

Information Infrastructure: Basics, Nature and Technological Aspects - A Review

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ABSTRACT

In modern time, Information is most important and valuable part of everything. Therefore Information is required in different areas, sectors, industries and so on. Proper Management techniques and technologies are applicable in healthy and improved Information practice. Information Management plays an important role in Information Infrastructure Management. Information is rising rapidly, hence proper mechanism is highly solicited for the timely changes in Information Systems. Here healthy Information Infrastructure (II) may be considered as good alternative in respect of IT Infrastructure as II considered as broad concept with larger periphery for manual information management. Information Infrastructure is dealing with technological and manual stakeholders and primarily consists with the Networking, Database, Web related and Multimedia Infrastructure for the healthy ICT Infrastructure Management. The emerging technologies viz. Cloud Computing, Big Data, HCI Based Systems, Robotics and so on, are also useful in proper, healthy and developed Information Infrastructure building. This is a scientific documentation with reference to review of literature on the topic of Information Infrastructure with the basics of evolution, basic meanings, stakeholders and so on. It also depicts the Information Infrastructure with technological aspect.

Keywords: Information Infrastructure, IT, Computing, Information Governance, Information Management, Content Management, Review of Literature

Information Infrastructure is very important in healthy Information Management. As per the literature survey it has been studied the characteristics, nature and stakeholders of Information Infrastructure. Information Infrastructure is a broad area. It deals with various kinds of component viz. information, knowledge, data and so on. Information Infrastructure plays a leading role in all the fields. Information

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Infrastructure may be manual or Computational Information Infrastructure. Various tools, systems are also important in Manual Information Infrastructure.

Human Resources are needed in healthy Information Infrastructure.

Information is considered as an important and valuable tool for the work, success and development. Therefore proper Information Infrastructure in technological and manual means can provide the information solutions. It can enhance the organizations performance. However there is less awareness about Information Infrastructure, only IT Infrastructure is generally considered important. Since Information Infrastructure comes with both manual and technological solutions, therefore there is a need for proper involvement, initiative, planning, manpower development is required for healthy information solutions.

Objective of the work

The present work is a review of literature and theoretical in nature with following objectives—

- ❖ To get an idea about the Information Infrastructure such as its meaning, concepts as well as evolution.
- ❖ To know about the expert opinion on Information Infrastructure given by eminent experts.
- ❖ To gain knowledge about the basic concepts of Infrastructure including nature, and characteristics of the Information Infrastructure.
- ❖ To know about the similar area and concept i.e. Data Infrastructure with basics, nature and stakeholders.
- ❖ To gather knowledge on IT/ ICT Infrastructure including on allied components as well as emerging technologies.

Review of Literature

Review of literature is the source of the knowledge and that includes various types of primary sources, secondary sources and tertiary sources and here for the completion of the work such sources are gathered, consulted and reported.

Method Adopted

The present work entitled ‘Information Infrastructure: Basics, Nature and Technological Aspects—A Review’ is a kind of literature review and mainly prepared with the published works mainly research papers, case studies, books etc. The expert opinion, views on the topic has been analyzed and reported here. Major findings on Information Infrastructure have gathered from the expert views and it has been depicted here chronologically whereas all the sources had been provided here with APA Style manual at the end.

Information Infrastructure: Foundation Aspects, Characteristics and Nature

Information Infrastructure is consists with the information and other technological systems for better

information activities. Information is needed in different activities, establishments, or organizations and applicable in Government, Public, Private sectors. Further, it may be Profit Making or non Profit Making and it is also applicable in different types of organization. Earlier only manual information related activities are performed by the documentation centre, or data centre. Information Infrastructure is dedicated for various types of information needed in various organizations with the proper computational and IT systems to the entire arena of traditional information establishments. Since Information Infrastructure is about Information, therefore it is deals with different types of data in an organization. According to Mach lap “information is piecemeal, fragmented, particular, whereas knowledge is structural coherent and universal; information is timely transitory perhaps even ephemeral whereas knowledge is of enduring significance; information is flow of message, whereas knowledge is a stock, largely resulting from the flow, in the sense that the input of information may affect the stock of knowledge by adding to it, restructuring it or changing it in any way. The basic characteristics of information is the following—

- ❖ *information is a flow of message.*
- ❖ *information is a transitory by nature.*
- ❖ *information is dynamics.*
- ❖ *information inherits meaning.*
- ❖ *information is a particular.*
- ❖ *information is fragmented.*
- ❖ *information is timely.*

The concept of information is closely related to notions of constraint, communication, control, data, form, instruction, knowledge, meaning, mental stimulus, pattern, perception, and representation. As Information Infrastructure is deals with the concept of Infrastructure therefore following are treated as the infrastructure in generally—

- ❖ Economic Infrastructure,
- ❖ Healthcare Infrastructure,
- ❖ Social system Infrastructure,
- ❖ Educational Infrastructure,
- ❖ Agricultural Infrastructure,
- ❖ Research Infrastructure,
- ❖ Commercial Infrastructure and so on.

According to the Ciborra, Claudio and Hanseth, Ole (1998), the concept of Infrastructure is changing rapidly with various developments.

Generally Infrastructure is deemed as physical Infrastructure though in recent past Infrastructure also considered as a logical entity like Intellectual Infrastructure. In 1875, the term first coined in French and in English it was coined in the year 1887, as far as English is concerned it is the installation of any

operation and system. Infrastructure broadly classified into the Hard Infrastructure and Soft Infrastructure. As depicted in Fig. 1 for more clarification.

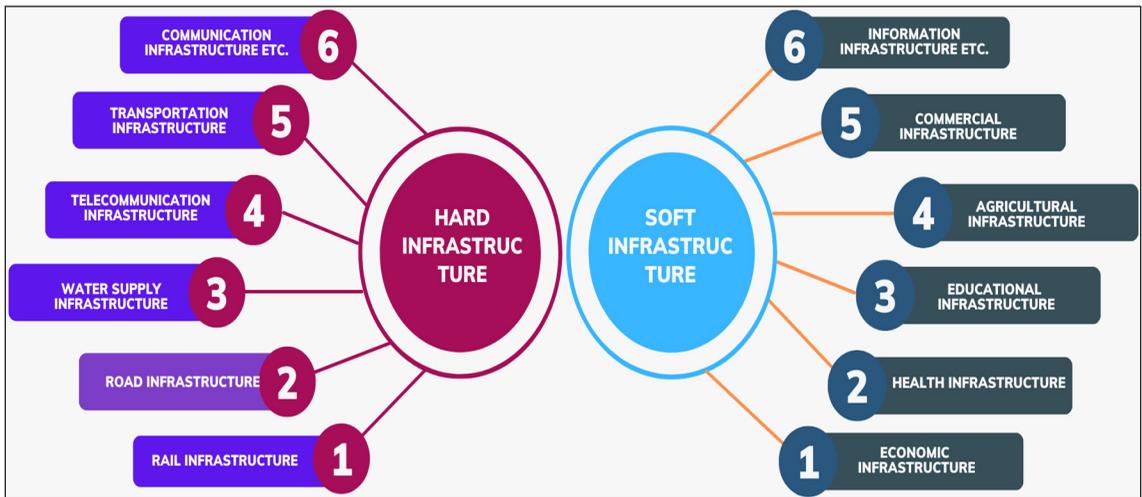


Fig. 1: Broad Category of Infrastructure

Information Infrastructure is an emerging term and the concept may varies from country to country which can be classifies as developing countries and undeveloped countries. The development of a country depends on quality Infrastructure and in many contexts these are governed by the Government bodies with smaller scale Infrastructure under the private undertaking. It is comes from the term/word (Latin root) ‘Infra’ conveys the concept of ‘Bellow’. Some experts argues apart from the Soft Infrastructure and Hard Infrastructure another valuable is Critical Infrastructure viz. public health, agriculture etc.

Depending upon organization, institutions and individuals the meaning of Information Infrastructure is different viz. Ciborra and Hanseth (1998), Information Infrastructure can as formative context shape not only the work routine but also the way peoples look at practiced consider them natural and give them their overarching character of necessity. Infrastructure becomes an essential factor for any organization.

Henseth (2002), expressed that ‘Information Infrastructure is a share evolving open standardize and heterogeneous installed based. Hence after analyzing the word it can be expressed that all kind of entities and objects may considered as communication network that are associated with the software utilization of technologies in common people and organization. Further there is a misconception of the Information Infrastructure that it is restricted in internet context only. However it is more than that and even it could be beyond technological concentration or affiliation. Prironti (2006), provides importance of the HR also into this and in his word ‘As all of people process, procedure, tools, facilities and technology with support the creation, use, transport, storage and destruction of Information. Whereas Braetal (2007) defines with a little different as ‘Information Infrastructure is the technological and human component, network systems and process that continued to the functioning of the health information systems.

As far as the opinion of Edward (2007), is concerned, it is the set of organization practice, technological infrastructure and social norms that collectively provides for the smooth operation of scientific work at a distance. The perception of Information Infrastructure is also changed from time to time. Even the some

author or experts have changed their perception regarding Information Infrastructure. If we analyze the definition of Hanseth other than in 2002 then we could follow these as follows.

However according to Greer (2007) The information infrastructure is a global network of people, organizations, agencies, policies, processes, and technologies organized in a loosely coordinated system to enhance the creation, production, dissemination, organization, storage, retrieval, and preservation of information and knowledge for people. The primary objective of this network is the diffusion of knowledge for a society. Whereas this definition focused with community, society or people centric and Information Infrastructure should hold the social organization technologies even some cases political factors according to recent researcher Information Infrastructure is beyond the technological application and include innovation in the Information Infrastructure sector or Information sector.

Hanseth and Lyytinen (2008) ‘A Shared evolving heterogenous install based Information Technology capabilities developed on open and standardize interface. In the year 1994 with the National Information Initiative in United States under Clinton administration period the context of National Information Infrastructure was first emerged. Here the term was defined as an Infrastructure that supports the Information Society: the equipment, systems, application support system and so forth that are needed for operating in the Information Society.

National Information Infrastructure hyper dictionary defines it is a Future Integrated communication in the USA. The National Information Infrastructure is Pan USA network of networks which allow all American to take advantage of Nation’s Information, Communication and Computing resources. The definition of the Council on Foreign Relation in cooperation with the Marlle Foundation expressed as the computers and communication lines underlying critical services that American society has come to depends on financial networks, the power grid, transportation, emergency services, governmental services, information infrastructure includes the internet, telecommunication network ‘embedded systems’ (the built in micro processor or that control machine from micro web to missiles) and dedicated device like the computer you are using now”. Therefore it is the structure of both ICT and traditional information need of the consumer. It is the seamless web of communication network, computers, database and consumer electronics that will put vast amount of information at user finger tips. This definition is about full of technology and not address some of the important aspect of common individual, human and social facets (Source: IT Task force).

A sophisticated interlinking is very important in Information Infrastructure designing and development with Sub Systems connectivity. Additionally Information Infrastructure needs a proper feedback and also newer of recent technological input system.

Proper Management techniques are required in healthy designing and development of the Information Infrastructure; and here visualization and digitalization are considered as facets. Based on institutional nature or establishment Information Infrastructure may hold different nature. Information Infrastructure is dedicated in complete solution for information and technological support in the institutions and organization. And therefore in the organizational systems it is worthy to solve manual and computational information need. Therefore Information Infrastructure is helpful in—

- ❖ Enhancing Productivity.
- ❖ Time Saving
- ❖ Cost Saving

- ❖ Better Knowledge Transfer Systems
- ❖ Knowledge Management
- ❖ Improved Transparency
- ❖ Enhance Collaborative Environment.

Therefore Information Infrastructure if deals with the manual way then it may uses indexing, abstracting, proper documentation tool and all these services may be offered by the in-house settings or it may be external houses viz. Information Centre, Information Analysis Centre, Documentation Centre, Data Centre etc. Further as far as technological Information Infrastructure is concerned it is supported by the IT components viz. Database Technology, Web Technology, Networking, Multimedia Technology etc by the in-house settings or arrangements or by the Telecommunication, Knowledge Networks and Grids etc. The Fig. 2 herewith depicted in detail.

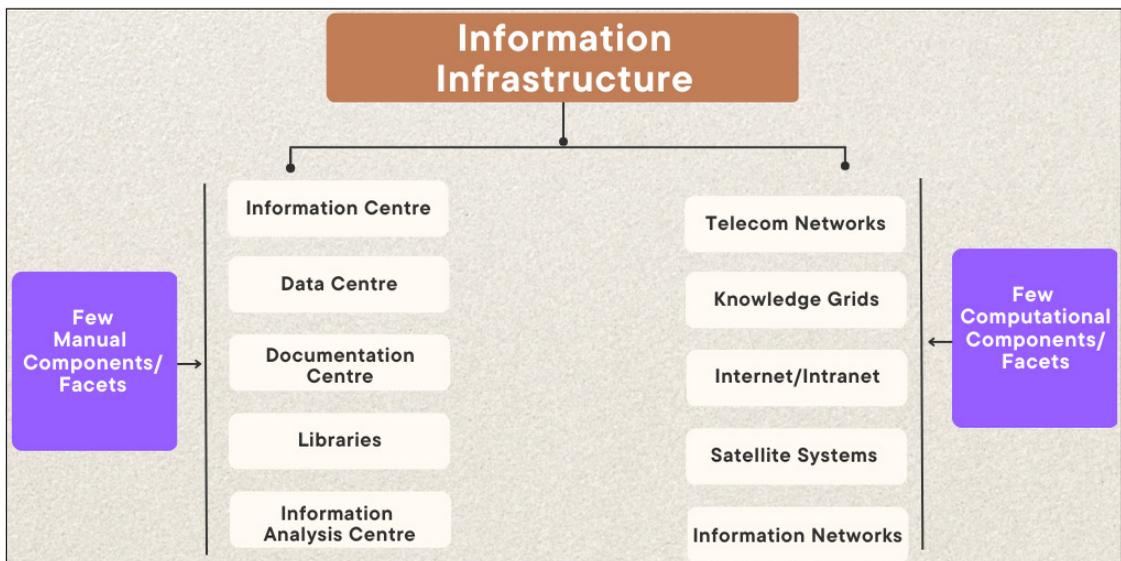


Fig. 2: Information Infrastructure supporting agencies at a glance

Human resources is important in Information Infrastructure designing and development and it is ultimately helps in the sharing of ideas, views, knowledge and expertise. Information generation is increasing rapidly and managing large amount is become difficult but with proper Information Infrastructure adaptation it may be suitable for the office executive, top level HR of the organizations. Information Infrastructure in current context also supported with the automation and therefore offers collaboration environment. Information Infrastructure in generally consists with firstly Information and another is Infrastructure.

Components and Systems in Information Infrastructure

Information Infrastructure is a collection of different components which are responsible for advanced communication systems with higher level of values. Information Service uses computer and other supporting systems that can help Information Systems to maintain a healthy information infrastructure

according to protocols and architectures. According to the systems and tools; following can be considered as important tool—

- ❖ Fiber optic communication (for the region or territory or city to city communication).
- ❖ Communication Satellite (It is with the communication with the support of satellites towards Information Infrastructure development).
- ❖ Hardware—*Network Based* (for interconnections of the systems, tools and the ‘contents’).
- ❖ Computing based Hardware (The computer and similar devices).
- ❖ Facility and Data Centre (It is mainly offered by the Data Centre and Cloud Computing Service Section).
- ❖ Software (For the sophisticated Information Infrastructure designing and services).
- ❖ Platform (the battle for delivery).
- ❖ End user devices (the core for Information Infrastructure).
- ❖ Human Resource (It is the humans who are associated with the design, development, implementation and also users).
- ❖ Content (may be text, audio, video or any multimedia).

Data Infrastructure and this is commonly known as digital Infrastructure dedicated in the promotion of data sharing and data related activities or data activities electronic way of data mechanism. Due to nature it may also called as E Infrastructure. The European Strategy Forum on Research Infrastructure (ESFRI) initially helps in the development of the Data Infrastructure for the trend, future, root and further here E Infrastructure reflection group proposed the concept Data Infrastructure towards existing Data System with the support of tools, technologies, systems, procedure, mechanism. Therefore here information technology important in healthy Data Infrastructure development and establishment—

- ❖ IT is needed in better and healthy Establishment and modernization of the Data Centre.
- ❖ In proper Data Centre and Data Centre communication, or with the Network and End Users supporting system.
- ❖ Towards the development of healthy and Technology depended Data Centre regarding proper E Government Systems.
- ❖ For the development of Cyber Infrastructure and with advance computational systems, acquisition and management systems.
- ❖ The Data Infrastructure may be for the local, regional, national, continental, international foundations and organizations.
- ❖ Similar to Information Infrastructure, the Data Infrastructure is also fruitful in education, medical and healthcare, government and administration etc.
- ❖ The Data Infrastructure is associated with different kind of technological systems, and other components.

IT Infrastructure is a broader than Data Infrastructure but it is smaller than Information Infrastructure with the following generally—

- ❖ Network Infrastructure
- ❖ Web Infrastructure
- ❖ Software Infrastructure
- ❖ Multimedia Infrastructure
- ❖ Community Infrastructure etc.

According to IT Infrastructure, Library Foundation Course Glossary ‘IT Infrastructure can also be termed as “All of the hardware, software, networks, facilities, etc., that are required to develop, test, deliver, monitor, control or support IT services. The term IT infrastructure includes all of the Information Technology but not the associated People, Processes and documentation. Therefore IT Infrastructure is include (in response to Software Infrastructure) the system software, application software, utilities even web server, content management, operating systems etc. Additionally it include—

- ❖ Cloud Infrastructure.
- ❖ Converged Infrastructure.
- ❖ Dynamic Infrastructure.
- ❖ Hyper Converged Infrastructure etc.

Emerging IT Infrastructure can be managed by third party or from other institutions and here the emerging Cloud Infrastructure is also important and valuable towards practice of virtualization Infrastructure and IoT Infrastructure. Here general aspects of Web Servers, Enterprise Resources, Planning, Customer relationship management, productivity application, firewall management etc. played a leading role for the development. Here remote infrastructure management is gaining day by day. Further Network security management also need of the hour with cloud based services viz. amazon web service, Google Cloud, Microsoft Azure, Active Directory, Microsoft Exchange management etc.

Therefore Information Infrastructure Management may be consider as important and also Information Technology Infrastructure Management can be consider for the designing, development, deployment and management of IT Systems.

Latest Technologies involved in advanced and smart Information Infrastructure Mechanism

Cloud Computing

Cloud computing is an important and latest technology which is used to reduce the cost and increase the efficiency of the Information Infrastructure Mechanism. Cloud Computing is the process of virtualization of any system where all the Information and Communication Technology (ICT) resources are available through the internet and networked services. It helps in minimizing the uses of hardware, software, database, applications, firmware by installing appropriate tools in a centralized place and used at the

remote places. Cloud computing technologies are used to provide durable, flexible, secure and easy to maintain of the information.

Big Data and Analytics

Big Data Analytics is one of the complex tasks for Information Infrastructure Management. It is the very difficult job to deal with the large and complex data. The main challenges are analysis, data collection, sharing, storage, transfer, virtualization and information privacy. To store and retrieve huge amount of data, processing the data and analyze the data is very tough task. So the Information Infrastructure Management system uses Big Data analysis tools and appropriate softwares which helps in decision making, report generation, MIS reporting, annual reporting and so on.

Robotics and AI

Information Infrastructure Management is very important aspect of Robotics. The more information it has the more accurate it will work. The Artificial Intelligence algorithms are analyses the information stored in the data base and try to generate more accurate result. Robotics technologies worked more efficiently by analyzing the information with the help of Artificial Intelligence algorithms. Artificial Intelligence technologies and other emerging technologies help to transfer of knowledge to re-training the previously designed pre-trained model. Information Infrastructure Mechanism is also helpful for reinforcement learning based on the feedback based learning. Machine learning technologies and AI agents are very helpful to analyze the environment and getting feedback to learn automatically.

HCI and UX

Information Infrastructure Mechanism is very helpful to develop Human Computer Interface (HCI) and User Experience (UX) Deign. It help to collect user feedback and analyze automatically as per the requirement of the user it design the customize user experience for the user which enhance the average retention time per user. HCI is another key feature of future system. To get a well design and attractive HCI, it needs Information Infrastructure Mechanism. The well organized and well maintain Information Infrastructure is able to design a futuristic System which could be applied in all types of user interface design.

Major Findings with Concluding Remarks

As far as Information Infrastructure is concerned, it is a broad information development initiative, project and system. It is dedicated in different kind of organizations and institutions such as private or public, profit making or nonprofit making, small or large. It is also useful in each and every organizations and institutions. Information Infrastructure is considered as one of the important factors in information activities and therefore in Information Infrastructure is required both in manual and computational information systems development. Proper Information Infrastructure is needed in design, development and evaluation of the any system. For the development of any system Information Infrastructure is the backbone of the system. A strong Information Infrastructure can change the operational performance of any organization.

REFERENCES

1. Aanestad, M., Jolliffe, B., Mukherjee, A. and Sahay, S. 2014. Infrastructuring work: Building a state-wide hospital information infrastructure in India. *Information Systems Research*, **25**(4): 834-845.
2. Akman, I. and Mishra, A. 2014. Green information technology practices among IT professionals: Theory of planned behavior perspective. *PROBLEMY EKOROZWOJU-Problems of Sustainable Development*, **9**(2): 47-54.
3. Chatterjee, R. 2021. Centre for Railway Information Systems (CRIS)-The Automated Railway Management System: A Case Study. *International Journal of Information Science and Computing*. **08**(02): 103-118.
4. Chatterjee, R. 2021. e-Governance Implementation in India-Basic Concepts, Foundation in India, Architecture, Benefits & Challenges: An Overview. *Information, Communications and Computation Technology (ICCT): The Pillar for Transformation* (pp. 265-288). New Delhi Publishers, India. ISBN-978-93-88879-95-8.
5. Chatzipoulidis, A., Michalopoulos, D. and Mavridis, I. 2015. Information infrastructure risk prediction through platform vulnerability analysis. *Journal of Systems and Software*, **106**: 28-41.
6. Ciborra, Claudio and Hanseth, Ole. 1998. Toward a Contingency View of Infrastructure and Knowledge: An Exploratory Study. *ICIS 1998 Proceedings*. **23**.
7. Constantinides, P. and Barrett, M. 2015. Information infrastructure development and governance as collective action. *Information Systems Research*, **26**(1): 40-56.
8. Dong, B., O'Neill, Z. and Li, Z. 2014. A BIM-enabled information infrastructure for building energy Fault Detection and Diagnostics. *Automation in Construction*, **44**: 197-211.
9. Edwards, P., Jackson, S., Bowker, G. and Knobel, C. 2007 Understanding Infrastructure: Dynamics, Tensions and Design, NSF Report of a Workshop: History and Theory of Infrastructure: Lessons for New Scientific Cyber infrastructures (<https://deepblue.lib.umich.edu/bitstream/handle/2027.42/49353/UnderstandingInfrastructure2007.pdf>)
10. Floridi, L. 2005. Is semantic information meaningful data?. *Philosophy and Phenomenological Research*, **70**(2): 351-370.
11. Friedman, C.P., Rubin, J.C. and Sullivan, K.J. 2017. Toward an information infrastructure for global health improvement. *Yearbook of Medical Informatics*, **26**(1): 16.
12. Hidas, M.G., Proctor, R., Atkins, N., Atkinson, J., Besnard, L., Blain, P., ... and Galibert, G. 2016. Information infrastructure for Australia's integrated marine observing system. *Earth Science Informatics*, **9**(4): 525-534.
13. Hu, Z., Gnatyuk, V., Sydorenko, V., Odarchenko, R. and Gnatyuk, S. 2017. Method for cyberincidents network-centric monitoring in critical information infrastructure. *International Journal of Computer Network and Information Security*, **9**(6): 30.
14. James Gleick. 2011. *The Information: A History, a Theory, a Flood* (2011), Pantheon Books (ISBN-978-0-375-42372-7)

15. Krishnan, S. and Teo, T.S. 2012. Moderating effects of governance on information infrastructure and e-government development. *Journal of the American Society for Information Science and Technology*, **63**(10): 1929-1946.
16. Luo, F., Zhao, J., Dong, Z.Y., Chen, Y., Xu, Y., Zhang, X. and Wong, K.P. 2015. Cloud-based information infrastructure for next-generation power grid: Conception, architecture, and applications. *IEEE Transactions on Smart Grid*, **7**(4): 1896-1912.
17. Ole Hanseth. 2012. From systems and tools to networks and infrastructures - from design to cultivation. Towards a theory of ICT solutions and its design methodology implications. (http://heim.ifi.uio.no/~oleha/Publications/ib_ISR_3rd_resubm2.html) (Unpublished Manuscript)
18. Paul, P.K., Dangwal, K.L. and Kumar, A 2013. Information Infrastructure and Academic and Education World: The Role and Opportunities in Contemporary Perspective. *International Journal of Education for Peace and Development*, **1**(1): 31-36.
19. Paul, P.K., Kumar, K. and Chatterjee, D. 2014. Cloud computing emphasizing emerging possibilities to the entire Information Infrastructure. *Trends in Information Management (TRIM-An International Journal)*, **9**(2): 121-129.
20. Paul, P.K. 2014. Information Infrastructure at Secondary Schools in India: Challenges, Issues- A Conceptual Study. *BRICS International Journal of Educational Research*, **5**(1): 32-35
21. Pincus, M. 1983. Information characteristics of earnings announcements and stock market behavior. *Journal of Accounting Research*, pp. 155-183.
22. Pironti, J.P. 2006. Key elements of a threat and vulnerability management program. *Information Systems Control Journal*, **3**: 1-5.
23. Rautenbach, V., Coetzee, S. and Iwaniak, A. 2013. Orchestrating OGC web services to produce thematic maps in a spatial information infrastructure. *Computers, Environment and Urban Systems*, **37**: 107-120.
24. Sorokin, A.A., Makogonov, S.V. and Korolev, S.P. 2017. The information infrastructure for collective scientific work in the Far East of Russia. *Scientific and Technical Information Processing*, **44**(4): 302-304.
25. Vassilev, Vesselin K., Terence C. Fogarty, and Julian F. Miller. 2000. "Information characteristics and the structure of landscapes." *Evolutionary Computation*, **8**(1): 31-60.

