Organisational Mechanisms for National Knowledge Network and Outcomes in the Institutes of Higher Education & Research: Moderating Role of Needs & Ecosystem

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Abstract

We have looked at the relationship between organisational processes/ mechanisms for development, adoption and implementation of national knowledge network in the institutes of higher education and research and the organisational and individual level outcomes in those institutes. Our findings, based on regression analysis in a quantitative study covering 112 faculty members from user institutes show strong support for a positive relationship between organisational processes/ mechanisms and organisational level outcomes as well as between organisational processes/ mechanisms and individual level outcomes. We also found that need for high bandwidth and advanced computing resources and ecosystem or support for NKN in the user institutes positively strengthens the relationship between organisational processes/ mechanisms for NKN and individual level outcomes.

Key Words: National Knowledge Network; Organisational Mechanisms; Need for ICT resources; Ecosystem; Higher Education.

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Introduction

National knowledge network (NKN) is a "state-of-the-art multi-gigabit pan-India network" (http://www.nkn.in/). It is government funded and provides high bandwidth and information and communication technology (ICT) resources to knowledge related institutions. These resources can be utilised for distance education and sharing knowledge across geographies. With high growth in the number of institutes in the country (MHRD, 2014) and lack of faculty resources to meet the fast growing demand, ICT was considered a great enabler to bridge these gaps. It was envisaged that institutes of higher education and research institutes will be able to utilise the vast potential of this resource. However, except in small pockets, the adoption of NKN by user institute was not as smooth as expected by the NKN providers (Jain and Singh, 2015). Without the much needed integrated planning for ICT resources by the user institutes and lack of proper understanding of the necessity to broaden organisational mechanisms to adopt ICT resources, the organisational and individual objectives cannot be realised. In this study we focus on the user institutes' perspective of NKN and examine the link between organisational mechanisms and outcomes. The study also examines the effect of the ICT needs on the relationship between the organisational processes/ mechanisms for NKN and the organisational and individual level outcomes. Similarly, we also look at the effect of the ecosystem or support provided.

Literature Review

National ICT networks play a vital role in enhancing the quality of education by improving the learning experience and removing geographical barriers. They enable access to variety of educational resources, participatory pedagogy, collaborative learning and multiple-classroom learning. Distance learning programs and web-based e-learning modules could also address the issue of affordability by increasing the size of the addressable classroom and bringing down unit cost. Access to internet enables students as well as teachers to access both knowledge and pedagogical resources.

National ICT networks support research institutions by connecting libraries, providing access to digital resources and supporting collaborative research across geographically distant

partners. It provides high bandwidth and supports advanced computing power which is required for conducting complex calculations, particularly for research involving large data sets. It provides opportunities for analysing huge amounts of data in a fast and accurate manner through grid computing resources which brings a variety of computing equipment together (Sarkar, 2012).

Although there are tremendous benefits to adoption of national ICT network in higher education, these are limited by how effectively this network is implemented. ICT network can be effective in providing support for education and research by having proper administrative processes (Ng, Miao, and Lee, 2006) for planning, monitoring, and resource sharing.

Effectiveness and Adoption of ICT Networks in Higher Education

Past studies have highlighted factors related to individual such as motivation, facility with technology, beliefs about pedagogical approaches (Bullen, Morgan and Qayyum, 2011; Phillips, 2005), awareness and attitude (Sife, Lwoga and Sanga, 2007) of ICT adoption in higher education (Richardson, 2006; Sharpe, Benfield, Roberts, and Francis, 2006; Thorpe, Conole, and Edmunds, 2008). A large number of studies focus on factors that facilitate e-learning that is learning through ICT-enabled systems (Ozkan and Koseler, 2009; Ramayah, Noor Hazlina and May-Chiun, 2010; Sharpe, Beetham and de Freitas, 2010; Yusuf and Al-Banawi, 2013) and its evaluation (Mandinach, 2005).

Stockdill and Morehouse (1992) have demonstrated the critical factors in adoption of technology. The five main categories are educational need, user characteristic, content characteristic, technology characteristics and organizational capacity. In a study by Farquhar and Surry (1994), four categories of factors that influence adoption were identified. These include user characteristics, perceived attributes (of technology), physical environment that examines the organization's technology infrastructure and support environment that examines the resources required to maintain the innovation.

Studies have highlighted the role of organizational mechanisms in the deployment and adoption of ICT networks. Limited incentives, lack of support, weak communication channels, slow action on critical issues (Dooley and Murphrey, 2000; Philips, 2005),

management support, delay in provision of resources, and the need for technological support (Dalgrno, Lee, Carlson, Gregory, and Tynan, 2011; Philips, 2005) are barriers to adoption. Literature on the integration of instructional technology in higher education has identified the 'need for policies and procedures to adopt new technology' (Collis and Wende, 2002; Stensaker, Maassen, Borgan, Oftebro and Karseth, 2007; Surry, Ensminger and Haab, 2005). The need for institutional support and technical training in adoption is highlighted in many studies (Al-Senaidi, Lin and Poirot, 2009; Collis and Wende, 2002; Dalgarno, et al., 2011).

The role of the ecosystem in accelerating the deployment of ICT networks has been documented in a number of studies. Components of such an ecosystem include a support environment, basic service components and generic integrated solutions (Uden, Wangsa and Damiani, 2007). The need for developing a support system to facilitate adoption has been highlighted in Phillips (2005) and Surry, Ensminger and Haab (2005).

Outcomes of Adoption and Usage of ICT Networks for Higher Education

Adopt of ICT networks by user institutes creates expectation in terms of usage, collaboration, etc. Some of the benefits or outcomes (Armstrong and Franklin, 2008; Collis and Wende, 2002; Conole and Alevizou, 2010; Dalgarno, et al., 2011; Dalsgaard, 2006; Franklin and Van Harmelen, 2007; Nicol and Coen, 2003; Oliver, 2002; Pedro, 2003; Redecker, 2009; Selwyn, 2007; Singh and Jain, 2014; Stensaker, et al., 2007) to be considered in the evaluation of ICT networks in higher education are enhanced quality of student learning through more relational interactions; higher interactivity, flexibility and innovation in teaching and learning; enhanced collaboration; improved access to learning resources, including pedagogical tools; improvement in organizational efficiency; and development in staff skills.

Conceptual Model & Hypotheses

In the context of deployment of public ICT networks in higher education, we examine the relationship among organizational mechanisms, need for resources, ecosystem and outcomes.

Organizational Processes/ Mechanisms for National ICT Networks: For effective development, implementation and adoption of such ICT networks, it is important to recognize that the perspective of administrators, faculty and support units within the institution play an

important role. As the technology changes, there is a need to change the organizational structures in the institution from those of conventional educational institutions to leverage the benefits of new technology (Bates, 2004). Successful implementation of national ICT networks in higher education as in other contexts requires changes in the organization, faculty roles and administrative structures (Dooley and Murphrey, 2000). Therefore, the effectiveness of these ICT networks would be influenced by the extent to which organizational support is provided for such initiatives. Such support could be established through organizational processes, availability of information regarding such resources, knowledge about whom to contact for accessing resources and existence of relevant committees. The need to have organisational mechanisms is driven by the extent to which educators and researchers in education and research institutes perceive that their teaching and/or research requires them to have access to high bandwidth, e-Learning tools, high-speed information and library access. Such demands could put pressure on management to adopt ICT networks. If such infrastructure is publicly available, then it is easier to access it, as individual institutions may have little or no financial burden because of such requirements.

Ecosystem or External/Internal Support: Studies (for example, Dooley and Murphrey, 2000; Sife, Lwoga and Sanga, 2007) have emphasized the role of ecosystem and support of management in effective adoption of ICT networks. These include support from implementing agency, IT staff, management and government, in the case of publicly funded infrastructure.

Outcomes: The outcomes could be at the organizational or individual level. These relate to whether access to infrastructure, extent of collaboration, opportunities for distance learning, availability of virtual libraries, availability of pedagogical tools and improvements in teaching and learning and access to shared resources have improved.

Organisational Processes/ Mechanisms for NKN and Organisational Level Outcomes

The learning and teaching effectiveness of ICT resources in higher education depends on the way these resources are utilised and the purpose for which they are used (Sarkar, 2012). The way resources are utilised and the purpose for which they are utilised are governed and guided by the organisational processes and mechanisms. The second p in the RIPPLES model (Surry, Ensminger and Haab, 2005) emphasises the need to adapt organisational mechanisms to the new technology been adopted. Many times institutes of higher education think that

adoption of ICT resources is a minor change (Collis and Wende, 2002) and fail to adapt and widen their institutional policies and systems to meet new requirements. For effective adoption of NKN, presence of organisational processes and mechanisms in the user institutes that will help them to achieve their objectives is very important. So, organisational processes and mechanisms in the user institutes for NKN will be positively related to the outcomes achieved by these institutes. This relationship is stronger when the teaching and research work in the institutes of higher education and research requires high bandwidth and advanced computing resources for sharing, creation and dissemination of knowledge. The positive relationship between organisational processes and mechanisms in the user institutes and their organisational level outcomes gets strengthened by the ecosystem/ internal and external support for the effective usage of knowledge networks. Hence, we can hypothesise that,

> *H1a: Better organisational processes/ mechanisms for NKN are positively related to better organisational level outcomes.*
>
> *H1b: Need for ICT resources positively strengthens the relationship between organisational processes/ mechanisms for NKN and organisational level outcomes.*
>
> *H1c: Ecosystem or support for NKN positively strengthens the relationship between organisational processes/ mechanisms for NKN and organisational level outcomes.*

Organisational Processes/ Mechanisms for NKN and Individual Level Outcomes

In case of higher education and research institutes, proper systems in the institute are required so that faculty members can effectively leverage NKN resources to achieve their teaching and learning goals. Need for high bandwidth and advanced computing resources for their teaching and research related work strengthens this positive relationship between organisational processes and mechanisms in the user institutes and their individual level outcomes. Also, ecosystem/ internal and external support for the effective usage of knowledge networks in the institutes of higher education and research strengthens the positive relationship between mechanisms and outcomes. Thus, we can hypothesise that,

> *H2a: Better organisational processes/ mechanisms for NKN are positively related to better individual level outcomes.*
>
> *H2b: Need for ICT resources positively strengthens the relationship between organisational processes/ mechanisms for NKN and organisational level outcomes.*
>
> *H2c: Ecosystem or support for NKN positively strengthens the relationship between organisational processes/ mechanisms for NKN and organisational level outcomes.*

Figure 1 shows the conceptual model of the study.

Figure 1: Conceptual Model
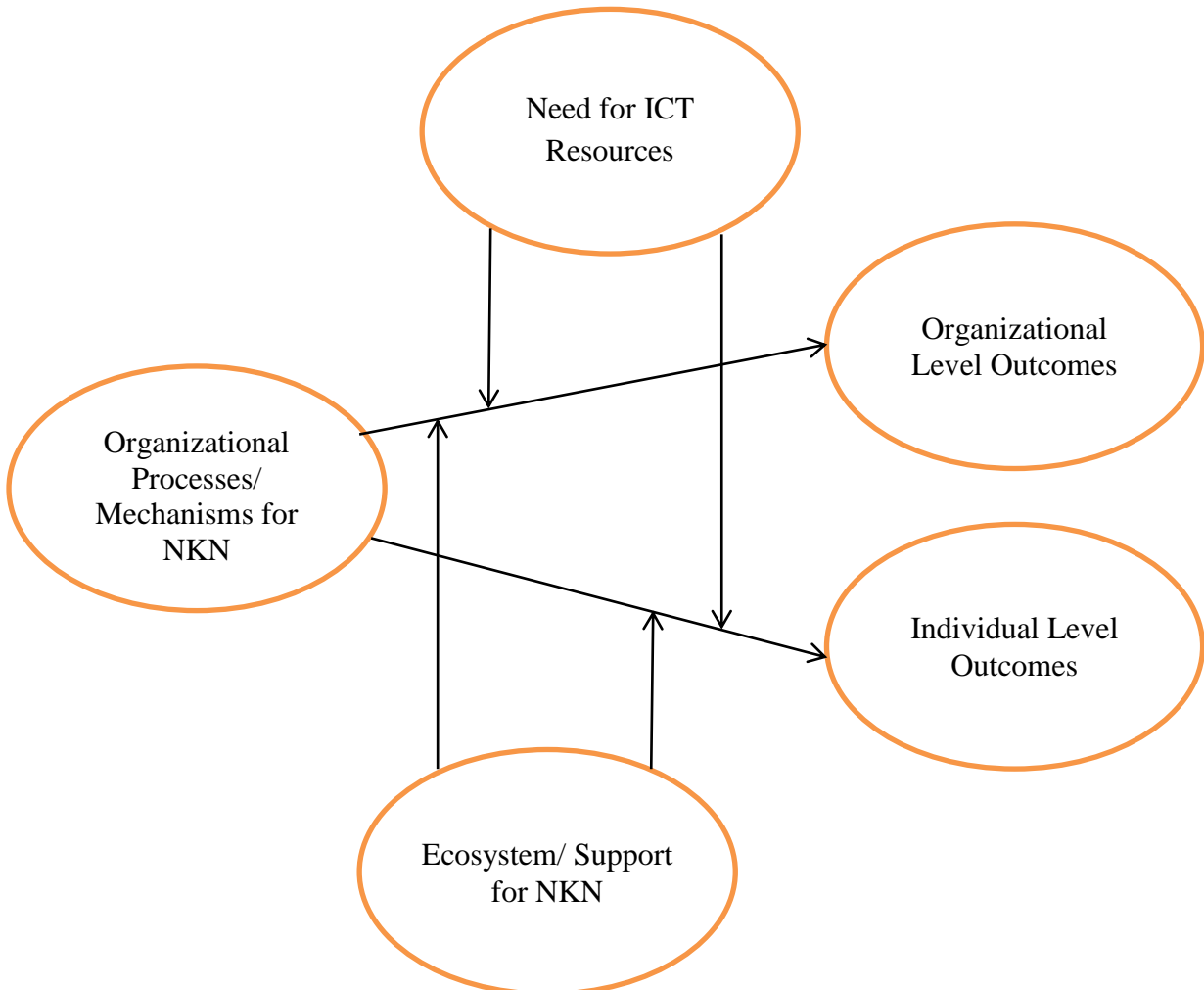
Methodology

Sample

Before planning the survey detailed information related to NKN was collected from government sites/offices, internet and library sources. We conducted a survey in research and educational institutes both at national level and at state level. Research institutes have research programs and offer only doctoral programs, whereas educational institutes have programmes at graduate, post-graduate and doctoral levels. Our sampling plan was based on

the understanding of different requirements as well as difference in the usage of NKN in these two categories of institutes. For example, the educational institutes would require bandwidth and support in virtual classrooms, whereas research institutes would need infrastructure for sharing and transfer of massive amounts of scientific data over the network. We covered three disciplines in the educational institutions: engineering, science, and management. We also expect differences in usage across hierarchical levels in the institutes based on various factors such as portfolio of teaching and research, access to resources, information regarding resources and so on. The national and state level institutes are expected to differ in terms of usage since penetration of the knowledge networks may be better at national level institutes. On the other hand, options for state level institutes may be and so they may depend more on NKN.

We covered both users and administrators in our survey. The administrators in the user institutes were nodal officers (contact person appointed by the NKN in target institutes), IT staff and faculty managing the IT resources in the institutes. Users were faculty and researchers using knowledge networks. We considered administrators and users separately to get a perspective both on the implementation issues and on usage issues.

In short the following five parameters were used for sample selection:
1. Level of institute: National or State
2. Type of institute: Research or Higher Education
3. Level of faculty based on designation: Professor or other faculty member
4. Level of faculty based on position: Head of the department (HOD) or Non-HOD
5. Type of role: User or Administrator

Data Collection

Survey was conducted from March to June 2014 using two questionnaires: one for users and the other for the administrators. The questionnaires had open-ended as well as close-ended questions. Seven-point scale was used for close-ended questions. Before the questionnaires were finalised, they were validated based on expert opinion and pilot study on a small number of users. Questionnaire designed for the nodal officers/IT personnel was sent to all 60 individuals from various research and educational institutes whose contact details could be found in their institute websites. Out of this, 14 usable responses were received. Questionnaire designed for users was sent to 2,231 individuals from various research and educational institutes, of which only 112 usable responses were received (please see Table 1). We got the contact details of the individuals from the list of connected institutions available on NKN website, covering all research and educational institutes both at national level and at

state level. We had identified 621 institutes, but we could find the contact information of head/faculty only for 211 institutes and of nodal officer/IT personnel only for 23 institutes. In a gap of two weeks, two reminders were sent after the original questionnaire was sent.

Table 1: Response Rate for Survey Questionnaires

		Users			Administrators		
		Questionnaires Sent *(No.)*	Usable Responses Received *(No.)*	Response Rate *(%)*	Questionnaires Sent *(No.)*	Usable Responses Received *(No.)*	Response Rate *(%)*
Total		2,231	112	5.0	60	14	23.3
Level of Institute	National	1,630	78	4.8	34	6	17.6
	State	601	34	5.7	26	8	30.8
Type of Institute	Research	1,236	48	3.9	7	1	14.3
	Education	995	64	6.4	53	13	24.5
Designation of Individual	Professor	890	47	5.3	---	---	---
	Other faculty members	1,341	65	4.8	---	---	---
Position of Individual	Head of Department (HOD)	373	8	2.1	---	---	---
	Non-HODs	1,858	104	5.6	---	---	---

Based on our discussion with some users and NKN officials, our understanding is that many of the individuals who did not fill up the survey either were not aware of NKN or had no explicit knowledge about its usage in their own context. This was also confirmed in phone follow-ups with some of the people to whom the questionnaires had been sent.

Analysis

Organisational level outcomes and the individual level outcomes are the dependent variables; organisational processes/ mechanisms for NKN is the independent variable, and need for ICT resources and ecosystem/ support for NKN are the moderating variables in our study. We have used hierarchical regression to test for moderating effects. The interactive terms has been calculated after centering the variables as suggested by Aiken & West (1991).

Results

Table 2 gives the mean, standard deviations, zero-order correlation, and Cronbach α of the study variables. Cronbach α for all four variables is above the desired cut-off value of 0.7

(Hair, Anderson, Tatham, & Black, 1998). Mean values range from 4.52 for need for ICT resources to 3.92 for individual level outcomes. Organisational processes/ mechanisms for NKN is positively and significantly correlated with organisational and individual level outcomes (r = 0.57[***] and 0.42[***] at p≤0.001 level respectively). Need for ICT resources and ecosystem/ support for NKN are not correlated with organisational level outcomes but positively correlated at p≤0.01 with individual level outcomes (r = 0.27[**] and 0.25[**] respectively).

Table 2: Mean, standard deviation, zero-order correlations and Cronbach α of study variables

Variables	Mean	s.d.	Number of items	1	2	3	4	5
1. Organisational Level Outcomes	4.06	0.99	11	(0.92)				
2. Individual Level Outcomes	3.92	1.10	7	0.70[***]	(0.93)			
3. Organisational Processes/ Mechanisms for NKN	3.97	0.99	4	0.57[***]	0.42[***]	(0.74)		
4. Need for ICT Resources	4.52	0.59	4	0.03	0.27[**]	0.04	(0.75)	
5. Ecosystem/ Support for NKN	4.49	0.69	4	0.13	0.25[**]	0.12	0.40[***]	(0.80)

N=112. Cronbach α in parenthesis. [***] p≤0.001; [**] p≤0.01; two-tailed tests

Results of the hierarchical regressions are given in Table 3. Standardised regression coefficient of organisational processes/ mechanisms for NKN for Model 1a is significant and positive (β=0.57[***] at p≤0.001 level), thus supporting the hypothesis H1a that better organisational processes/ mechanisms for NKN are positively related to better organisational level outcomes. The independent variable 'organisational processes/ mechanisms for NKN' explains 32% variation in the dependent variable 'organisational level outcomes'. The insignificant values of interaction terms in Model 1b and 1c shows that there is no support for hypotheses H1b and H1c that need for ICT resources and ecosystem/ support for NKN respectively strengthens the relationship between organisational processes/ mechanisms for NKN and organisational level outcomes.

Table 3: Effects of Organisational Mechanisms for NKN on Organisational and Individual Level Outcomes with Need and Ecosystem as Moderator

Variables	Model 1a	Model 1b	Model 1c	Model 2a	Model 2b	Model 2c
	Dependent Variable: Organisational Level Outcomes			Dependent Variable: Individual Level Outcomes		
Main Effects						
Organisational Processes/ Mechanisms for NKN	0.57^{***}	0.56^{***}	0.56^{***}	0.42^{***}	0.43^{***}	0.41^{***}
Need for ICT Resources		0.01			0.23^{**}	
Ecosystem/ Support for NKN			0.03			0.26^{**}
Interactions						
Organisational Processes/ Mechanisms for NKN x Need for ICT Resources		-0.07			$0.14^{\dagger}$	
Organisational Processes/ Mechanisms for NKN x Ecosystem/ Support for NKN			-0.09			$0.17^{\dagger}$
Overall Adjusted R^2	0.32	0.31	0.32	0.17	0.24	0.22
Overall F	53.53^{***}	17.93^{***}	18.42^{***}	24.07^{***}	12.73^{***}	11.44^{***}

Standardized coefficients are shown. N=112

*** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$; † $p \leq 0.10$; two-tailed tests.

Standardised regression coefficient of organisational processes/ mechanisms for NKN for Model 2a is significant and positive ($\beta=0.42^{***}$ at $p\leq0.001$ level), thus supporting the hypothesis H2a that better organisational processes/ mechanisms for NKN are positively related to better individual level outcomes. Organisational processes/ mechanisms for NKN explains 17% variation in the individual level outcomes. Standardised regression coefficient of the interaction between organisational processes/ mechanisms for NKN and need for ICT resources in Model 2b is significant and positive ($\beta=0.14^{\dagger}$ at $p\leq0.10$ level), thus weakly supporting the hypothesis H2b which states that need for ICT resources positively strengthens the relationship between organisational processes/ mechanisms for NKN and organisational level outcomes. Similarly, standardised regression coefficient of the interaction between

organisational processes/ mechanisms for NKN and ecosystem/ support for NKN in Model 2c is significant and positive (β=0.17† at p≤0.10 level), thus weakly supporting the hypothesis H2c which states that ecosystem or support for NKN positively strengthens the relationship between organisational processes/ mechanisms for NKN and organisational level outcomes.

Discussion

Strong relationship of organisational processes/ mechanisms for NKN in user institutes with both organisational and individual level outcomes shows its critical role. User institutes may underestimate the importance of organisational processes/ mechanisms and feel that ICT needs would create a pull factor for more usage of NKN resources. Our results show that pull factor may work for individual level outcomes but not for organisational level outcomes. Same is true for the support climate created by ecosystem for NKN. In the current dynamic and competitive environment in which institutes of higher education operate, well-defined ICT strategies are critical to make informed and effective decisions regarding ICT resources (Collis and Wende, 2002). Unfortunately, ICT implementation in institutes of higher education in developing countries is often done without proper planning (Sife, Lwoga and Sanga, 2007). Organisations may also struggle to understand what organisational mechanisms are required by their constituents and what mechanisms are suitable for their needs.

Bivariate analysis also shows that organisational processes/ mechanisms for development, adoption and implementation of NKN have stronger link with organisational level outcomes as compared to individual level outcomes. This provides stronger case for decision-makers in the institutes to proactively design and implement proper mechanisms for NKN rather than depend on individual initiatives to utilise NKN. On the other hand, institutes while developing mechanisms also need to ensure that sense of ownership is not lost (Sife, Lwoga and Sanga, 2007) and individuals are proactive in adopting ICT resources in their work. Mechanisms need to be in conceptual accordance with the multi-stage process map of the Rogers' Diffusion of Innovation Theory (Rogers, 2003) as applied in the context of ICT adoption and diffusion.

The link with individual level outcomes can also be improved by promoting ICT resources within the institutes. According to Stensaker, Maassen, Borgan, Oftebro and Karseth (2007), promotion of ICT resources within the organisation is a normative

assumption, not the reality. On similar lines, implementation of ICT resources in institutes of higher education seems to be based more on naïve optimism (Al-Senaidi, Lin and Poirot, 2009; Taylor, 1998) than actual scenario. Respondents of our study felt that more awareness regarding NKN needs to be created among faculty members, many of whom are not even aware about it or its advantages. Looking at it from the perspective of Technology Acceptance Model (Davis, 1989; Venkatesh, Morris, Davis, and Davis, 2003), both "perceived ease of use' and 'perceived usefulness can be increased through organisational mechanisms creating more awareness regarding NKN and facilitating its adoption.

The weak support of H2b and no support for H1b can be because ICT needs are not as readily recognised for learning purposes as physical and environmental constraints (Bullen, Morgan and Qayyum, 2011). Lack of awareness of ICT resources (Tusubira and Mulira, 2004) is one of the reasons for individual's lack of self-awareness of her/his ICT needs that would facilitate learning in higher education.

Respondents of our study felt that mechanisms and environment for collaboration requires to be strengthened and the potential of NKN in supporting collaborative work needs to be systematically encouraged. This would help in better realisation of organisational and individual objectives. The findings of our study clearly emphasise the need for institutes to emerge out of their cocoon of complacency and take proactive measures to establish institutional processes and mechanisms for NKN.

Conclusion

We have looked at the effect of organisational processes/ mechanisms for development, adoption and implementation of NKN in the institutes of higher education and research on the organisational and individual level outcomes in those institutes. Our findings show strong support for a positive relationship between organisational processes/ mechanisms and organisational level outcomes as well as between organisational processes/ mechanisms and individual level outcomes. We also found that need for high bandwidth and advanced computing resources and ecosystem or support for NKN in the user institutes positively strengthens the relationship between organisational processes/ mechanisms for NKN and individual level outcomes.

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