



Role of Information System on Innovation and Technology Transfer for Sustainable Development

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ABSTRACT:

Information Systems (IS) play an important role in improving the efficiency of firms' operations and supply chains, which links to sustainability. Therefore, this study conducted a systematic literature network analysis to review 132 articles that discuss current trends in the IS discipline. Based on a citation network analysis, this study discovered three main research domains (sustainable competitive advantage, environmental sustainability, and sustainable online social communities), and two emerging research domains (the role of IS in developing countries and sustainable information infrastructures). Furthermore, a main path analysis was conducted to understand the knowledge structure of each research domain. This addresses how different trends are reflected in the IS literature related to improving firms' competitive advantages and environmental sustainability. The results found that the sustainable competitiveness of enterprises is improved by the synergy between IS and other recourses within in the enterprises. Green IS initiatives not only solve the issues of environmental sustainability, but also enhance sustainable competitive advantage (i.e., stock price). As social media becomes the optimal enterprise communication channel, this study discusses the factors affecting sustainable online social community, such as structural dynamics (i.e., membership size, communication activity), social dynamics (the basic nature of interactions among members), participation costs, and topic consistency. Overall, the Information System literature is highly focused on three areas—economy, environment, and society, which supports Triple Bottom Line theory.

KEYWORDS: Technology transfer, sustainable development, innovation and technology

INTRODUCTION:

The overall life of mankind follows the development and utilization of various technologies. Since early centuries up till now the world creates and applies technologies aiming to make life better and solve some problems. In doing so, the technologies have become an integrate part of our common life. Each technology, including those from pre historical times is some instrument or tool for increasing the capacity of the individuals. In some cases this capacity is multiplying on the basis of more applications. Technologies can make a society more powerful and enhance its ability for various activities like production, construction, etc. which can be done in an effective manner. The aim of the article is to outline the main tasks of technology transfer and its meaning for the new global competitive world. Contemporary role of technology transfer Mankind has four main needs, presented in a hierarchal manner as follows (Maslow, 1954): physiological needs (food, water, clean air, etc.), security needs (health care, shelter, etc.), social needs (education, mobility, etc.) and esteem needs (freedom, power and attainments). The latter needs demand more new technologies, ensuring higher quality of life. In order to address their needs, people try to do more active operations and streamline them in new ways. The development of technologies requires a set of elements such as appropriate resources, new knowledge and new skills. Because of the different level of development of the countries, transfer of technologies plays an important role for providing an intelligent contribution for non-industrial countries and also supports the realization of the 5-th freedom, the freedom of knowledge. Several cycles have been identified in the overall development of the world: primitive phase (hunting, gathering), early developing phase (farming, shifting), developing phase (agriculture, mining, manufacturing), developed phase (recycling, synthesizing) and future phase (manipulating, innovation services). Technology transfer is an intrinsic element of the last two phases. Following Sharif, 1995, the basic problems recognized for the transfer of knowledge are as follows: lack of real access to technologies, scantily financial resources, lack of appropriated infrastructure, etc. The technology transfer operates with two equal elements - hardware and software. Hardware elements can be quantified as long as the software element deals with tacit knowledge. As we review the industrial society, we could note that technologies are the main force for the economic development of each country. They are a precondition for sustainable and effective growth. In some sources technologies are defined as driving economic forces and lead to significant structural changes. As far as economic development is seen as a very dynamic process, the technology transfer can also be considered as a dynamic process, leading to new results and effectiveness. All technology changes are on the basis of innovation and technology transfer and in many cases the functionality of the technology transfer leads to faster achievements and technological advancement. Porter (1985, p.65) says that technological changes are the principal driver of competition and when pursuing competitiveness and building up knowledge and innovation-based society, we have to secure an active milieu for technological transfer. Many of the large companies have achieved their prosperity thanks to new technologies and their fast transfer. At the same time a wide gap exists between developed and developing

countries and an appropriate mechanism is badly needed to be able to fill it. Technology transfer can be the solution of the above problem. That is, increased technology transfer can be used as an instrument for enlarging modern productivity and raising the efficacy. But the effect of the technology transfer will be weak, if it is not combined with a proper policy strategy. The role of the private sector is growing and any stable realization of Public Private Partnership requires more expertise and modern policy tools such as technology transfer. It is defining as process where technology in use in some group of countries - often developing - is available without the necessary presence of knowledge of this technology. Technology prosperity as well is an ongoing process and some novelties necessitate improvement or diversification. The free access to technologies is a very disputable process and requires free technology transfer with consequences toward convergence. If we consider the Ramanathan (1995) definition of technology, we could define its three main roles: technology as a transformer (where TT plays an essential role), as a tool and as knowledge (where again the TT is considered an instrument of knowledge transposition). Edosomwan (1989) defines technology as a special body of knowledge aiming at reaching specified purposes. The knowledge can be various in forms, but in any way some channel is needed for its transfer and in this case the TT performs this task. Through technological processes the people communicate easily and effectively.

2. INFORMATION SYSTEMS AND SUSTAINABLE DEVELOPMENT:

Business value, from investment on IS, can only be generated through business improvement and innovation (i.e., product, service innovation, improved business process) [31]. In other words, sustainable competitive advantages should be realized through good cooperation between the operation of the enterprise and the IS [10]. To be specific, IS can be applied in operations management, including knowledge sharing in the entire supply chain, healthcare, and omni-channel retailing and recommendation systems [32]. In the past, a small number of IS review papers focused on the role of IS in the sustainable development of enterprises, such as Peppard and Ward [31], Wade and Hulland [33], and Piccoli and Ives [34]. Peppard and Ward [31] indicated that resource-based theory is suitable to explain the role of IS in sustainable competitive advantage. From the perspective of resource-based theory, the performance of an organization depends largely on IS capability [31]. To be specific, IS capability supports and improves the operations of enterprises, enhancing organizational performance in the long-term [31]. Wade and Hulland [33] also agreed that the complementarity of IS and other resources affected sustainable competitive advantage and highlighted that this is moderated by organizational factors (i.e., strong top managers) and environmental factors (i.e., stable business environment, turbulent business environment). To be specific, in the context of strategic initiatives, a sustainable competitive advantage is achieved by IT resource barriers (i.e., IT assets, IT capabilities), complementary resource barriers, IT project barriers (technology characteristics, implementation process), and preemption barriers (switching costs, value system structural characteristics). The deterioration of the natural environment brings risks and opportunities to enterprises [35]. IS research can contribute to the knowledge link between information, organization, and natural environments, to the innovation of environmental strategy, to the creation and evaluation of eco-friendly systems, and to the improvement of the environment [35]. Therefore, Melville's [35] review paper discussed the factors that promote or inhibit the adoption of environmentally sustainable business practices (i.e., culture), the relationship between environmentally sustainable business practices and business performance, and the relationship between IS and the environmental performance of a supply chain. Enterprises are considered key contributors to environmental sustainability because of their global, national, and/or local innovation and rapid change capabilities [19]. Elliot [19] analyzed the challenges of environmental sustainability, including accessing the state of environmental deterioration, the acceleration towards deterioration caused by human activities, and the uncertainty of the human response to deterioration. They describe how people face these challenges through reviewing previous studies in the areas of environment, society, governments, industries and alliances, organizations, and individuals and groups within organizations. In a word, previous articles only focused on one aspect. For example, Wade and Hulland [33] and Piccoli and Ives [34] focused on economic sustainability, while Melville [35] and Elliot [19] focused on environmental sustainability. However, according to Elkington's [36] Triple Bottom Line theory, economic sustainability, environmental sustainability, and social sustainability integrate in a whole organic unity. In addition, no review studies explore Systematic Literature Network Analysis (SLNA) in the description of the role of IS in the sustainable development of enterprises entirely and systematically. To fill the research gap, this study discusses the role of information systems in the sustainable development of enterprises from the perspective of integrating the economy, environment, and society.

3. WHAT ARE THE ELEMENTS OF TECHNOLOGY?

As described by Ramanathan, there are four elements of technology: technoware, humanware, infoware and orgaware. Technoware is the availability of physical facilities. It is a combination of materials and information processes. Humanware is the availability of skilled human resources. Infoware is the so-called documented knowledge. Orgaware is the institutional organization and adjoining networks. And technology transfer is the horizontal axis for all of them. These four elements are interrelated and create common environment for activities. They can have an interconnected effect. Each element affects the others. The absence of one of these elements makes the process or system inefficient. The process of transfer must take into consideration these four elements and the selected approach has to be balanced. Availability of all four elements as well as their dynamic framework for realization of given technology is needed in order to reach good progress in technology. The final aim of each new technology is its transferring and utilization by various consumers. In the scope of this framework each element is important. Without physical facilities and information there is no chance to be realized given technology, but without human resources and organizational structure it is not possible to be absorbed, disseminated and applied the technology. When speaking of technology transfer, we have to discuss also the issue of technological capability. It is an important element of the transfer because the process of building capability takes a long time, functioning on various levels and it can't happen overnight. Capability is mental, legal or material. Ramanathan (1993) again refers to four types of capabilities: operative, acquisitive, supporting and innovative. All of them are linked to the real technology process but the most important component is always humanware. Technology transfer can be seen as a complex multivariate

process, which also can be influenced by many temporary factors, but operating predominantly by the four main elements of the technology. During the different stages of technology transfer the notability of the main elements are different, but there is no stage where one of these elements to be ignored.

4. HOW TO PERCEIVE TECHNOLOGY TRANSFER?

Rosenberg (1982) treats technology as a knowledge, commodity or socioeconomic process. Research and innovations are tools bringing knowledge to new products or services. In these processes the ability of consumers to adapt some technology to the new socio-economic media is one of the criteria for the technology transfer. Bearing in mind that advanced technology and innovation are more private than science - which is a public benefit, we have to treat the technology transfer as a special instrument, predominantly functioning as a specific bridge between public and private sectors. Unless each technology is moving from one place to another along various paths, the movement of knowledge is the first point of effective technology transfer. The transfer affects both sides - creator and consumer, and therefore is a convertible learning process having a strong communicative component. In the broader sense technology transfer takes place in ordinary life too, but it is not the point of this study. The stable economic development depends very much on technology transfer, because preconditions for sustainable development are applicable technologies and innovation, and their transfer and adaptation respectively. The selection of proper and timely technologies is strongly linked to effective transfer, while the transfer is predefined by techno-economic criteria, internal coordination among various actors, needs assessments etc. So far as the techno-economic criteria depend on technical factors and mainly seeking for benefit, the incorporation of other factors as available infrastructure or capability of the consumer is also important. Among the appropriated measures for selection of a given technology and highly considered by technology transfer, the following criteria are recognized: energy consumption, labor intensity, cost/ benefit ratio, productivity, durability, ecological issues, socio-cultural effect, raw material consumption, technological complexity, profitability, etc. For any technology to be transferred effectively, a number of various mechanisms can be used. Generally considered, there are market-oriented and non-market-oriented mechanisms. The market-oriented mechanisms are based on profit, while the non-market-oriented mechanisms are those not motivated by market drivers. To the market-oriented mechanisms we can refer various purchasing (plants, products, equipment), foreign direct investments, technical collaborations and licensing, subcontracting, turnkey contracts, various contracts for instance management, special expert services, etc. Non-market-oriented mechanisms represent informal ways of acquiring knowledge of new technologies. They do not necessarily lead to any actual commercial transfers and the effect on the infoware, orgaware and especially humanware is not so strong. The financial situation has a decisive role for the technology transfer. There are a number of financial flows affecting and supporting technology transfer. Among these can be identified official development assistance (ODA), official aid (OA), loans on market rate, commercial sales, foreign direct investments (FDI), venture capital, activities supported by NGOs, etc. Technology transfer can be implemented through part of these financial flows to three channels- government, private sector and society.

In addition, technology diffusion penetrates through FDI, trade acts and intellectual property rights. For instance, prosperity of BRIC economies relies a lot on licensing and other commercial activities of IPR. If we scrutinize the influence of various financial flows on the sectors, some interesting results become visible. ODA has tremendous impact on governments, but the loans and FDI, as well as commercial sales have a major role on the private sector. The broader societal effects are predominantly the result of activities supported by NGOs. The aid instruments play an important role for stimulating technology transfer. The relations between FDI and technology transfer are complex. For instance with the increase of FDI the technology flow to a country does not necessarily increase, too. It is however important to point out that the greater the variety of existing financial flows, the more efficient ways toward technology transfer can be realized. In the new member states and countries in transition a number of targeted financial flows are functioning. Starting with some specific national instruments, through some supra regional and European instruments, all are very much supportive of technology transfer activities. It is symptomatic that pre-accession programs PHARE and IPA, as well as OP's of the EU Structural Funds have been also used for technology transfer activities. Different countries had different progress in the absorption of such financial resources but a good start for these specific tasks has been set. For instance Bulgaria started used the PHARE program for establishing technology transfer offices. Later continuity of their work was ensured with the help of some Operational program measures of the Structural Funds. How effective can technology transfer be? In order to be effective, a technology transfer has to meet the expectations and requirements of economic and innovation sustainability, social stability, environmental protection, safety energy, etc. Concerning economic stability, several points can be discussed. The benefits should exceed the consumer expenditures. The average costs should be comparable to some similar options. Adequate financing should be guaranteed for the technology providers. Sustainable effect on some macro-economic parameters should be visible - inflation, interest rates, etc. Concerning social stability and sustainability, the following points are important. The consumers must have adequate access to the technology after signing an agreement. Accurate, correct and timely information is needed for the delivery of a new technology. Relevant consumer capability is recommendable. Modern consumer policy should be developed. Capacity building is needed for adapting and absorbing the new technology. Concerning environmental sustainability, the following points are taken into consideration. The new technology should guarantee clean soil, water, air and natural resources in general. The new technology should be protective of human resources. Technology implementation should keep harmful emissions at a low level. The new technology should align with the existing environmental standards. Innovation sustainability means equal treatment of different impacts on the regions or/and countries, implementation of better training and management practices, monitoring and analysis of the overall processes and feedback to the provider, aiming at fast and proper adaptation, periodical evaluation of the process and action plan for reducing possible risks and finally elaboration of a strategy for further development of the sustained process. Who are the stakeholders of the technology transfer? Technology transfer includes a broad scope of actions. Various individuals, entities, public and private organizations, science bodies and universities etc. can participate in the process. In its course new knowledge and skills are adopted through a variety of official or informal channels. All the participants (stakeholders) are actively involved. They can be generally considered in several groups - governments and local authorities, scientific organizations (institutions, universities, R&D departments),

companies (in their role of consumers, producers or distributors), innovators (individuals or organizations) and financial institutions. All stakeholders should understand well the process of technology transfer in order to be able to take participation in the decision-making processes in an informed manner and properly execute their engagements. The efficient process of, technology transfer also necessitates intermediaries. They can organize the fluent transfer process and mitigate certain strains in the chain. Those could be specialized agencies, non-governmental organizations, university liaisons departments, various technology centers. Using the capacity of the intermediaries some extra activities can be performed, such as training, retraining, dissemination and communications; identification of skills and the necessary human resources, building up of various networks, feasibility, evaluation and packaging of various projects searching to generate financial support etc. Last but not least, the information channels should also be part of the stakeholders. They are needed in order to prepare the relevant acceptance and perception of the process, dissemination of information and preparatory work, contributing to new processes.

5. CONCLUSION.

What is the role of the technology transfer in the process of globalization? The global economy is streamlining towards economic growth and prosperity. Economic growth is laid on new frontier research, more new and skilled human resources, greater competitiveness and improved quality of life. The new European agenda “Europe 2020” emphasizes these aspects. Among the crucial tasks to be taken are the leading market development and transfer of comprehensive technologies. The effective formulation of referred tasks faces certain policy challenges - faster transition of the economy toward higher value added production with knowledge content, reinforcing the domestic R&D sector, improving the absorption capacity of the national economies for innovation products and services. Technology transfer acts as a catalyst contributing to closing the market pool, shortening the access to the market and closing the gap between curiosity-driven and market-driven approaches. The transfer stimulates demand for new products, raises the market awareness of the new products, and ensures a feedback to the inventors and supporting creation of intellectual capability, so that the market is able to absorb the novelties

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