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Knowledge Transformation and Economic Development: The Role of Digital Technology- An Analysis

Gobind M. Herani,^{*} Riaz Ahmad Shirazi,^{**} Noor Zaman,^{***} and Adnan Alam^{****}

ABSTRACT

This paper assesses the role of evolutionary process in knowledge transformation and economic development, especially due to emerging diversified digital technology. Everywhere, in the world, ever-advancing digital technology is performing a revolutionary role in converting the world into a global village. The knowledge, scientific and non-scientific, is being transformed with an enormous speed through digital media. Getting education through technology is providing audio-visual way of enhancing knowledge. But digital technology has its positive and negative affects. It needs some positive steps to ensure the qualitative knowledge transformation. In this article copyrights of accessing computerized data is also discussed, which prevents legal transformation of knowledge for globalisation of the world, research based education, and economic development. There different views of different. Learned authors have presented different views for reflection and deeper understanding. This study, with brief history of knowledge transformation, is worthy of fruitful suggestions.

JEL. Classification: L86; M12; O33.

Keywords: Technology, Knowledge, Transformation, Scientific-Data, Research, Fair- Extract, Revolution and Low-Cost economic development.

1. INTRODUCTION

This study begins with brief description of the relevant legal infrastructure during the pre-digital period and by identifying certain factors, such as an introduction of electronic photocopying machines. It then outlines digital technologies' role in accelerating the exchange of information as a commodity to be bought or sold, and economic development. The review of relevant literature describes and analyses a few of available studies for, (<http://.nap.edu>) and are referred also in this paper, but in Pakistan analysis of such type of studies has been limited to only a few studies (Mehtar, 2005 and Rehan, 2003). No attempt has been made to estimate and analyze the development in the transformation of knowledge and economic development especially role of technology in knowledge transformation in Pakistan.

^{*}The material presented by the authors does not necessarily represent the view point of editors and the management of Indus Institute of Higher Education (IIHE) as well as the authors' institutes⁵

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Thus main aim of this study is to understand the evolution in knowledge transformation. The study specially examines: i) The trend of digital technology in knowledge transformation. ii). Period wise knowledge transformation since the creation of first human being, Adam. iii). Comparison of technological knowledge transformation in pre-digital and post digital period. iv) Economic development associated with the emergence of technological transformation of knowledge. This study has a wide scope for the people the role of digital technology in the economic development and may also try to use this knowledge in attaining formal and informal education in order to boost the economic development.

Objectives are also set to test the following hypothesis: i) It is hypothesised that technology has accelerated the transformation of ever-advancing technology and its beneficial affects on economic development. ii) It is also hypothesised that the emerging digital technology has also accelerated the exchange of scientific and non-scientific data and information.

Methodology for collection of data is secondary source from journals, Internet and available studies on the subject. An interview of a world-renowned instructor is also incorporated in this study.

This paper is structured as follows: In section 2, review of literature is discussed as: 2.1 provides, since Adam, the first human being, the history of pre-digital knowledge transformation, 2.2 provides information about contribution of digital technology in knowledge transformation, 2.3 Role of privately controlled databases, 2.4 Role of scientific and educational communities, 2.5 Expected results of an overly protectionist database regime, 2.6 Data from publicly funded research: economic perspective. 2.7 Role of technology in economic development. Conclusion is given in section 3 and finally section 4 provides policy implications.

2. REVIEW OF LITERATURE

In this section interviews and different types of secondary data is incorporated for testing the hypothesis and to achieve the target of objectives of this study.

2.1. History of Pre-Digital Knowledge Transformation: The human mind is like a mine bestowed with billions of innovative seeds, and every seed of which have a fruitful tree of new inventions At home, the education of newly born child starts from the lap of mother, for whom it is an obligatory privilege to look after her child. Education starting from the dark-age is being transformed from mind to mind and race to race, based on spiritually traditional ways of learning, observations, and experiences. First Source of teaching and training, which starts at home is known as informal education linked with the environment in which he lives. Second source of learning is formal learning provided to the child by institutions or schools. In this way the knowledge, informal and formal, is progressively travelling through human minds. In the formal ways different material was required as tool of knowledge transformation. Knowledge was transformed from man to man by heart, and then by presentation of different types of models like shapes, diagrams, symbols etc. Human mind learned to remember things using parts of the body like fingers to indicate numbers. The wrist, for example, stood for six, the arm

for seven and the elbow for eight. Human being used to write with wooden pen and then coloured material came into existence. Before the invention of paper, leaves, skins, stones and barks etc. were used for writing. Introduction of paper manufacturing promoted its growth towards the manufacturing of typewriters and printing machines. “The great changes have occurred in the way information is distributed since the invention of printing by movable type in the 15th century.” (Kurtz, 1996 ; Samuelson, 1996).

At the same time religions have also encouraged man to acquire knowledge. “About one-third verses of the Holy Qur’an, gives the order and instruction for the research and to collect the observations and knowledge about the things in the universe. It is important to note that in the verses Holy **Qur’an**, different prayers are associated with different prophets. Adam requested for pardon, Moses asked for the power of communication, Jesus asked for determination in the way of Allah and Muhammad (PBUH) encouraged for enhancement of knowledge. It implies the importance of the ‘creation of knowledge’ for Muslims. Once Muhammad (PBUH) asked the Muslims, to acquire knowledge from wherever it is found. According to *Hadith*, ‘acquisition of knowledge is obligatory for every man and women’” (Mehar, 2005, pp.24-25)

2.2. Contribution of Digital Technology in Knowledge Transformation: In recent years, the advent of new technologies, from photocopying machines to computer programs, optical scanners and telecommunication network has contributed in knowledge transformation. By enabling even copies for private research uses to displace commercial markets, and also by making it possible to overcome most of the transaction cost problems that increasingly had been used to justify application of the fair use exception in practice. Although it is important to emphasize that this market has been largely concerned with non-scientific data and information. Despite the relatively weak legal infrastructure governing use of data, a thriving market for compiled information has grown up, and U.S. publishers appear to play a dominant role in it, though it¹ is important to emphasize that this market has been largely concerned with non-scientific data and information, which is going to be transferred. This industry seems largely characterized by niche marketers who supply and dominate specific market segments. The limited size of these segments and the relatively high start-up and servicing costs seem to deter

¹ See, e.g., Debra B. Rosler (1995), "The European Union's Proposed Directive for the Legal Protection of Databases: A New Threat to the Free Flow of Information," *High Tech. L. J.*, 10:105; Paul Durdik (1994), "Ancient Debate, New Technology: The European Community Moves to Protect Computer Databases," *Boston Univ. Int'l L. J.*, 12:153, n. 1 (citing E.C. sources showing that U.S. and European producers account, respectively, for about 56 percent and 25 percent of "world electronic information services output," but that the European share had been "only one-tenth the size of the U.S. market" in 1980. For the view that U.S. dominance of the private sector stems from its loose copyright regime, which "most closely approximates a free market for data compilations" based on superior product development, see Charles von Simson (1995), "Feist or Famine: American Database Copyright as an Economic Model for the European Union," *Brooklyn J. Int'l L.*, 20:729.

second comers from readily entering such markets². In other words, once the threshold level of investment has been crossed, the first comer tends to take the relevant market segment as a whole.

By the late 1980s, however, digital technologies and new telecommunications networks had combined to produce "the greatest changes in the way information is distributed, since the invention of printing by movable type in the 15th century³."

The use of computers made it economically feasible to collect, store, manage, and deliver huge amounts of data at a time when continuously expanding databases have become ever more prominent building blocks of knowledge, especially in the observational sciences. Electronic databases further blur the line between these collection and application functions by allowing users to make their own tailor-made extractions from the mass of data available in the collection as a whole (Hunsucker, 1997). These tools allow users to "add immense value to what would otherwise be masses of incoherent disparate, data."⁴ Moreover, the latest value-added data products, once disseminated worldwide via the Internet and other media, frequently lead to the rapid production of new technical innovations, which result in the generation of more data. (David, and Foray 1995; Ginsparg, 1995; Antonelli, 1992) Electronic publishing thus broadly advances the revolutionary process that computerization began, and it makes both data and research results potentially available at very low cost all over the world. (David and Foray, 1995, note 35; Antonelli, 1992, note 35, pp. 5-28)

As this digital and telecommunication revolution has created vast new markets for electronic information goods and tools. Quoting sources estimate the value of the global information industry to reach \$3 trillion by early in the next century; (Hunsucker, 1997) note 33, p.1). Quoting sources that estimate E.C. database market at \$10.2 billion, which amounted to about 30 percent of

² . See, e.g., Rosler, note 28. For evidence of a similar phenomenon with regard to databases that serve the legal community, see, e.g., *West Publishing Co. v. Mead Data Central, Inc.*, 799 F. 2d 1219 (8th Cir. 1986), *cert. denied*, 479 U.S. 1070 (1987); see also L. Ray Patterson and Craig Joyce (1989), "Monopolizing the Law: The Scope of Copyright Protection for Law Reports and Statutory Compilations," *UCLA L. Rev.*, 36:719.

³ . Leslie A. Kurtz (1996), "Copyright and the National Information Infrastructure in the United States," *EIPR*, 18:120. See also Pamela Samuelson, "Technological Protection for Copyrighted Works," paper presented to the Thrower Symposium, Emory Law School, Feb. 22, 1996 (stating that, although digital technology "poses a serious challenge for copyright owners because works in digital form are vulnerable to uncontrolled replication and dissemination in networked environments," it is "not just part of the problem; it may also be part of the solution").

⁴ .Hunsucker, note 33, See also Pamela Samuelson, "Missing Foundations of the Proposed European Database Directive," paper presented to the Specialist Meeting on Law, Information Policy, and Spatial Databases, sponsored by the National Center for Geographic Information and Analysis, Arizona State University College of Law, Oct. 28-30, 1994 (stressing importance of add-on or value-added products in the digital environment).

the world market in 1994. (Melnick,1994) Electronic publishing and computerization has outpaced the legal infrastructure, which remains geared to the slower-moving print media. In a larger perspective, however, it has been argued that the legal problems of electronic databases are assimilate able to those of industrial designs, computer programs, plant varieties, biogenetically engineered products, and numerous other forms of design-dependent, sub-patent able innovation that fall into a widening penumbra between the increasingly obsolete patent and copyright paradigms (E.C, 1995).

This strain manifests itself in two contradictory ways: first, sometimes digital technology aggravates the basic market-failure characteristic of information goods and thus deepens a chronic state of under protection. This can occur, for example, when second comers download the originator's data and enter the market with a competing product, that free rides on the originator's investment. See e.g., CCC took "virtually the entire compendium" of Maclean's used car valuations and "effectively offers to sell its customers Maclean's Red Book through CCC's database." (Hunter, 1994). Statistically, Microdos' work contained from 96 to 99 percent of Warren's data on nationwide cable TV services. (Warren, 1995). Second, at other times, however, digital technology so thoroughly overcomes the threat of market failure that it endows the first to invest with abnormal market power that can result in a chronic state of overprotection. This can occur, for example, when sole-source data providers charge exorbitant prices or oblige libraries and research institutions to accept terms and conditions that effectively waive both the special privileges and the fair use exceptions set out in the Copyright Act of 1976 (Office, 1992).

To the extent that databases are commercialized, whatever their origin, the refined digital technologies that enhance the compiler's power to collect and disseminate data will enhance as well the free-riding competitor's power to appropriate the fruits of the first comer's investment. If the second comer independently generates its own data, or combines its inputs with the first comer's data to produce value-adding applications, the former contributes knowledge, capital, and skilled efforts to the data-generating communities' overall endeavour. These second comers, who do not merely duplicate or "clone" the first comer's product, are hardly free riders even when they do not contribute directly to the first comer's production costs under a licensed royalty transaction (Samuelson, 1994). The second comer who purchases the originator's product, say, in the form of a CD-ROM, may electronically extract and recompile the data in question at a fraction of their collection and distribution costs. The second product may then be sold for less than the first, because its publisher has contributed nothing directly or indirectly to the research and production costs. Digital technology also enables second comers to extract and recombine the originator's data into value-added products that improve on the original, or that compete in different and sometimes-distant market segments (Reichman and Samuelson, 1997). In some cases, third parties may even extract the compiler's data in order to make them available over telecommunications networks, an act that can destroy any residual incentives to invest. In one recent case, for example, a database maker spent about \$10 million to compile some 95,000,000 residential and commercial listings from some 3,000 telephone directories. A purchaser who paid \$200 for a compact

disk electronically extracted and recompiled part of the data and then made his listings available over the Internet. In *Pro CD Inc. v. Zeidenberg*, 908 F. Supp. 640 (W.D. Wis. 1996), the federal district court rejected the plaintiff's copyright claim as well as state law claims in contract and unfair competition law (see also Hunsucker, (1997, note 33, pp. 13-14), but was reversed on appeal, in *Pro CD, Inc. v. Zeidenberg*, 86 F. 3d 1447 (7th Cir. 1996). In such cases, existing copyright laws generally afford little or no relief, as explained above.

2.3. Role of Privately Controlled Databases: When the database maker is the sole source of the data in question, and substitute databases cannot readily be compiled from public domain sources, digital technology greatly strengthens a supplier's market power. By restricting access to identifiable, on-line subscribers, for example, and by "placing conditions on access and [using technology] to monitor customer usage," the publisher can largely restore the power of the two-party contractual deal that the advent of the printing press had appeared to destroy (Litman, 1992). In effect, publishers in this position may not need copyright law at all, even if they qualified for protection. They may prefer to reject the state-imposed cultural bargain in order to override both its fair-use provisions and its specific exemptions favouring the public interest in teaching and research (Ginsburg, 1993). Moreover, electronic publishers may have virtually no transaction cost problems to overcome because digital technology now enables them to track and charge for every instance of electronic access, even for browsing and scientific uses that were previously exempted (Litman, 1994). The resulting market power then enables the publisher to impose monopoly prices and arbitrary terms on users, including libraries, educational institutions, and research centres and to disregard the social consequences that ensue from the inability of such public organizations to foot the bills (Kurtz, 1996, note 32).

2.4 Role of Scientific and Educational Communities: At the time of legal protection of databases writing, neither the scientific nor the educational community has played any part in the relevant deliberations concerning the legal protection of databases, and they have not been consulted on any official basis. If matters proceed without adequate input from researchers and educators, Congress could enact the proposed *sue generis* database regime, despite the risk that "it would allow a limited group of database creators to control the dissemination of information" and that the "resulting restrictions on the transfer of knowledge would be detrimental to society, as information lies at the core of social advancement" (Rosler, 1995, note 28, pp. 141-42).

2.5. Expected results of an Overly Protectionist Database Regime: With or without the more pro-competitive conceptual framework of a liability model, a socially balanced database law should preserve and promote the public-good aspects of science and education. This goal requires careful crafting of its technical legal machinery, as well as the inclusion of safeguards that address the specific needs of the scientific and educational communities. Exclusive control over data, like exclusive control over ideas, raises serious

concerns, including First Amendment concerns that are particularly germane to open scientific inquiry. While meeting these concerns does not necessarily imply that data should become available without charge or proprietary interests, it does mean the following:

- The law itself should define the parameters of an evolving public domain from which investigators can freely extract and use data for certain purposes.
- The law must also guarantee scientific and educational users access to that domain on reasonable terms and conditions.
- The definition of a protectable database should be narrowed so as to exclude ideas and contents of scientific theories.
- Database owners should never possess the right to preclude (prohibit) access to otherwise publicly available data when sought for purposes of basic scientific research.

The terms of access would then depend in part on the size and scope of any free use and fair use zones built into a proper *sue generis* law for the benefit of scientific and educational users. Meanwhile, the adoption of different legal regimes to protect database makers by countries with different agendas and at varying stages of economic development could further complicate the full and open flow of scientific data across international frontiers. Measures to harmonize the domestic database-protection laws, or at least their effects on the translational flow of scientific data, will therefore require intergovernmental study, as will measures and proposals affecting the regulation of national and global information infrastructures. Pressures to integrate these and other international intellectual property standards ever more deeply into the global trade apparatus will certainly mount as countries move to implement and expand the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) and related international conventions within the framework of the World Trade Organization and that of World Intellectual Property Organization (WIPO), which continues to administer the Paris and Berne conventions. The ensuing tensions and conflicts will make it more necessary than ever to develop a framework treaty to safeguard the full and open exchange of scientific data in an increasingly commercialized environment. The difficulty of regulating both public and private interests within such a treaty should not be underestimated, however, while the developing and least-developed countries are likely to play a more conspicuous role in intellectual property policymaking as time goes on.

2.6. Data from Publicly Funded Research: The Economic Perspective: The most striking theme throughout this report is how progress in information technologies has changed the way science is accomplished. It has enabled the collection, processing, storage, and dissemination of information undreamed of even a few decades ago. Sensing systems (e.g., Earth observation satellites, the Hubble Space Telescope, ground-based radars) and other forms of automated data generation (e.g., genome studies) produce enormous amounts of useful data, which is being utilized by scientists to study natural phenomena at a much greater level of detail. Science and scientists have been using this

highly sophisticated and often very expensive technology, to push forward the frontiers of knowledge in their respective disciplines. The ever-increasing processing power available to analyze the data is as crucial to this evolution as the improvements in data generation capabilities. Surprisingly, these capabilities are reflected from cheaper but more powerful workstations and PCs available to the scientist community. The development of inexpensive mass storage media has ensured that the preservation of bulk of data, both processed and unprocessed, which is both possible and affordable. Finally, the most recent enhancement in technology has been the worldwide growth of the Internet systems with potential to send and receive data from anywhere in the world. These factors, taken together, have revolutionized the way scientific methods of making it truly global. Perhaps most interesting is that this progress has changed the way scientists communicate with each other. Scientists, compressing the time between discovery and communication of the results, are producing the electronic journals. Acceleration can be observed in rapid pace of discovery and innovation, as the cycle time of discovery, communication, and next discovery is reduced. The term "digitization of science" is used for the flow of scientific data and due to which the cost of publication and of access to information has been drastically reduced. Scientists in various countries have full access to modern PCs and Internet facilities, the future of which is unpredictable. This digitization of science has occurred contemporaneously with the demise of the great powers. Russian and U.S. scientific data-relations have become less heavily dominated by security considerations. This factor also has led to an increase in the availability and transfer of scientific data. Fundamental changes have taken place in many countries of the world in relation to market research. The evident success of market economies, have led many governments to privatize activities previously delivered via the public sector, in the hope of relieving the burden on taxpayers while improving the allocation of economic resources. These pressures have begun to be felt in the area of scientific data; for example, in the United States, and some European countries, in order to protect data have strongly urged limits on the sharing of meteorological and other data. (<http://bob>).

2.7 Role of Technology in Economic Development: At present information technology has played an important role in knowledge creation and transformation. It is very helpful in research and especially in empirical studies lot of software is available to analyse, test, verify, estimate and forecast. This research transforms and leads directly to technology innovation and the creation of knowledge is the only factor for sustainable economic development and catalyst for the development process.

The knowledge-based technology has the largest share in world trade basket at present. The activities relating to the enhancement of knowledge is also important from the economic point of view. The Table-1 shows that the change in patterns of foreign trade. It is evident that share of knowledge based products is rapidly increasing in world trade basket, while the contribution of primary goods is declining in the world trade. The use of creative knowledge is the key element to promote the technological advancement as well as economic

development. It is important to find out new technologies to economic growth and develop fruitful relations between Agriculture and Industries through innovative theories. According to research report published by the Stanford Economic Development establishes a link between economic history, economic theory and application of technology. (World Bank: 2000).

Table- Share of Technology Innovations in Global Trade Type of commodity

	19787	1998
High technology	11 %	22%
Medium technology	22%	32%
Low technology	21%	18%
Resource based	11%	11%
Other primary goods	34%	13%
Miscellaneous	1%	4%

Source: **Mehar, 2005**. "From Knowledge Creation to Economic Development: The Missing Links in Muslim World", *Journal of Management and Social Sciences*" Institute of Business & technology, vol. 1.No. 1(spring 2005), J. Int'IL., p.26

3. CONCLUSION

From the detailed review of literature given above, the following conclusion can be made. The knowledge is evolutionary process from the time of first human being, Adam, who was taught by Almighty Allah the names of all the things. The mine of Knowledge is innate in every person from the moment he comes into this world. He has been bestowed with the will and intelligentsia to conquer the cosmos for which the virtues are already built-in in the human mind. He is only to break some barriers to produce things. The formal and informal sources are required to break the barriers and to transform the knowledge conscious level. Heredity also plays an important role in knowledge transformation, genetically into the newly born child. That is why intelligence is heredity character and cannot be bought. Those who are naturally extra-intelligent can naturally perceive more in comparison to others, who have average intelligence. It is a historical fact that the process of knowledge transformation is constantly advancing with the emergence of newly developed digital technologies. In pre-digital era and after the advent of digital era, unbelievable inventions have been emerged as miracles. Transformation of knowledge was very slow in pre-digital era. But it remained evolutionary through informal and formal traditional ways. With the help of stone shapes, drawings and statues massages were being conveyed to others. After that it replaced writing on the barks, skins, and leaves and at last it was further enhanced with the invention of paper. Great changes have occurred in the way of information dissemination after the invention of printing machines in the 15th century. All the existing religions of the world also played an important role in the advancement and transformation of the knowledge. According to a technical definition technology means evolutionary techniques to speed up the transformation of knowledge. In recent years advent of computer technology, optical scanners and telecommunication networks have contributed an amazing knowledge transformation. This technology has facilitated the world to

exchanging knowledge comfortably faster than traditional ways. Information technology is playing a great role in uniting the mankind and transforming the world to a global village. Yes! this is the age of globalization and human being is conquering the space through super-computer and producing complex components through robots. Now it is easier and faster to access any type of information from any corner of the world through internet. Computer technology now has become an essential tool for acquiring education, doing research work and contributes in the economic development at national and international levels. The reason is that computer, as compared to human mind, can perform job speedily, accurately and diligently. It can store and manage and disseminate huge amount of data in seconds. The databases have become an ever more prominent building block of knowledge especially in the field of scientific inventions. These tools allow to “add immense value, to what would, otherwise to be masses incoherent disparate, data in digital environment.” The latest value added products, which are being produced by computer-based industrial machines, are being marketed via electronic media and being disseminated world wide via internet. This trend also leads to the rapid production of new technical inventions. Digital and telecommunication revolution has captured world-wide markets through electronic media. Sources estimate that the value of the global information industry to reach \$3 trillions by early in this century. However, there is a negative side of this technology i.e. the legal problem of databases such as intellectual property rights, which create trade disputes and hindrances in firm business negotiations. This strain, manifest itself in two contradictory ways. First some times digital technology aggravates the basic market failure characteristics of information, goods and deepens a chronic state of under protection. Secondly, on the other hand times, digital technology overcomes the threat of market failure that it endowed with investing in abnormal markets, which may, some times, result in a chronic state of over-protection. Thus, to conclude, the main aim of this article being supported with remarks that: there is significant advancement in knowledge transformation. The objectives already set above have been proved as correct. i) The trend of knowledge is significantly going upward. ii) Progressive transformation of knowledge, from the very beginning remained evolutionary in the pre-digital period till the 15th century. After the invention of printing machines, great changes occurred and trend of growth also shows rapidly upward graph. iii) When comparing pre-digital with digital period, it is observed that the digital era is revolutionary and full of technological inventions. iv) The emergence of technological inventions and rapid transformation of knowledge has helped a lot in economic development at an enormous speed. Thus technology has played a vital role in the process of globalisation. All theoretical testing show that hypothesis i, is accepted. At the same time testing also shows that hypothesis ii, is also supported by the review of literature and re-interpretation of it.

4. POLICY IMPLICATIONS

Following recommendations are made for the further rapid progress in knowledge transformation and to encourage the educational communities and

researchers to achieve the targets of globalization, which is the only solution to stop clashes between different cultures.

- Importance should be given to all relevant legislative forums, to allow free exchange of publicly funded research data.
- These forums consider laws that would apply to the exchange of scientific data and disseminate clarification in order to avoid the fear of access to data that comes under copy right.
- Computer studies be utilized in imparting knowledge relating to scientific and non-scientific subject, from the grass-root level.
- All the subject books be provided with CDs thus encouraging audio-visual teaching even from pre-school levels in order to provide quality education on firm foundation.
- Communication networks be installed in educational institutions to download research material from the
- At the universities level computer-based research should be made a compulsory and project-based tool and students be taught as how to collect data, analyse, test it and produce research oriented material for the benefit of others.
- Lectures delivered at university level should be supported by on line system to enable the students to fully understand the subject and produce qualitative assignments.
- Copyright for educational based research should be exempted in the best interest of quality education to serve the humanity.
- E. journals produced by Universities be worthy of on line material, to promote the research oriented papers. The researchers should be encouraged to benefit from E.journal, be treated as worthy as printed journals.

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