Integrated Framework for Increasing the Effectiveness of Knowledge Networks: Roles of Network Providers and Users

Rekha Jain
Manjari Singh

W.P. No. 2015-03-27
March 2015

INDIAN INSTITUTE OF MANAGEMENT
AHMEDABAD-380 015
INDIA

Integrated Framework for Increasing the Effectiveness of Knowledge Networks: Roles of Network Providers and Users

Rekha Jain
Executive Chair, IITCOE
Professor, Information Systems Area,
Indian Institute of Management Ahmedabad
E-mail: rekha@iimahd.ernet.in
Phone: +91-79-6632-4822
Fax: +91-79-2630-6896

Manjari Singh
Faculty
Personnel & Industrial Relations Area,
Indian Institute of Management Ahmedabad
E-mail: manjari@iimahd.ernet.in
Phone: +91-79-6632-4914
Fax: +91-79-2630-6896

Abstract

The National Knowledge Network (NKN) was set up to enhance collaboration amongst higher education (HE) and research institutes. The government of India implemented the NKN to provide connectivity to nearly 5000 institutions, including publicly funded higher education and research institutes. The objective of this paper is to provide an integrated framework for increasing the effectiveness of knowledge networks. We do this by identifying the organizational mechanisms, key processes and competencies required to support HE and research institutes in India that would enable them to exploit the public high speed National Knowledge Network. We examine this from the perspective of Knowledge Network Provider and User Institutes.

Key Words: National Knowledge Network; Organisational Mechanisms; Key Processes; Competencies; Higher Education Research Institutes.

----
[*]Authorship of the paper is in alphabetical order of their last names with both authors contributing equally

Acknowledgement of Funding Support and Research Assistance

**Integrated Framework for Increasing the Effectiveness of Knowledge Networks:
Roles of Network Providers and Users**

Introduction

India has aspirations to be a knowledge and service driven economy. Its research and higher education (HE) institutions will therefore play a key part in it. The role of knowledge infrastructure in the progress of the society is country specific (Cassi, et. al., 2008; Gupta and Gupta, 2012; Hanna, 2003; Martey, 2004; Thuvasethakul and Koanantakool, 2002) and government is an important actor. In India, government funding plays a very significant role in both the education and research segments. In its quest to achieve quality education for its population, the numbers of research and HE institutions have significantly increased. Interconnections among various geographically dispersed institutes are very critical to synergise the faculty, teaching, and research resources.

The National Knowledge Commission (NKC) recommended setting up a National Knowledge Network (NKN) to enhance collaboration amongst higher education (HE) and research institutes. The Government of India (GoI) implemented the NKN[1] to provide connectivity to nearly 5000 institutions, including publicly funded higher education and research institutes. However, our preliminary field visits to several institutes that had been connected to NKN, showed that while some users and user institutes had been able to exploit NKN, many users and user institutes were not aware of it. Many institutes were using it for augmenting their existing bandwidth, but unaware of the full scope of NKN, were not exploiting it for collaboration in research or distance learning.

Objectives

The objective of this paper is to provide an integrated framework for increasing the effectiveness of national knowledge networks. We do this by identifying the organizational mechanisms, key processes and competencies required to support HE and research centres in India that would enable them to exploit the public high speed National

---

[1] NKN refers to both the organization implementing the national ICT network and the national ICT network. The usage is clear from the context.

Knowledge Network. We examine this from the perspective of Knowledge Network Provider and User Institutes.

Literature Review

The use of distance education technology in HE has brought a tremendous change in reaching a wide range of audience and has the potential to influence it further (Dawson, et. al., 2010). ICT in HE helps in improving quality, widening access, cutting costs, especially in four areas of HE: research, community engagement, teaching and administration (Balasubramanian, et. al., 2009). For emerging economies such developments have significant value as due to poor availability of physical, financial and human resources, governments in these economies are not able to provide access to HE for large parts of their populations (Ng, et. al., 2006). In this context it is imperative to understand the role of national knowledge network infrastructure in facilitating HE and research.

Our literature review showed that while studies have looked at factors that contribute to increasing ICT adoption and use, both at the organization and individual level, there are few that deal with national ICT networks. The interesting part about national ICT networks is the role of the national ICT provider in relation to the user institutes. There are few studies that deal with the specific role of the network provider and user institutes. In the context of emerging economies, this aspect is especially important as user institutes have low institutional capabilities and digital literacy. Therefore, the national ICT network provider needs to play a more significant role. To understand this aspect, there is a need to have an integrating framework that examines key elements that influence adoption and usage both from the provider and user institutes' perspective. In order to develop our integrated framework, we examine existing frameworks. We give below a broad outline of research on ICT in HE.

a. Framework based on adoption and diffusion of technology: There are some studies that have looked at adoption and usage of ICT in HE context. Almost all of them have used Roger's framework of diffusion and adoption of technology (Nachmias, 2002; Ng, et. al., 2006). The contextualization of this framework has been done by (Nachmias, 2002) by considering the need for different frameworks to emerge as university types are different.

An open university versus a university that attempts to integrate existing in-class delivery with virtual resources is likely to have different needs. The study develops a three level framework as the macro, mezzo and the micro level. The macro deals with the institutional process of integrating Internet in campus teaching and learning and factors that enhance or inhibit such diffusion. The mezzo perspective focuses on changes in instructional process consequent to the technology implementation such as the emergence of collaborative learning, new ways of assessment, quality of communication, changes in roles of students or teachers etc. The micro level deals with the actual consequences of introducing on-line learning resources for students and teachers in specific courses. On the other hand, Ng et. al. (2006) has examined how capacity building for ICT integration needs to match the stage of diffusion and adoption of ICT.

Other studies of ICT network adoption of users in HE have highlighted various stages through which people in the organization go through during the adoption of technology and levels of use (Hall and Hord, 1987). Ely (1999) has highlighted the strategy for implementing innovations in instructional technologies. Further, the study identifies the conditions under which such innovations must be implemented for them to be successful, such as existence of knowledge and skills, availability of resources and time, existence of rewards or incentives, participation, commitment and leadership.

Other studies have highlighted the requirement-driven aspect in the adoption of ICT networks in organizations. Surry et. al. (2005) have identified the need for technology to enhance the educational goals of the college and continually assess whether technology is allowing the organization to enhance its learning outcomes. Such goals may enhance the learning experience by allowing dynamic interaction, reaching new student groups and developing new ways of serving existing students.

On another dimension, successful implementation and adoption of public ICT in any institution is dependent on the support from the government in funding the infrastructure (Dalgarno, et. al., 2011; Gichoya, 2005; Sife, et. al., 2007). Further, IT staff support has been identified as necessary for proper maintenance of the infrastructure and to guide or help the academic staff across the institution with technical problems and the usage of the new technology (Conole and Alevizou, 2010; Dalgarno, et. al., 2011; Newton, 2003).

Nachmias (2002) has highlighted the need for a central support centre for such initiatives, not only for troubleshooting but also for providing pedagogical and technical support to instructors. This will facilitate adoption and usage.

b. Frameworks for integrating educational technologies in higher learning institutes: Several studies have identified the challenges in integrating educational technologies in HE. Contributory factors include lack of systemic approach to ICT implementation, administrative support, including the critical role of top management, lack of well-conceived national and institutional policies, high cost of hardware and software, and absence of sustaining services and systems (Balasubramanian, et. al., 2009). Other factors include the role of institutional support, management support, resources (Dalgarno, et. al., 2011; Sife, et. al., 2007), increased workload and expenses (Nachmias, 2002). Awareness and attitude towards technology (Sife, et. al., 2007), inadequate infrastructure for access, support and training for sustaining technology, lack of high-level vision in administration about the role of technology (Gichoya, 2005; Newton, 2003) have been identified as barriers.

Acceptance and use of technology based teaching contributes to the issues in integrating educational technologies in HE. Factors that influence this aspect are training of teachers, incentives for using ICT, administrative support for teaching and institutional support (Newton, 2003).

Ng et. al. (2006) has identified the need to develop capacity on ICT integration amongst policy makers and teachers, based on the stages of ICT adoption and usage. Armstrong and Franklin (2008) have elaborated on integrating Web 2.0 and its impact in teaching and learning. The need to co-evolve pedagogy with technology has as an important determinant of success has been developed in (UNESCO, 2005).

On the theoretical side, Surry et. al. (2005) developed RIPPLES model for integrating instructional technologies in HE using resources, infrastructure, peoples, policies, learning, evaluation and support as the underlying elements.

Based on the above, recommendations for HE institutions have included a. the need to create awareness regarding the use and benefits of the technology, b. identification of specific ways in which application of ICT could be used for HE, c. enhancement of bandwidth/connectivity d. promotion of collaborations amongst HE institutions (Dalgarno, et. al., 2011; Newton, 2003), e. build the capacity of faculty and other relevant personnel on ICT. The ICT policy of HE institutions should i. provide frameworks for support of specific ICT projects ii. address individual needs of faculty, iii. training of staff, iv. take into account the existing ICT level in the institution, and v. incorporate new training technologies and their pedagogy, cost and technical implications.

The literature review revealed that though significant work had been done in ICT adoption and usage, it is an emerging field where certain perspectives have not been explored. For example, there were hardly any studies in the context of national knowledge infrastructure. There were hardly any studies in emerging economies. Based on our search, there were no papers that examined the infrastructure provider's perspective and how its organizational mechanisms could influence the user institutes. Most studies focused on developed countries. The studies were not specific to large networks and number of connected institutions. We believe that while the areas identified in the literature survey are important, the existing gap could have implications for deployment, adoption and usage of such networks. In emerging economies, it is more critical that national resources are leveraged effectively.

Our study attempts to bridge this gap by examining the organizational mechanisms, key processes and hence the competencies required at both the infrastructure provider's and the user institutes. Since institutional support in emerging economies is weak, the organizational mechanisms, key processes, and competencies at the infrastructure provider's end could complement or supplement those at the user end. For example, a framework for institutional support required for virtual libraries may be easier to support in a centralized way at the infrastructure providers end rather than letting it evolve from an emergent coalition of users as the latter may not have the required capabilities.

Multi-Stakeholder Approach for Assessing the National Knowledge Network

In our study, we covered research and educational organizations/institutes both at national level and at state level. We differentiated research institutes as those that had research programs and offered only doctoral programs, whereas educational institutes covered graduation, post-graduation and doctoral programs. This classification was based on the understanding that the requirements as well as usage of NKN would differ in these two categories of institutes. For example, the use of bandwidth for virtual classrooms is expected to be higher in educational institutes, whereas sharing massive amounts of data over the network is expected to be more in research institutes. Among the educational institutions, we covered engineering, science and management disciplines.

For assessing the NKN deployment and network infrastructure and usage, we covered both administrators and users. The administrators were nodal officers (staff appointed by the NKN in target institutes), IT staff and faculty managing the IT resources in the institutes, whereas the users were faculty and researchers using NKN and/or working on model projects. We considered two categories, namely administrators and users, to get a perspective both on the implementation issues and on usage issues.

Based on the above mentioned attributes, we conducted five focus group discussions (FGDs) and personal interviews (PIs) of head and other staff who were users of NKN, nodal officers and administrative persons of user institutes, and technical and administrative persons managing NKN. In all, we covered the following:

- One FGD each involving the heads of department (HODs) and senior and junior staff members from five premiere engineering, management and science institutes.
- Detailed individual interviews covering six HODs and a total of 30 individuals from all the selected institutes in India.
- Detailed interviews of technology and administrative persons managing the NKN at Delhi and Mumbai offices.

For the model projects we reviewed the Open Source Drug Discovery (OSDD) project of CSIR, New Delhi, Large Hadron Collider (LHC) at TIFR, Mumbai, and the E-Foundry project at IITB, Mumbai.

Key Findings

NKN is a very significant initiative of the GoI. It could be a path breaking system for HE and collaborative research. It had shown the potential for transforming both these aspects. NKN has been effectively working with a number of public-sector/government organizations to deliver a high-quality national ICT infrastructure. Given the criticality of this network for strengthening HE and research, the outcomes needed to be strengthened significantly.

Table 1 gives the strengths of the NKN that include its gigabit high speed, support for highly computing intensive infrastructure through GARUDA, robustness, the availability of the resources and the support from top-level management. The NKN provided an interactive platform for distance education. To encourage the usage of this network, the NKN had come up with an idea of model projects showcasing work that could leverage high-bandwidth or high computing intensive research.

Table 1: Strengths of National Knowledge Network of India

Strengths of National Knowledge Network
High availability of resources
Strong top level support from government
Capable and experienced implementing agency
Robust network
Motivated and competent people
Very high potential scope
Model projects
Very proactive in enlarging the user base
Providing opportunity to the public institutions through high-speed and high-bandwidth network
Planned network

Source: Authors' analysis

Research and educational institutions that required high bandwidth for research and teaching purposes were enabled for the same through NKN, which otherwise could have been unaffordable.

NKN had supported projects of national importance such as E-Foundry at IITB, LHC project at TIFR and OSDD project at CSIR. E-Foundry served professionals in the casting domain for accessing teaching content in casting design and simulation developed by IITB. The NKN made it possible for TIFR to access and work on large sets of data and provided connectivity to similar networks in Europe such as GEANT. The OSDD unit was able to develop collaborative platforms which enabled development of Bio/cheminformatics modules using in silico methods, which are critical for drug discovery (Bhardwaj, et. al., 2011). Using the NKN, IITB was able to provide distance learning modules to up to 74 centres and provide shared learning resources.

Although the NKN had connected a large number of institutes, we found out that not many individuals in these institutes were aware of its availability or had leveraged it to the maximum extent possible for academic purposes. Those who had made the most effective use of NKN were the ones who either already had some applications that required greater or lower cost bandwidth than what they had (IITB distance learning and e-Foundry) or were planning some applications but could not implement that due to lack of availability of high-end compute grid infrastructure which was available over NKN (CSIR-OSDD).

We assessed a possible competency gap among the nodal officers deployed at the user sites vis-à-vis their role at the designated institutes. Their backgrounds led to limited support in disseminating possible uses and methods for leveraging NKN. Further, their organizational position precluded them from participating in senior level or academic committees.

Some user institutes were constrained regarding the uniform bandwidth of the network and hence insufficient bandwidth during peak load hours which in turn defeated the purpose of providing high-speed network. The following were several process gaps at the user level in organizations connected to the network:

- Identification of content/online courses as part of curriculum was a challenge. A lot of progress has been made in some premier institutes in conducing virtual classrooms. However, processes for these had not evolved at both types of institutes, which led to second-level users either not having enough information or having too much information but no clear directions/factors for identifying required/needed content/process.

- Decisions regarding the virtual modules that could form a part of the curriculum needed to be taken in a systematic manner before the start of academic session so that curriculum may be planned and virtual teaching could be more effective. Often, this dissemination was not effectively done by first-level institutes.

- Administrative processes that supported virtual teaching or online content were not in place at user institutes.

- There were no specific committees to recognize the needs of educational and research institutes. There were no proper organizational mechanisms to oversee the collaborative learning and research.

- Organizational mechanisms both within NKN and HE and research institutes required extensive support in developing information, education and research strategies not only for HE and research but also for management aspects related to the two.

Framework for Increasing Effectiveness of National Knowledge Networks

Based on our findings, we developed our conceptual framework for the requisite organizational mechanisms, key processes and the competencies required in both the national ICT network provider and user institutes for increasing effectiveness of national knowledge networks. Within user institutes, we examined teaching and research institutes separately (Table 2).

Table 2: Increasing the Effectiveness of Knowledge Networks

Providers - Governing Body at the National Level and other Related Government Organisations	Organizational Mechanisms	Move away from a supply-driven to a demand-driven organization			
		Move towards a service orientation			
		Collaborative forums of users			
		Governance Structure	Common Committees: - Infrastructure and resources committee - Coordination committee	Education	Institutional committee for supporting distance/virtual education
					Committee for learning and teaching through ICT
				Research	Institutional committee for research support
					Committee for developing research support resources
					Committee for coordination across research groups
	Key Processes	Processes for information dissemination to users/institutes			
		Processes regarding user institutes	Processes for building collaborative relationship with top management of user institute		
			Processes for creating and managing user forums		
			Processes for incorporation of feedback		
			Processes for incentivising usage		
			Processes for interfacing with user institute		
	Competency Requirements	Leadership skills to influence both providers and users			
		An orientation to review various processes			
		Academic expertise to provide content related advice to user institutes			
		Administrative expertise to provide advice to user institutes on administrative processes for knowledge networks			
		Technical expertise to supervise network infrastructure implementation			
		Project management skills to supervise network infrastructure implementation			
		Technical expertise to provide technical advice to user institutes			
		Content expertise to manage interactive forums/blogs			
		Technical expertise to manage interactive forums/blogs			

Users - Academic Institutes	Organizational Mechanisms	Education	On-line education content facilitation committee
		Research	On-line research resources facilitation committee
	Key Processes	Education	Administrative processes that support virtual teaching or online content at user institutes (for example, support for uploading and managing content and facilities for searching and archiving content)
			Administrative processes for faculty involved in virtual teaching (for example, credit calculation in faculty performance management system)
			Teaching assistance and monitoring process required at second-level institutes for supporting students
			Learning evaluation process for virtual classrooms
		Research	Processes for managing the configuration, version and change management of downloadable research tools.
			Processes for audit trails of intellectual property usage.
			Processes for support for researchers in usage of tools.
	Competency Requirements	Education	Subject matter expertise for content building & delivery
			Academic expertise for content review
			Expertise for educational technology
			Technical expertise of knowledge network infrastructure
			Administrative support for delivery and maintenance of digital content and online resources
		Research	Subject matter expertise for knowledge creation
			Academic expertise for inter-institutional coordination
			Technical expertise of knowledge network infrastructure
			Administrative support for content transfer and maintenance

Source: Authors' analysis

Our recommendations are divided into two parts. The first part deals with NKN and other related stakeholders and the second one with user organizations/institutes. We have done the analysis for Knowledge Network Providers such as the HLC for NKN and User Institutes.

A. Recommendations for Providers

The related stakeholders in this context are mostly government departments and ministries. User institutes are covered in the next section.

1. *Organizational Mechanisms*

a. *Move away from a supply-driven to a demand-driven organization:* NKN's perspective was predominantly supply driven. However, from a review of the interviews and FGDs, it was clear that a demand focus based on the type of organization it was serving would enable its resources to be leveraged more effectively in the national interest. In order to highlight this point, we considered the example of Joint Academic Network (JANET) in UK. It was recognized that institutions that support identification of relevant areas of work and promote innovative use of ICT in curriculum and research would accelerate adoption and usage of a public infrastructure. Therefore, Joint Information Systems Committee (JISC), a UK non-departmental public body which had oversight over JANET and supported HE and research had committees that provided support for learning, teaching and research ("JISC", 2015). This showed a recognition that the needs of educational and research institutes were likely to be different. It a similar vein, NKN along with related stakeholders could focus on mobilizing setting up committees each entrusted with a specific user group.

b. *Move towards a Service Orientation:* NKN should look beyond its current focus on infrastructure provision and support of generic applications such as security and authentication to the service aspect. Well-developed networks such as JANET provide shared services as administrative resources for educational institutes

connected to it. JANET also provides access to centralized library resources, consulting advice on procurement, websites development and capacity planning. NKN or any technical agency related to NKN could plan for similar scope. The following types of shared services could be provided:

- As in JANET, the NKN should become the underlying ICT network of choice and possible service provider for administrative support to HE and research institutes[2]. This will lower the cost of services across public institutions and increase the uptake of NKN.

- It should support tools and structures for domain-specific knowledge creation and dissemination, such as development of ontologies. Semantic representation tools would accelerate the knowledge generation process, enabling innovations to leverage knowledge across different domains (Armstrong and Franklin, 2008).

- With increasing focus on mobiles/tablets, NKN should develop to provision services on these devices.

- NKN should link a number of public institutes and organizations such as those in the broadcasting culture and arts that require high bandwidth. This would increase the quality of experience for other NKN users such as university students and staff who may like to access and use this resource. This would create greater linkages for institutes to remain on the network.

c. *Collaborative Forums of Users*: NKN should design a forum for users for sharing best practices, etc. This would help NKN to get early feedback and also facilitate users to find solutions to common problems. This would also enable users to get ideas and information on other projects.

d. *Governance Structure:* The governance structure of the future should reflect the requirements of its different communities. Currently, HLC-NKN consists of funding arms of the government. NKN would need to ensure more effective participation and broader representation from different organizations and possible funders in the future. The existing governance structure of NKN only partly

---

[2] Examples include ERP systems for HE administration.

reflects this. The HLC has representation from the OSDD project, radio-physics, electronics and nuclear science. But this representation is not formalized as a part of the design. It is not clear that the HLC has a formal design or specified designated positions for research and teaching communities separately. For example, one of the objectives of NKN was to develop the brain and cancer grids. There should be designated positions for representing such domains. This organizational structure then must be represented in the executive and TACs as well.

The governance structure of NKN should also reflect the requirements of the two broad communities - Education and Research institutes it works with. While there may be requirements that are common across both, there are some that are specific to each. Based on the above we suggest that the following sub-committees be formed.

- Common Committees
    i. Committee for Infrastructure and Resources: This would be common across both communities. It would ensure availability of cost-effective solutions across all network elements from connectivity to devices.
    ii. Coordination Committee: This committee would coordinate across chairs of various committees.

- *Support Development of Communities for Research*: In order for NKN to facilitate the creation of different types of virtual domain-specific networks or knowledge/research communities and hence a niche for itself, it must increase its focus on the needs of the Indian context. For example, in the existing cancer, brain and climate change grids it should focus on those areas, where research is India specific. This way it could leverage the existing global grids in these areas more effectively. It would encourage Indian researchers to join such networks. In such cases, NKN's role would be to provide requisite bandwidth and computational tools for researchers. Those aspects of such research say in cancer, which arise because of the specificity of the Indian context, could be supported by NKN, not only through provision of high

bandwidth and computational support across partnering institutions but also through sharing experience of successful projects and the processes adopted by them for maintaining workflow, databases and ontologies.

Another dimension to consider when examining the growth of domain-specific knowledge clusters or communities' vis-à-vis their scope is that there is increasing recognition that such networks need to be diverse. A narrow scope leads to problems. Knowledge transfers in proximate clusters (not in terms of geographical distance but in terms of overlap of content) lead to greater innovation. The provision of support for diverse communities would greatly accelerate the development phase.

While inter-institute collaboration/information sharing is likely to be an emergent phenomenon, the NKN could facilitate this by providing tools that help in managing such virtual networks, for example, DAE had leveraged NKN to form its virtual network by connecting to all IITs. The NKN could support such user initiatives by providing appropriate tools for sharing, security and authentication within the group.

While core groups working on research problems may have developed their own processes and systems for communication, the same for inter-group communication may not be well developed. Since greater leverage of NKN is possible in areas that are multi-disciplinary it may also be useful to find ways of bringing together researchers of different disciplines. While user forum is one of the ways in making it possible and it would be more beneficial if these user forums are interactive (a more powerful way is to identify the role of a knowledge broker/brokers for NKN).

The role of a knowledge broker – an entity that facilitates knowledge exchange or sharing between and amongst researchers, practitioners, and policy makers is critical for the creation of new knowledge and innovation (Meyer, 2010). Such knowledge brokers could also look at common tools and techniques that have been developed in a specific domain for their applicability to other

domains. Knowledge brokers not only have cross-domain knowledge (such as a person working on brain cancers, who understands the aspect of brain structure, physiology and so on, is associated say with the ontologies related to the brain as well as with those related to cancer) but also have a perspective on computational aspects of creating, storing, and maintaining such ontologies. For example, the China Knowledge Grid Research Group has developed evolving semantic reasoning tools to link different types of reasoning and contextualize it to the background (Zhuge, 2004).

- *Support Development of Communities for Education:* NKN and other stakeholders need to create mechanisms for institutions to develop quality and cost effective support for interactive learning. Such a design should be flexible and scalable. While technological advances are embedded in NKN's offerings, individual institutes need to work towards being able to leverage resources made available through NKN. It should be NKN's or related stakeholders' responsibility to work closely with lead institutes to develop best practices and dissemination strategies. User institutes would need to bring about changes in pedagogy and skills required at their end. At NKN end, there is a need to ensure that it supports integration of its tools on those platforms available at HE and research institutes.

- Education
  i. Institutional Committee for Supporting Distance/Virtual Education: This committee would provide guidance on the institutional support required for providing distance education to those institutes that want to offer the same.
  ii. Committee for Learning and Teaching through ICT: This committee would support development of mechanisms and tools for teachers and students to leverage ICT effectively.

- Research
  i. Institutional Committee for Supporting Research: This committee would provide guidance on the institutional support required for the research

community through facilitating setting up of inter-institutional linkages for collaborative research.

ii. Committee for Developing Research Support Resources: This committee would enable development of research tools, workflows and domain specific ontologies.

iii. Committee for Coordination across Research Groups: This committee would enable development of cross domain ontologies and help to build linkages across common research areas.

2. *Key Processes*

Our analysis showed that NKN needed to review its processes regarding information dissemination and encouraging usage. While NKN had connected a large number of institutes, our research showed that not many individuals in these institutes were aware of its availability or had leveraged it to the maximum extent possible for academic purposes. Those who had made the most effective use of NKN were the ones who either already had some applications which required greater or lower cost bandwidth than what they had (IITB distance learning and e-foundry) or the ones who were planning some applications but could not implement that due to lack of existing availability of high-end compute grid infrastructure which was overcome by using NKN (CSIR-OSDD).

While NKN was aware of the need to widen the user base so that its potential could be properly utilized, it is important to have a time-bound mechanism for showcasing model projects and also for making the users aware.

We give below some key processes.

a. *Information Dissemination to Users/Institutes*

- NKN disseminated information mainly through its workshops where it invited possible/potential user groups along with current users. However, many potential users who were not able to understand the advantages of NKN may

not attend such workshops. It may be more useful if NKN showcased its applications in other events or conferences where possible/potential users may be present.

- There was more likelihood of people getting interested in NKN if there were some talks or seminar given on it by very-high-profile individuals. NKN may not be able to attract people on its own but audience may be interested in attending talks by high-profile people in the course of which they would come to know about NKN and were more comfortable using it in future. To some extent, NKN was doing this but may need to draw in more frequently and involve more high-profile individuals for this task, even those not directly involved with NKN.

- NKN had been sending emails for dissemination of its various activities. However, these may not be an effective medium of communication as users may not understand the implications of NKN deployment and its benefits only by reading emails. Emails may be ignored as possible spam, unless it comes from a trusted source. In this era of information deluge, readers have become more selective about what they want to read. Unless NKN came up with a more creative way of disseminating this information to attract users at first sight, emails may not be so effective.

- NKN regularly held workshops in various regions where users shared their concerns as well as opportunities available to them through NKN. It may be a good idea that minutes of such meetings were more widely available through website or other sources to even those who were not part of those meetings. These may also be put in the form of FAQ in the NKN website. This site should be promoted on various research and teaching forums.

- If possible, the NKN link should be available prominently on the website of the user institute. The NKN should make it a condition for user institute to provide a status report about use of NKN on their website. This should form the part of MOU sign between user institute and NKN.

b. *Processes Regarding User Institutes*

- *Build collaborative relationship with top management of user institute:* Nodal officers were not at high enough levels to facilitate information dissemination to potential users, particularly in large organizations, though they were considered as key resources by NKN. Therefore, it needs to develop a mechanism to involve higher levels of management of user institutes and build collaborative relationship.

- *Creation of user forums:* These should be created on the website. These can bring together researchers so as to facilitate collaborative trouble shooting and sharing of ideas.

- *Incorporation of feedback:* Given the positioning of nodal officers, they could take up the issues of either disseminating information regarding NKN, its usage or integrating it with the teaching/research activities of the concerned institute. NKN and other stakeholders of NKN could do this by involving several institutes and developing a workable plan, reviewing and monitoring types of usage and facilitating further adoption.

- *Incentivising usage:* NKN could encourage usage by having a process for categorizing and incentivizing usage along the lines of frequent flyer program of airlines. The basic tier could be Bronze and would largely depend on usage. The Silver members could be those with very high usage and who have also successfully developed special applications. Gold members meet the criteria of Silver members and are also instrumental in promoting the usage of NKN to various institutes through its applications. There can be special category (e.g. high-potential user focus group) for the institutes that have very high potential for use but lack the support mechanisms/IT expertise). There can also be a category for users in small towns/rural areas called developing area users focus group. These different categories could get additional benefits based on their on-going usage.

- *Interfacing with a user institute:* NIC needs to create a position of a manager who can interact with the user institutes or strengthen existing project implementation units to identify the needs of the institutes and formulate a proper MOU with them. He or she should also be capable of identifying the

process bottlenecks in the user institutes and give suggestions to deal with emerging issues. The other position should be a person who can handle interactive blogs and forums which needs to be created on the NKN website.

3. *Competency Requirements*

At the national level the following competencies need to an integral part of NKN. These emerge from the analysis above.

a. *Leadership skills to influence both providers and users:* This is required not only at the highest level but also at Nodal officer level. At the highest level, the competency could lead to effective uptake and usage of NKN. At the nodal level officer level, this could lead to higher adoption by removing process related dysfunctionalities at both NKN and user end.

b. *An orientation to review various processes* is required to enable incorporation of feedback at various levels from user institutes in NKN offerings.

c. NKN should have the -

- *Academic expertise to provide content related advice to user institutes*. This would enable user institutes to identify relevant content that is amenable for sharing.

- *Administrative expertise to provide advice to user institutes on administrative processes for knowledge networks.* User institutes may need advice on setting up relevant administrative processes for using NKN.

- *Technical expertise to supervise network infrastructure implementation.*

- *Project management skills to supervise network infrastructure implementation*

- *Technical expertise to provide technical advice to user institutes*

- *Content expertise to manage interactive forums/blogs*

- *Technical expertise to manage interactive forums/blogs*

B. Recommendations for User Institutes

Our recommendations in this area have emerged from a context of low user awareness and usage of NKN. As the awareness and usage of NKN improves, other issues regarding processes at user institutes may come forth.

At the user end, we analysed processes that need to be reviewed for enhanced adoption and usage of NKN. To leverage the facilities and features provided by NKN, user institutes may need to design new processes or change existing ones. Our study showed that few organizations had adequate focus on the same. Further, adequate organizational mechanisms, such as academician/committee to align curriculum, selection and identification of content, content check and to assess outcomes that should comprise faculty members and students from both types of institutes, need to be in place. Where mechanisms existed, they were very sketchy. For example, we came across only one educational institute – IITB that had educational technology experts to train faculty for virtual teaching. The following provides the key aspects of user side processes for education and research organizations.

1. *Organizational Mechanisms*

    a. *Educational Institutes*

- On-line Content Facilitation Committee: The scope of this committee would include the following:
  - i. Planned and systematic curriculum design before the start of academic session by the first-level (delivering) institutes: Decisions regarding the virtual modules that could form a part of the curriculum need to be taken in a systematic manner before the start of academic session so that curriculum may be planned and virtual teaching can be more effective. Often, this dissemination was not effectively done by first-level institutes.
  - ii. Support for the second-level users (recipients) for effective and planned utilisation of educational resources in a sustainable manner: Often second level institutes had no planned mechanism for leveraging on-line resources.

They may need support, for example, for identification of content/online courses as part of curriculum.

iii. Support for the funding and certification for such programs needed to be formalized. Identification of content/online courses as part of curriculum is a challenge. There has been a lot of progress in conducting virtual classrooms in premier institutes; however, detailed processes, best practices and guidance for instructors and staff responsible for conducting such classes are sparse. This does not allow the second-level users to start such activities on their own in a sustainable way.

iv. To create demand orientation rather than the current supply-driven perspective in the development of course content: The content chosen by the first-level (delivering) institutes may not be relevant to the second-level (recipient) institutes. Therefore, second-level users (recipients) should have a significant say in the design of such content. There is a need to create a demand orientation in development of such content and move beyond the current supply-driven perspective. Therefore, a rating mechanism that evaluates content based on relevance may need to be put in place. Thus a process for systematic and continuous inputs from the second-level users (recipients) to first-level (delivering) institutes needed to be put in place.

v. Mechanisms to convert faculty interest in online resources to actual practice: There were hardly any processes to guide institutes or groups of faculty members to convert their interest into practice.

b. *Research Institutes:* Organizational mechanisms in Research Institutes include the following:

- On-line Resources Facilitation Committee: The scope of this committee would include the following:

  i. Ensuring that the user institute had adequate infrastructure to support usage of on-line resources in terms of bandwidth, computing resources and personnel.

  ii. Developing institutional processes for leveraging existing on-line content for the institute. The committee should lay down guidelines for access and

usage such as entities responsible for uploading shared resources, maintaining integrity of data, testing and validating.

iii.Encouraging use of existing tools, work-flows and ontologies and supporting re-usable components.

iv.Putting processes that encourage early sharing of intellectual property.

2. *Key Processes*

a. *Educational Institutes*

- Administrative processes that support virtual teaching or online content were not in place at user institutes. Key processes that support the following would be required:

  i. Support Virtual teaching or online content: Faculty may need support for uploading and managing content and training on usage of facilities for searching and archiving content.

  ii. Faculty involved in virtual teaching: Processes regarding giving credits to faculty for virtual teaching may need to be properly designed to incentivize participation in virtual classrooms and for generation of online content.

  iii.Teaching using virtual resources: Teaching assistance and monitoring processes are required at second-level institutes for supporting students. Student submissions and evaluations in such situations also need to be properly designed. Teaching assistants and monitoring process may be required at second-level institutes for supporting individual students.

  iv.Learning evaluation process for virtual classrooms: New processes may need to be designed or existing ones may need to be modified for evaluating learners performance in a virtual environment.

b. *Research Institutes*

Research institutes did not have organizational processes to leverage on-line resources or collaboration. Key processes that support the following would be required:

- Managing the configuration, version and change management of downloadable research tools.
- Audit trails of intellectual property usage.
- Support for researchers in usage of tools.

3. Competency Requirements

Many research organizations/institutes deploying NKN and its services may not have the required competencies to leverage the features and facilities provided by NKN. For example, to deploy virtual classrooms, institutes may require an educational technology expert who could help faculty members that wish to use virtual classrooms in integrating various tools to integrate their teaching resources to make them amenable for distance learning.

Based on the organizational mechanisms and processes at User institutes, we identified the following competencies:

a. Educational Institutes

- Subject matter expertise for content building review and delivery
- Expertise in integrating educational technology with content
- Technical expertise of knowledge network infrastructure
- Administrative support for delivery and maintenance of digital content and online resources

b. Research Institutes

- Subject matter expertise for knowledge creation
- Academic expertise for inter-institutional coordination
- Technical expertise of knowledge network infrastructure
- Administrative support for content transfer and maintenance

Summary and Conclusions

We identified the organizational mechanisms, key processes and competencies required to support innovation in HE and research centres in India that would enable them to exploit the public high speed National Knowledge Network. We examined this from the perspective of Knowledge Network Provider and User Institutes. Our analysis identified that it was important both for the Knowledge Network provider to have the requisite organizational mechanisms, processes and competencies to enable the user institutes to make more effective use of its networks. The perspective of moving away from supply driven to demand orientation would help the knowledge network provider to facilitate adoption and usage. A well designed governance mechanism both at the knowledge infrastructure provider and user institute was essential. It was important that the required organizational mechanisms, processes and competencies were available at user institutes as well.

This paper gives specific recommendations on the dimensions identified above. While this work has been done in India, we believe that it has wider applicability amongst emerging economies, as they share several common attributes with the Indian situation namely low resource availability, poor institutional infrastructure and low levels of digital literacy, among others.

References

1. Armstrong, J., and Franklin, T. (2008). A review of current and developing international practice in the use of social networking (Web 2.0) in higher education, *A report commissioned by the Committee of enquiry into the Changing Learner Experience*. Retrieved from http://www.franklin-consulting.co.uk/LinkedDocuments/the%20use%20of%20social%20networking%20in%20HE.pdf, accessed on March 5, 2015.

2. Balasubramanian, K., Clarke-Okah, W., Daniel, J., Ferreira, F., Kanwar, A., Kwan, A., Lesperance, J., Mallet, J., Umar, A., and West, P. (2009). ICT for Higher education, *the UNESCO world conference on higher education*, Paris, July 6-8, 2009. Retrieved from http://unesdoc.unesco.org/images/0018/001832/183207e.pdf, accessed on February 20, 2015.

3. Bhardwaj, A., Scaria, V., Raghava, G. P., Lynn, A. M., Chandra, N., Banerjee, S., Raghunandanan, M. V., Pandey, V., Taneja, B., Yadav, J., Dash, D., Bhattacharya, J., Misra, A., Kumar, A., Ramachandran, S., and Thomas, Z. (2011). Open source drug discovery - A new paradigm of collaborative research in tuberculosis drug development, *Tuberculosis*, 91(5), 479-86. doi:10.1016/j.tube.2011.06.004.

4. Cassi, L., Corrocher, N., Malerba, F., and Vonortas, N. (2008). Research Networks as Infrastructure for Knowledge Diffusion in European Regions, *Economics of Innovation and New Technology*, 17(7-8), 663-676.

5. Conole, G., and Alevizou, P. (2010). A literature review of the use of Web 2.0 tools in Higher Education, *A report commissioned by the Higher Education Academy,* August 2010.

6. Dalgarno, B., Lee, M. J. W., Carlson, L., Gregory, S., and Tynan, B. (2011). Institutional support for and barriers to the use of 3D immersive virtual worlds in higher education, *proceedings ascilite Hobart 2011*, 316–330, December 2011.

7. Dawson, S., Heathcote, L., and Poole, G. (2010). Harnessing ICT potential: The adaptation and analysis of ICT systems for enhancing the student learning experience, *International Journal of Educational Management*, 24(2), 116–128.

8. Ely, D. P. (1999). New perspectives on the implementation of educational technology Innovations, *paper delivered at the Association for Educational Communications and*

Technology   Annual   Conference,   Houston.   Retrieved   from http://files.eric.ed.gov/fulltext/ED427775.pdf, accessed on March 20, 2015.

9. Gichoya, D. (2005). Factors affecting the successful implementation of ICT projects in government, *The Electronic Journal of e-Government*, 3(4), 175-184.

10. Gupta, D., and Gupta, N. (2012). Higher Education in India: Structure, Statistics and Challenges, *Journal of Education and Practice*, 3(2), 17-24.

11. Hall, G., and Hord, S. (1987). *Change in schools: Facilitating the process*. Albany, NY: SUNY Press.

12. Hanna, N. K. (2003). Why National Strategies are needed for ICT-enabled Development, *ISG   Staff   Working   Papers*,   No.   3,   June   2003.   Retrieved fromhttp://wsispapers.choike.org/national_strategies.pdf, accessed on March 20, 2015.

13. JISC.   (n.d.).   In   *Wikipedia*.   Retrieved   March   25,   2015,   from http://en.wikipedia.org/wiki/Jisc.

14. Martey, A. (2004). ICT in Distance Education in Ghana, *Library Hi Tech News*, 21(5), 16-18.

15. Meyer, M. (2010). The Rise of the Knowledge Broker, *Science Communication*, 32(1) 118-127.

16. Nachmian, R. (2002). A research framework for the study of a campus-wide web-based academic instruction project, *Computers and Education*, 5, 213-229.

17. Newton, R. (2003). Staff attitudes to the development and delivery of e-learning, *New Library World*, 104(10), 412-425.

18. Ng, W., Miao, F., and Lee, M. (2006). Capacity-building for ICT integration in Education, *Digital Review of Asia Pacific 2009–2010*, 67-76.

19. Sife, A. S., Lwoga E. T., and Sanga, C. (2007). New technologies for teaching and learning: Challenges for higher learning institutions in developing countries, *International Journal of Education and Development using Information and Communication Technology (IJEDICT)*, 3(2), 57–67.

20. Surry, D. W., Ensminger, D. C., and Haab, M. (2005). A model for integrating instructional technology into higher education, *British Journal of Educational Technology*, 36, 327–329.

21. Thuvasethakul, C., and Koanantakool, T. (2002). National ICT Policy in Thailand, *presented at Africa-Asia Workshop Promoting Co-operation in Information and Communications Technologies Development*, Malaysia, March 25-29, 2002. Retrieved

from http://www.nectec.or.th/users/htk/publish/20020302-National-ICT-Policy-v16-word.pdf, accessed on March 19, 2015.

22. UNESCO. (2005). Regional Guidelines on Teacher Development for Pedagogy-Technology Integration, *based on a Series of Workshops in Pedagogy-Technology Integration organized by UNESCO Asia and Pacific Regional Bureau for Education.* Retrieved from http://unesdoc.unesco.org/images/0014/001405/140577e.pdf, accessed on March 20, 2015.

23. Zhuge, H. (2004). China's E-Science Knowledge Grid Environment, *IEEE Computer Society*, January/February 2004.