizens including a timely sharing of information, enhanced efficiency, transparency and accountability (Kettani & Moulin, 2014). Additionally, Covid-19 pandemic has placed extraordinary pressure on public agencies to use online platforms in their operations as well as in service provision. While the new constitution 2010 of Kenya, gives the public, the right of access to information, this may not be realized easily in the case of KNEC because it holds most of their records in hard copy. Therefore the need for digitization of records held by the agency is urgent.

In Kenya, public organizations face many challenges while trying to digitize documents. Across the spectrum of public institutions in Kenya agencies such as the Ministry of Lands and the Judiciary of Kenya, which embarked on digitization process back in the year 2007 are yet to conclude it to date (Kariuki, 2018). KNEC, which forms basis of this study started a digitization journey way back in 2010, and has seen a fair share of challenges. The sheer number of hard copy documents involved and complexity of this activity has led to inconclusive results. KNEC has hardcopy records that date as far back as seventy years ago, stored as either hard copy printouts or microfiche tapes. These records fade over time dictating reconstruction of data to resolve queries such as confirmation of results or issue letters of certification. The implication of this is a likelihood of errors of omission or commission. Further, it hampers the ability to share information and calls for measures to undertake digitization as a matter of urgency. For this to be accurately done, it is imperative that a digitization model is identified or developed through a scientific study, to support the digitization process.

Research Objectives

Prior studies, traditionally, have focused on the need to increase transparency, accountability and accessibility to information. This study proposes to take a different view that underpins the role of e-readiness as a way to improve ICT project management in government agencies. The main objective of the study was to develop a digitization readiness model for assessing the preparedness of public organization to undertake digitization. The study was guided by these objectives; to review success factor for digitization readiness; develop a readiness assessment model for digitization and validate the model to test its applicability by generating a digitization readiness index.

Literature Review
Digitization, digitization readiness and digitization drivers

Digitization is the process of converting analog information into a digital format aimed at eliminating inefficiencies of manual transactions. On the other hand, digital readiness refers to the capacity development for organizations to undertake on large-scale digital initiatives (Sánchez, 2017). Core components of digital readiness include people and skills, specifically how capable people are in using technology to undertake digitization.

Traditionally, the drive for digitization has been to bridge the digital

gap in operations and service provision. As witnessed during the latter part of 1990's, e-readiness concepts intentioned to provide unified frameworks for in-depth evaluation of the digital divide between the more and the less developed countries (Mutula & van Brakel, 2006). Heeks (2004) reviewed the factors for success as driver or enablers of digitization which refers to the active elements present in society that helps to overcome the potential barriers in the digitization process. For example, effective project coordination and change management are good practices for digitization success while cost reduction and improved quality of service are the key benefits of digitization to an organization (Gichoya, 2005). He also emphasized the need to have clear goals set and careful review of reasons for digitization before undertaking the process. On the other hand, Khan, (2015), views digitization in a social perspective and investigated overall benefits to societal welfare. Although, these studies continually indicate global connectivity impacted happiness and satisfaction to populations around the world, less developed countries continue to witness increased failures of digitization projects, mainly due to inadequate plans and execution (Kariuki, 2018). This implies that the traditional approaches that generated most of the current e-readiness tools and models may not necessarily address digitization needs in less developed countries like Kenya.

E-Readiness Models And Tools

Most of the reviewed e-readiness models look at ICT infrastructure like internet access in terms of speed, availability, quality and affordability. For example, Capability Maturity Model (CMM) by Pöppelbuß and Röglinger, (2011), focuses on process controls as a means to manage activities and actors in teams for software development projects. It proposes that we measure the quality of processes in five levels. From the very lowest being chaotic or ad-hoc to a more organized and dependable process. Likewise Benchmarking and Readiness Assessment for Concurrent Engineering Construction (BEACON), by Al Khalfan (2001) emphasizes the quality of process development in the domain of construction. He also measured the process in five levels from ad-hoc to a managed level. These models lack clarity on how one should move from one level to another. Construction Engineering Readiness Assessment Model (CERAM) addresses this lack of clarity by quantifying measurement for preparedness in four linear stages on a scale of 0 to 100 percent. On the other hand, Kashorda and Waema (2014) focused their studies on network connectivity and utilization of ICTs for research and education institutions. The study staged assessment level of preparedness along five dimensions on scale of 1 to 4. Technology Readiness Model (TRM) by Oztemel & Korkusuz (2006) combines CERAM and BEACON to create a systematic approach of measuring technology readiness in an enterprise along three levels; strategic, tactical and operational. E-Government E-Readiness Assessment Model presents a general framework model that assesses the necessary key factors to implement government-wide initiative (Al-Omari, A. and Al-Omari, 2006).

From this review, it emerges that more research is required on the assessment of digitization readiness at organizational level. Issues such as security of data, culture and technology acceptance by public officials require further

investigation (Al-Shihi, 2005). On the other hand, although many studies have successfully listed factors that drive digitization by categorizing them along dimensions that show their impact, it is not clear on how these studies can aid an organization to optimize resources. The current study seeks to provide a framework for assessing in detail factors that guide digitization processes at organizational level and rank their criticality in optimizing the process. This in turn will assist managers in undertaking digitization within public sector institutions in Kenya.

Proposed Digitization Readiness Assessment Model

In order to achieve its main objective, this study proposes a digitization readiness model that can be used to measure preparedness among the public sector institutions in Kenya. Figure 1 below illustrates the proposed digitization assessment model that is an adaptation of the existing E-government Model by Al-Omari and Al Omari (2006). We have elected to call it the Comprehensive Digitization Assessment Model (Kiratu, 2020: 39)
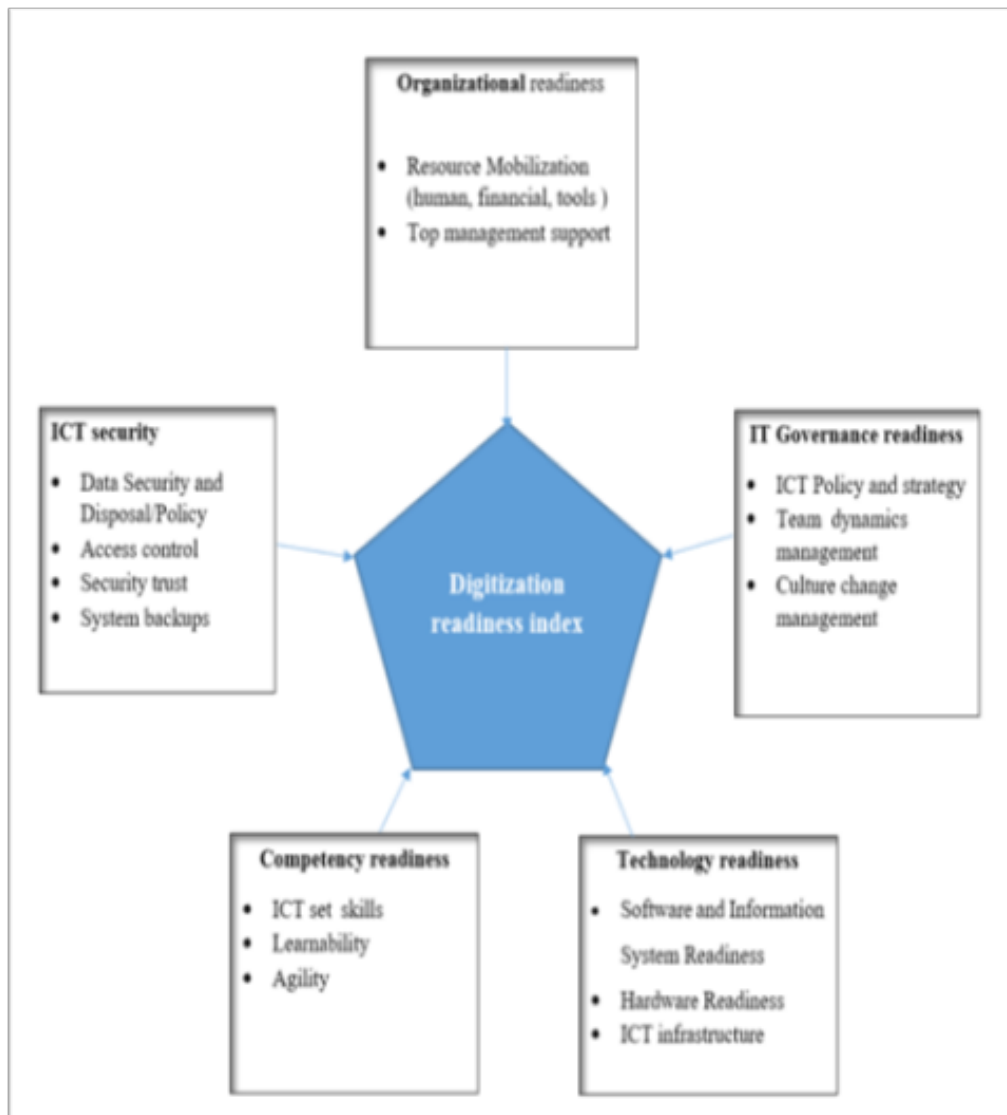

Figure 1: Proposed Comprehensive Digitization Assessment Model (Kiratu, 2020, P. 39)

Key Elements of the Comprehensive Digitization Assessment Model

(a)   *Organizational readiness*

Organization readiness is a measure of the preparedness to accurately link organizational IT efforts and expected outcomes. It assesses the organizations relative advancement towards achieving critical investment in ICT to meet business objectives (Hartman et al, 2001). In addition, it evaluates organizational readiness at two levels, resource mobilization and top management support. While top management is responsible for setting the goals and objectives for the projects, organizational readiness helps organize, plan and control digitization projects by mobilizing resources to maximize potential for success.

(b)   *ICT leadership and governance readiness*

ICT leadership and governance according to Bryson (2018) looks at governance and people leadership aspects of the projects. ICT leadership covers team dynamics management. According to DiTullio (2010) good teamwork correlates with project success. In addition, those teams must have positive a positive culture towards new changes, brought about by digitization. Governance on the other hand, looks at adherence to standard procedures through established policy. Chong (2006) indicates that institutional ICT policy and strategy supports human values that contribute optimally towards project deployment. IT governance readiness on the other side covers technology readiness, competency readiness and ICT security as drivers for digitization. These factors are assessed to determine their contribution towards digitization readiness index.

(c)   *Technology readiness*

According to Adjorlolo and Ellingsen, (2013), technological readiness is best-assessed using readiness for IT-support personnel, hardware, related software and network. This study assessed technology readiness in terms of capacity to carry out digitization project and availability of personnel to support digitization. Computers scanners and printers including software applications that support digitization are considered important. On the other hand there is need to have good networks that provide access and communication within the networks during digitization. Management should also be willing to invest on bandwidth if required during digitization.

(d)   *Competency readiness*

Competency readiness means the existence of qualified personnel in the public sector. Competencies show how people work within digital environments, attitudes, abilities to embrace technology, collaborate with others and work effectively in the digital world. This study looks at competencies in two aspects: personality and ability. For digitization to succeed it is important for team members to have ability to learn new concepts, have desire to develop and improve themselves. On the other hand, they should have the capability to adapt quickly and effectively to the new environment. They should also be trained and have ability to work with computers and scanners.

(e)   *ICT security readiness*

The international standard ISO/IEC 13335-1 (2004), describes ICT security as aspects relating to confidentiality, integrity and availability (CIA) of data. Ryoo et al, (2009) indicates that when computers are connected in a network there has to be proper security measures, as this potentially increases accessibility to intrusion via the Internet. This study considered data security and disposal policy, access control, security trust, backup and data recovery. Data security and disposal policy guides the behavior of users and IT personnel on the classification and safe handling of information system (NIST Special Publication 800-30, 2002). Access control is also important as a security technique that regulates who views or uses resources in a computing environment. Security trust on the other hand, increases confidence level of staff in systems and controls. Backup and data recovery is critical since it protects organizations against data loss. These are fundamental concepts in security that minimizes risk to the business or organizations data.

Computing the Digitization Readiness Index

Digitization readiness index was computed to assess the preparedness level of KNEC to implement digitization. A weighted mean is computed from expected level of readiness from existing factors; technology readiness, competency readiness, organization readiness, ICT security readiness and ICT Governance readiness. This model is referred to as Comprehensive Digitization Assessment Model (Kiratu, 2020).

Research Methodology

This study at KNEC was conducted using a survey design to validate the proposed Comprehensive Digitization Assessment Model. Purposive sampling technique was used. Data was collected by use of questionnaires as the main research instruments from a target population of 100 members of staff. In this study, a cross-sectional approach was adopted to collect views from staff drawn from three structurally different levels; management, operational and support staffs that deals with ICT functions at KNEC.

The cross-sectional survey research was descriptive and helped the researcher collect information in a brief time span. According to Kothari (2004), data analysis is an examination of what has been collected and making deductions and inferences from it. In this study, the filled questionnaires were checked for completeness and comprehensibility to ensure reliability. The study used Statistical Package for Social Sciences (SPSS) system for analysis. In order to present the indicators in a more informative way and reduce the dimensions of factors in an interpretable way, the study analyzed them over the Principal Component Analysis (PCA). PCA was used to explore the underlying structure of the data and then construct KNEC composite index using the weights obtained from the indices. PCA is important since it interprets large datasets by drastically reducing the dimensionality in an interpretable way (Joliffe & Cadima 2016). Descriptive statistics such as mode, frequency percentages were also used to undertake data analysis.

When constructing a digitization readiness index, the study carefully assessed the suitability of the data by studying the overall structure of the indicators and correlation between them. PCA was used to explore the underlying structure of the data and then construct KNEC composite index using the weights obtained from the indices. The index was presented in stages from level 1 to level 4. As seen in Table 1 below, Level 1 is the lowest indicating "not ready" while level 4 is the highest indicating "ready to go". The ability to identify areas to be addressed would strengthen the organization and in subsequent years, to enable it to view improvement and note where progress is still needed.

Table 1: Digitization readiness index scale

Indicator Levels	Mean	Status	Scale
Level 1	1-2	Unaware	not ready, needs a lot of work
Level 2	2.1-2.5	Ad hoc	not ready needs some work
Level 3	2.6-3	Institutionalized	Ready but needs a few improvements
Level 4	3.1-4	Guide	Ready to go

Data Analysis and Findings
Introduction

The study adapted approach used by Ouma, Awuor, and Kyambo (2013) in data analysis. The data collected was analyzed using frequencies, means, standard deviation, principal component analysis from the survey and tabulated according to factors and their indicators, to determine digitization readiness index. The mean score of each indicator is computed by SPSS software by using a simple average of $<x> = \Sigma x/N$ to get the indicator mean based on responses and presented as tables, graphs and charts.

To determine the digitization readiness index for each factor, the means of the indicators were averaged. The average of means were then converted to a scale of 1-4, in-line with existing practice: for instance, Ruikar et al. (2006) and Ouma, Awuor, and Kyambo (2013) measured e-readiness level on a scale of 1 to 4. In this research, a similar (four-point) scale is used.

PCA analysis of indicator

In order to interpret large datasets, Principal Component Analysis (PCA) is used to drastically reduce dimensionality of factors, and present them in an interpretable way (Joliffe & Cadima 2016). The study, thus, used PCA to reveal underlying factors among indicators (see Tables 4). To improve reliability of PCA, according to Field (2009), measure of sampling adequacy should be greater than 0.5 for bare minimum. For this analysis, KMO was .857 and KMO values for individual items were to be greater than .5, as acceptable sampling adequacy. Bartlett's test of sphericity was 567.18. $P<0.001$, indicated that correlation between items was sufficiently large for PCA (Table 3). Consequently, an analysis to obtain eigenvalues for each component in the data was undertaken. Three components had eigenvalues over Kaiser's criterion of one, showing clustering

of items along three components 1, 2, and 3. The clustered components were identified as either 1 (Most critical), 2 (Critical) and 3 (Less critical) towards digitization.

Table 2: Component Correlation Matrix

Component	1	2	3
1	1.000	.462	.350
2	.462	1.000	.192
3	.350	.192	1.000

Table 3: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.857
Bartlett's Test of Sphericity Approx. Chi-Square	567.188
Df	105
Sig.	.000

Table 4: Principal Component Analysis

Indicators	Component		
	1	2	3
Team dynamics management	.827		
Agility	.802		
Learnability	.789		
Top management support	.745		
Resource Mobilization	.682		
Data security and Disposal policy	.637		
ICT set skills			
System backups		.845	
ICT security trust		.789	
ICT policy and strategy		.779	
Access control measures		.653	
Culture change management			
Software readiness			.808
Hardware readiness			.643
ICT infrastructure			.559

The results of PCA, Figure 2 show factors grouped along three components. The study, in an attempt to analyze these factors, categorized them as ether "Most Critical", "Critical" and "Supportive" respectively along these groups. Accordingly, indicators grouped under the "most critical" are those whose absence would definitely impede digitization. While those grouped as "Critical" are directly supporting "most critical" factors. The absence of these critical components would definitely compromise effort put in the most critical components. "Supportive" are less critical components and are supportive elements

of the "Critical components" of digitization. This study finds out that culture change management and ICT set skills have can be acquired if good governance is in place .Hence, these have minimal direct influence towards digitization.
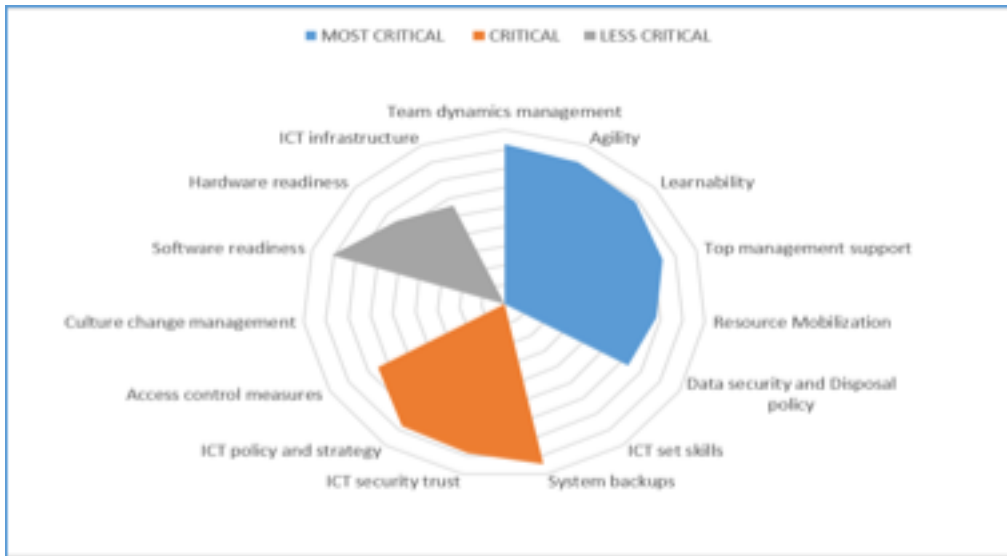
Figure 2: PCA Analysis of Indicators. (Kiratu, 2020, p.96)

Presentation of Results of Indicators Index for KNEC

An index, being a statistical aggregate that measures change, should clearly reflect its indicators according to the public service appraisal system. Hence, the study presented a framework for the digitization readiness index of KNEC in a circular fashion. Figure 3 below shows the framework for the Digitization Index. It is a radial diagram showing clearly the rating of indicators.   From the framework, it is easy to see indicators that lag behind; in this case, ICT set skills and determine the ones that are performing well .like data backup.
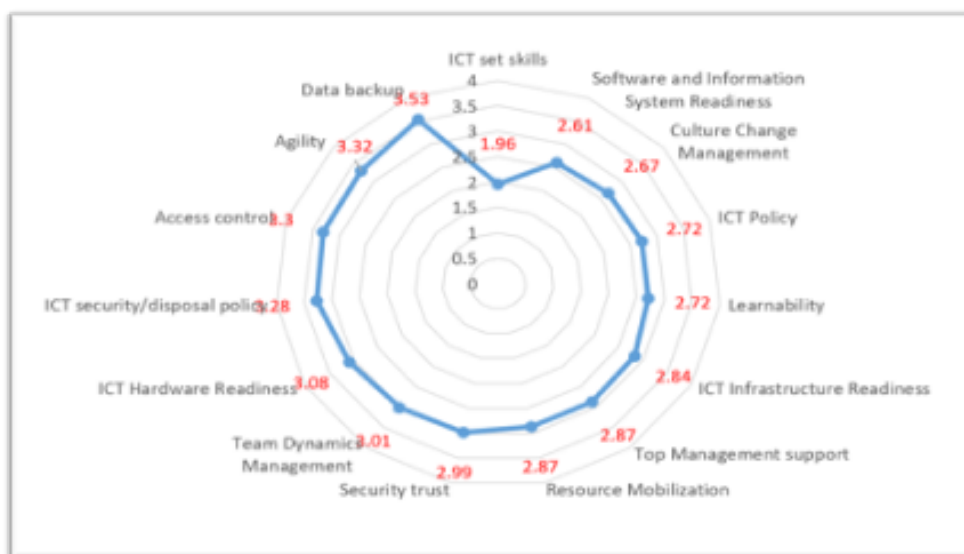

Figure 3: Framework for Readiness Level of Indicators (Kiratu, 2020, P.95)

Digitization readiness index for KNEC

To explain easily digitization readiness assessments, it is important to visually present summaries in a model for ease of interpretation (Ouma, Awuor, & Kyambo, 2013). This visualizes the summaries of indicators as shown in Figure 4. Accordingly, indictors that scored below 2.5 mark average are considered not ready for undertaking digitization. As seen in the model, the study findings depicts that all the factors are above the minimum expected level of readiness. Therefore, over a period, KNEC has achieved significant level of preparedness towards digitization in all factors. For example on this linear scale, the ICT governance factor rating is 2.8. This implies that ICT governance is "Ready but needs a few improvements" for undertaking digitization. The competency readiness factor has the lowest average score of 2.66, hence categorized, as "Ready but needs a few improvements". The indicator, which contributed towards low performance of competency readiness is ICT set skills (1.96), showing inadequacies in this area. From the findings, it is clear that appraisal system in KNEC does not adequately address training needs. The results for ICT security Readiness has a total average of 3.27, categorized, as "ready to go". It seems that KNEC has invested so much in security but less in skills development.
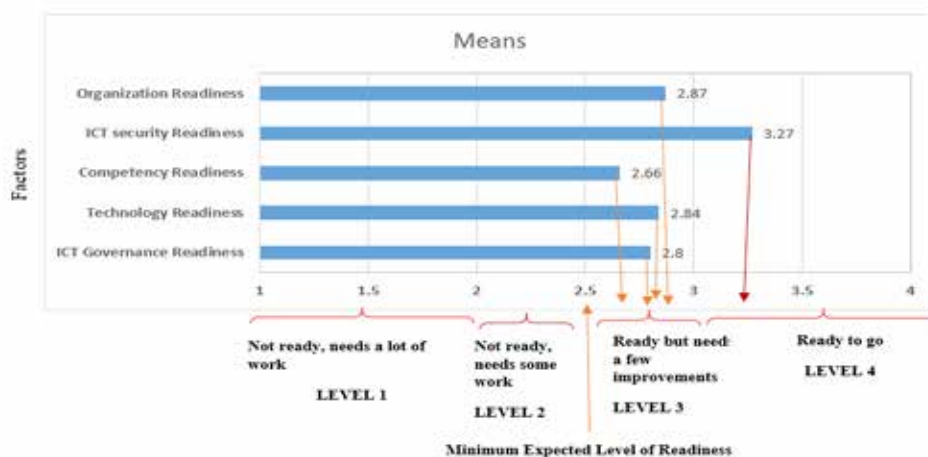
Figure 4: overall Digitization readiness index for KNEC (Kiratu, 2020, P.94)

Discussion of findings

This study compares favorably with prior studies (Gichoya, 2005; Davenport, 2000), where similar success factors for digitization are identified. As an extension to these prior studies, the current study aggregates success factors along three components "most critical", "critical" and "supportive" using PCA. This aggregation improves significantly the understanding of how these factor influence implementation of digitization projects. For instance, the first tier, "most critical", aggregate of factors suggest that if governance, resource planning and capacity development are not enhanced, specifically in public organizations, digitization projects are most likely to fail.

Different authors have reviewed key success factors in ICT projects. For example, Davenport, (2000) specifies that successful project implementation is achievable with high-level executives having strong commitment to the project, while, Pöppelbuß and Röglinger, (2011) only examined controls applied to manage activities and actors for software projects .These factors are considered as isolated events. This study findings shows that top management support, "most critical", factors cannot lead to successful implementation alone, unless supported by "critical" factors that regulate and reduce risk in digitization projects, such as system backups, ICT security, ICT policy, strategy, and access control. This implies that for digitization projects to succeed there is need to focus on both "most critical" and "critical" factor components simultaneously.

Afari-Kumah (2014), indicates that presence of hardware, network, related software, IT support personnel are critical for technology readiness. However, this study found them to be "Less critical" for digitization. From the findings of this study, although digitization projects require ICT hardware, ICT software and other ICT infrastructure, most of the hardware and software may not outlive the project. The implication is that organizations may over invest in the technology aspect and end up with unnecessary equipment after the project is completed. This implies that organizations should consider leasing and hiring of technology equipment for digitization, especially if they are considering conversion of historical documents to digital format. In addition, this study recommends that a nationwide policy on digitization should be developed, to address efficiency of sourcing of hardware and software. Additionally, pooling hardware and software resources across many agencies and their respective ministries should be a policy issue to support digitization.

The overall digitization index shows that KNEC, at 2.88 average score is ready to undertake digitization with minimal adjustments. A critical look however at the individual indices that aggregate this score shows weakness in some of the factors associated with the "most critical" axis. These are competency readiness (ICT skills, agility, learnability) and organizational readiness (top management support, resource mobilization) at 2.66 and 2.87 respectively. The implications of this are that KNEC must prop up these factors to a level of over 3.0 to assure successful implementation of digitization. This is particularly important for ICT skills – a "most critical" – which scored 1.96, an indication that this aspect is not ready and needs a lot of work. These indicators, that affect skills development and resource mobilization, require long-term preparation. This may hinder immediate initiation of successful digitization projects. Environmental factors like budgets, that take time to be approved by treasury, may cause delay that may affect digitization readiness index. Therefore, public organizations need proper planning to make sure all capacities are in place before digitization.

Conclusion

This study offers useful lessons to decision makers, ICT managers and ICT specialists in the public sector on digitization efforts in public organizations. This is useful since many government departments and parastatal organizations still need to digitize their data and documents. It equips organizations with a framework that could be applied in performing digitization readiness assessment,

identify limitations and provide suitable solutions. Agencies ready to digitize hardcopy documents may refer to this framework as a useful resource during the digitization project. This study empowers organizations with a comprehensive resource pertaining to digitization readiness and provides a comprehensive assessment methodology to guide on self-assessments. While this framework is useful, more research is necessary. The conceptual framework offered in this study paves the way for future empirical research to test the framework in different setups and geographical locations. Nevertheless, this study is an important conceptual step in identifying relevant factors from an organizational perspective for assessing digitization readiness in a public organization.

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