GRIFFITH UNIVERSITY

An Architectural Framework for IT Innovation Systems: A case study on IT diffusion in Iran

Author

Mohtarami, Amir, Khodadad, S., Kandjani, Hadi

Published

2013

Journal Title

European Journal of Scientific Research

Rights statement

© 2013 EuroJournals Publishing, Inc. The attached file is reproduced here in accordance with the copyright policy of the publisher. Please refer to the journal's website for access to the definitive, published version.

Downloaded from

http://hdl.handle.net/10072/59457

Link to published version

http://www.europeanjournalofscientificresearch.com/issues/EJSR_106_3.html

Griffith Research Online

https://research-repository.griffith.edu.au

An Architectural Framework for IT Innovation Systems: a case study on IT diffusion in Iran

Amir Mohtarami[*1],S.H.Khodadad[2],Hadi Kandjani[3]

Abstract

In this paper, with a novel approach, authors are trying to develop an analysis framework to promote IT innovation system by synthesizing terminologies, reference models and theories from Enterprise Architecture descipline and Innovation System Theory. A mixed method research (Qualitative/quantitative) has been applied to develop and emprically use of the framework. In the first step, through a qualitative method, using expert interviews, we conceptualised this framework. Then in the second step, a survey research has been conducted to explore the instititional model of IT diffusion as a part of the framework in a given country (Iran). The results shows that we may apply this framework in policy making and analysis of IT diffusion and development at the national level in forms of a framework and an institutional Model (list of institutions). It has been also shown that this framework can be an multi-faceted integrated tool by which we could extract and analyze different models on various dimension of an innovation system.

Keywords: Information Technology, Innovation System, Enterprise Architecture, Zachman Framework, Diffusion

1. Introduction

There is a consensus on the role of Information Technology (IT) in development of national economy and welfare. ICT performance is crucial not only for developed countries for sustaining and enhancing their innovation potential and long-term competitiveness, but also for middle-income and developing countries in fostering structural transformations, increasing efficiency as well as reducing the digital, economic, and social divides within their territories and vis-à-vis more advanced economies (Dutta and Bilbao-Osorio 2012).

Different methods and frameworks Analysis could be used to analise the IT diffusion in developing countries. Many researches in IT development in the world, focused on some traditional analysis methods such as SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis , SLEPT (Social, Legal, Economical, Political and Technological) analysis , and so on (Vonortas and Safioleas 1997, Dewan and Kraemer 2000, Pohjola 2000, Rao 2004)

Certainly, the challenges of IT devlopment and diffusion in developing countries can be traced in many political, social and economical contexts but one of the most and common elements amongst them is the institutional weaknesses of IT diffusion in developing countries (Mansell and Wehn 1998, Arun, Heeks et al. 2004, Wilson 2004, Kshetri 2008).

Innovation system approach as a well known approach in the field of economic analysis seems to be a proper analytical base for the analysis of IT innovation diffusion in developing countries. Some

[1,*] Phd Candidte in Science and technology policy making, faculty of Management and economics, Tarbiat Modares University, A.mohtarami@Modares.ac.ir

[2,] Associate Professor in Management, faculty of Management and economics, Tarbiat Modares University, *khodadad@modares.ac.ir*

[3,] Phd in Enterprise Architecture and Information Systems, School of ICT, Griffith University, *H.Kandjani@Griffith.edu.au*

of the key reasons justifing the use of this approach for the analysis of IT in developing countries are as follows:

(1) One of the main factors of the economic and social inefficiency in the developing countries is the institutional weaknesses in the form of weaknesses in oraganizational, regulations and rules governing development. Therefore, some argue that there is a need for some structural and institutional reforms to respond to the development requirements in IT sector in these countrise (Mansell and Wehn 1998). The core of the innovation system approach is institutional view towards innovation development.

(2) According to the studies conducted in COMSTEC[1], a dynamic and innovative mix of government and private sector actions in the national innovation system can be used in developing countries to utilise information technology (Mansell and Wehn 1998).

(3) Developing of information technology rather than technical aspects needs socio-economical capabilities . Kazoshi ohkawa (1978) used the term, Social Capability, meaning the degree of educational and technical skills as well as the institutional, political, industrial and financial readiness. Innovation system approach looks through these viewpoints.

(4) If there are no appropriate institutional changes, effective IT use will be hindered by traditional mechanisms and institutional inefficiencies and inflexibilities in a way that it will not be possible to have an appropriate diffusion in developing cuntries (Mansell and Wehn 1998). Institutional preparation for utilizing potencial capablities of IT is a key factor in development of countries.

For these reasons, in this paper, the innovation system approach is adopted for the analysis of IT diffusion. Nelson and Rosenberg (1993) define the innovation system as a set of institutions whose interactions determine the innovative performance of national firms (Nelson and Rosenberg 1993).While, it is passed more than three decades from intruducing of innovation system approach, yet there are many conceptual ambiguty in this field and there is a lack of practical analytical tools for this concept.

Here, we develop a new framework for the analysis of IT development at national level. So, we apply the terminologies, reference models and theories from enterprise architecture descipline alongside with the innovation system ceoncepts to enrich the practical analytical base for IT innovation system analysis. The reason for this choice is that the architecture is not restricted to technical systems and is applicable more generally to the socio-technical systems as well (Zachman 1997).

Therefore, in this paper, we persue firstly to develop an integrated framework for IT innovation system architecture, secondly, we perform an instututional investigation of IT diffusion in Iran as a case study and emprical use of the designed framework. For this aim, in the next section, we take a glimpse to the underlying concepts from three domains of Innovation system theory, Enterprise Architectire discipline and diffusion theory. In section three, we explain the research method of this paper. In the section 4, the designed architectural framework for IT Innovation System (AFITIS) will be introduced. In section 5, a case study will be analyzed through the institutional model of IT diffusion in Iran. In section 6, the use of AFITIS for policy making in the IT sector will be explained. And finally, in section 7, the conclusion, we suggest some furthur research.

2. Concepts and Definitions

2.1. The Concepts of Innovation System

Although there are several definitions for innovation, they all share some similarities. Some have defined innovation as: “a process of enhancing existing technology” (Rosenberg 1976, Nelson and Winter 1977, Dosi 1982), some others have defined it as: “a process of turning opportunities into practical use” (Pavitt 1984, Tidd and Bessant 2011), some authors refer to it as: “an integrated process

[1]COMSTEC

involving …" (Schott 1981, Rothwell and Gardiner 1985), and some believe that innovation is: "any new technologies and new processes"(Porter 1990, Voss 1994, Rogers 1995).

The common concepts among all above definitions are novelty and process-nature of innovation. In the early studies on innovation, Marquis (1969) has identified three types of innovation: 1) radical component innovations, 2) incremental innovations to existing technologies, and 3) radical system innovations. Marquiz (1969) states that the incremental innovation is a consequence of planned actions so it is predictable. This class of innovations is focused on Innovation system theories.

The focus and complexity of theories about innovation have increasingly expanded, concentrating on individual firm or entrepreneur, expanding out to the environment and industry in which the firm operates, and in addition encompassing the national system of regulations, institutions, human capital and government programs (Niosi, Saviotti et al. 1993).

Innovation is therefore the result of a complex interaction between various actors and institutions. In fact, innovation does not occur in a precisely linear sequence, but it has nonlinear feedback loops within this system. Firms, the way firms organise the production and innovation, and the channels by which firms gain access to external sources of knowledge reside at the core of this system. These sources might be other firms, public and private research institutions, universities or broker institutions at any level of regional, national or international. Here, the innovative firm is seen as operating within a complex network of co-operating and competing firms and other institutions, building on a range of joint ventures and close linkages with suppliers and customers (Agapitova 2003).

This section briefly elaborated on the concept of innovation. In the next section we discuss the systemic view on innovation and NIS.

1.1 Systemic view on Innovation and NIS

As it was mentioned briefly above it is believed that innovation is a complex process which requires interaction amongst many actors. This complex process has some inputs and outputs which can be defined through'system approch'. According to innovation system theory, innovation and technology development are results of a complex set of relationships among actors in the system, which includes firms, universities and government research institutes as well as many other actors.

System approach to innovation has not a long history starting since the last three decades. Although there are some historical antecedents to the NIS concept, its main background could be traced in academic and policy making organizations as well (Sharif 2006). According to Freeman (1995), following World War II, a linear model of science and technology, 'push', was often dominant in the new science councils that advised governments. It seemed so obvious that the Atomic Bomb was the outcome of a chain reaction in which basic physics led to a large-scale development in large laboratories and consequently it led to the applications and innovations (Freeman 1995). While this linear perspective was going to be pervasive as a principle for policy-makers, it proved to be unable to account for different rates of technological innovation and economic development experienced by industrialised countries. Despite similarities among various industrialised and semi-industrialised countries in investing on R&D starting in the 1950's and 60's, evidence showed that the rate of technical change and of economic growth depended more on efficient diffusion than on radical innovations and as much on social innovations as on technical innovations (Freeman 1995).

Although there is not a common consensus in the roots of National Innovation Systems, it seems that this concept first appeared in the 1980s in the context of debates over industrial policy in Europe. Since then, there were growing trend of applying this concept in academic as well as in practice so that many countries started to use NIS as an innovation policy framework. Freeman, Lundval and Nelson were the first scholars who dealt with this concept. Freeman (1995) defines the NIS as "a network of institutions in the public and private sectors whose activities and interactions produce, import, modify and diffuse new technologies"(Freeman and Christopher 1987). Similar concept could be found in Nelson's definition that defines NIS as a set of institutions whose interactions determine the innovative performance of national firms (Nelson 1993). These elements include firms, public laboratories and universities, financial institutions and government regulatory bodies and others who interact together. For Lundvall, it is "constituted by elements and relationships which interact in the production,

diffusion and use of new and economically useful knowledge" (Lundvall 2010). One account of NIS is the "set of institutions that (jointly and individually) contribute to the development and diffusion of new technologies. These institutions provide the framework within which governments form and implement policies to influence the innovation process (Metcalfe 1995). Patel and Pavitt believe that NIS consists of national institutions, their incentive structures, and their competencies that determine the rate and direction of technological learning in a country (Patel and Pavitt 1994).

Depending on the geographical borders of the system, we can define other variations of innovations systems as 'Regional' Innovation Systems (e.g., many innovative companies are concentrated in Silicon Valley), 'Sectoral' Innovation Systems, (e.g., Automobile-related industries); and 'Technological' Innovation Systems (e.g., Electronics with applications in a different industries).

There exist both empirical and practical reasons for focusing on the nation as the primary unit of analysis (Sachs, Mellinger et al. 2001). Many gaps in development adhere to national boundaries, and strong correlations have been observed between poverty and geography. Since the NIS perspective is primarily concerned with the flow of knowledge and its impact on economic growth, it makes sense to concentrate on the level that seems most centrally implicated in governing these flows (Sachs, Mellinger et al. 2001).

Based on the NIS literature, there are two main tenets about NIS: one defines it in a broad scope which includes everything which is playing a role in the socio-economic environment. While it seems that this type of definition has a minimum practical use in policy analysis; the other one defines NIS in a narrow context. Since the socio-economic system cannot be considered to be included in the innovation system, the question is then: *Which parts should be included?* (Edquist, 2002). A way to answer to this question is to identify the "functional boundaries" of an NIS, beyond the "overall function of producing, diffusing and using innovations".

According to Organization for Economic Co-operation and Development (OECD), NIS institutions, defined in the narrow context, can be divided into five main categories (OECD 1997):

- Governments that make policy directions;
- Bridging institutions, such as research councils and research associations, which act as intermediaries between governments and the performers of research;
- Private enterprises and the research institutions;
- Financial institutions which provide financial support of innovation and
- Universities and Educational institutions.

The broad definition of NIS includes, in addition to the components within the narrow definition of NIS, all economic, political and other social institutions influencing learning, searching and exploring activities, e.g. a nation's financial system; its monetary policies; the internal organisation of private firms; the educational system; labor markets; and regulatory policies and institutions. Conceptually, the narrow definition is embedded within the broader definition of NIS.

1.2 NIS Functions

There are two key attributes for any innovation system. IT is both social and dynamic (Lundvall 2000). These features come from the nature of the institutions that form the system, as well as the linkages and flows that connect them to one another. It is social in the sense that it relies on "an institutional context constituted by laws, social rules, cultural norms, routines, habits, technical standards, etc." (Niosi 2002). It is dynamic due to the "financial flows between government and private organizations, human flows between universities, firms, and government laboratories, regulation flows emanating from government agencies towards innovation organizations, and knowledge flows (spillovers) among these institutions" (Niosi 2002).

Therefore we can identify four basic interactions in a given NIS as follows:

1) Interactions among enterprises, primarily joint research activities and other technical collaborations;
2) interactions among enterprises, universities and public research institutes, including joint research, co-patenting, co-publications and more informal linkages;

3) Diffusion of knowledge and technology to enterprises and diffusion through machinery and equipment;
4) Personnel mobility, focusing on the movement of technical personnel within and between the public and private sectors.

To perform efficiently, innovation systems should function in a way that smooth these interactions towards the goal of innovation systems which is to develop, apply, and diffuse new innovations. In literature, the activities that contribute to the goal of innovation systems (both positive and negative), are called functions of innovation systems (Johnson 2001). Although several different activities take place in innovation systems, it is necessary to only focus on the relevant activities.

Interactive Learning, is one of the primary functions has been mentioned in innovation system literature (Lundvall 1992). Edquist and Johnson (1997) mention three functions of institutions in innovation systems: institutions reduce uncertainty by providing information, manage conflicts and cooperation, and provide incentives for innovation. McKelvey (1997) differentiates three functions of innovation systems: (i) retention and transmission of information, (ii) generation of novelty leading to diversity, and (iii) selection among alternatives. Galli and Teubal (1997) focus on linkages as they explain the transition of innovation systems. They distinguish between hard and soft functions. Hard functions require hard institutions (i.e., performing R&D), while soft functions may be operated by soft institutions (for instance regulatory entities) and involve catalytic and interface roles only. Hard functions are: (i) R&D activities (public) and (ii) the supply of scientific and technical services to third parties. Soft functions include: (i) diffusion of information, knowledge, and technology; (ii) policy making; (iii) design and implementation of institutions concerning patents, laws, standards, etc.; (iv) diffusion of scientific culture, and (v) professional coordination.(Jacobsson and Johnson 2000) outline eight primary functions for an NIS as follows:

1) Guide the direction of the search process;
2) Supply resources, i.e. capital and competence;
3) Supply incentives for companies to engage in innovative work
4) Recognise the potential for growth (identifying technological possibilities and economic viability)
5) Facilitate the exchange of information and knowledge and Create ‘new’ knowledge
6) Stimulate/create markets
7) Reduce social uncertainty (i.e., uncertainty about how others will act and react)
8) Counteract the resistance to change (provide legitimacy for the innovation)

Liu and White (2001) have developed a different way of defining the functional boundaries of an NIS, identifying five fundamental activities as the core of a framework that can be thought of as nation-specific. These are (1) research (basic, developmental, engineering), (2) implementation (manufacturing), (3) end-use (customers of the product or process outputs), (4) linkage (bringing together complementary knowledge), and (5) education. (Liu and White 2001)

Another attempt have been made by Hekkert et al (2007) to identify the innovation systems functions by introducing seven functions as follows: (1) entrepreneurial activities (2) knowledge development (learning (3) knowledge diffusion through networks. (4) guidance of the Search (5)market formation (6)Resource mobilization (both financial and human) (7) creation of legitimacy/counteract resistance to change (Hekkert, Suurs et al. 2007).

As it is shown, several functions and activities have been mentioned in literature, however it seems that there were not any integrated classification about functions and activities during these studies. Therefore, by incorporating all these activities and functions, as well as getting inspired by Porter’s value chain model (Porter 2000), it may be possible to describe the functions of any given NIS around these seven basic functions of primary and supportive ones.

Primary functions denote to those that shape the main value creation of innovation which consist of innovation, diffusion and production. Supportive functions are required to direct the innovation, provide human and financial resources, stimulate and generate the market and provide infrastructures. Each function has subordinate activities as follows:

1. Directing and Regulating
   1.1. Generating required policies: policies in the fields of science, technology, industry, education and other related policies
   1.2. Making regulations, rules and laws: rule setting to support the policies e.g. patent system
   1.3. Standardisation of the products and the processes to reduce costs and improve quality
   1.4. Legitimisation of the technology and firms: through socio-economic policies
   1.5. Providing infrastructures
   1.6. Enhancing networking: promoting networking among different entities
2. Humand Resources Development and Training
   2.1. Public training and education
   2.2. Professional education
3. Providing financial support
   3.1. Providing venture capitals
   3.2. Providing other financial supports (e.g loanes, investments)
4. Knowledge Creation and innovation (R&D)
   4.1. Research and Development: performing research and development in technology
   4.2. Technology transfer: technology transfer from the external sources
5. Production and commercialization
   5.1. Commercialisation of Innovation and entreprenurship
   5.2. Manufacture products or provide services
6. Diffusion of Innovations (Idea/product/Product/ Process)
   6.1. Informing: about technologies, knowledge, demand and supplies and opportunities
   6.2. Advertising of innovations and technologies
   6.3. Brokerage: bringing together complementary knowledge and resources
   6.4. Incubation: for new innovations and new entrants
   6.5. Other Supports for diffiusion

2.2. Enterprise Architecture and Zachman framework

2.2.2. Enterprise Architecture Concept

There are many definitions for Enterprise Architecture (EA) in literature. More commonly, when we are referring to the Enterprise Architecture, we are referring to the models, documents, and reusable items (as components, frameworks, objects, and so on) that reflect the actual architecture

However, moreover EA is defined as a framework or "blueprint" for how the enterprise achieves the current and future business objectives. It examines the key business, information, application, and technology strategies and their impact on business functions. Each of these strategies is a separate architectural discipline and Enterprise Architecture is the glue that integrates each of these disciplines into a cohesive framework.

EA is a new and heavily used term in the industry and relatively is sometimes "confused" with and other times "mis-interpreted" by both practitioners as well as researchers. IEEE 1471-2000 standard defines Architecture as the fundamental organization of a system, embodied in its components, their relationships to each other, and the principles governing its design and evolution (Hilliard 2000).

However, according to some researchers, EA should have a greater role to play in aligning technologies with the business to achieve strategic objectives and competitiveness. For example, Wegman (2003) claims that EA is a discipline whose purpose is to align more effectively the strategies of enterprises together with their processes and their resources (business & IT). In fact, EA represents a process, not a thing or entity. The process will result in the creation and iterative refinement of many artifacts that collectively define future enterprise architecture, and it will identify the gaps between the current or as-is architecture and future or to-be architecture.

2.2.3. Zachman Framework

Zachman framework as it applies to Enterprise is simply a logical structure for classifying and organizing the descriptive representations of an Enterprise that are significant to the management of the Enterprise as well as to the development of the Enterprise's systems (Schöenherr 2009). The framework is a matrix which describes various ways the stakeholders of an enterprise view the business and its systems. It characterises architecture in terms of the perspectives of different stakeholders (represented by rows) and focuses on different aspects of architecture (represented by columns). The framework is claimed to be applicable in any other scope of enterprises such as large scale socio-economic systems as well as an organization (Zachman 1997).

The basic idea behind Zachman Framework is that the same complex thing or entity that can be described for different purposes in different ways using different types of descriptions (e.g., textual, graphical). Zachman Framework provides thirty-six necessary categories for completely describing an enterprise and its entities; especially complex things like manufactured goods (e.g., appliances), constructed structures (e.g., buildings), and enterprises (e.g., the organization and all of its goals, people, and technologies). The framework provides six different transformations of an abstract idea (not increasing in detail, but transforming) from six different perspectives (O'Rourke, Fishman et al. 2003). It allows different people to look at the same thing from different perspectives. This creates a holistic view of the environment, an important capability illustrated in the figure1.

Each row represents a total view of the solution from a particular perspective. An upper row or perspective does not necessarily have a more comprehensive understanding of the whole than a lower perspective. Each row represents a distinct, unique perspective; however, the deliverables from each perspective must provide sufficient detail to define the solution at the level of perspective and must translate to the next lower row explicitly. Rows are described in six perspectives as: 1) Planner's View (Scope), 2) Owner's View (Enterprise or Business Model), 3) Designer's View, 4) Builder's View, 5) Subcontractor View (Detailed Specifications), 6) Actual System View or The Functioning Enterprise

Each perspective focuses on the same fundamental questions, then answers those questions from that viewpoint, creating different descriptive representations (i.e., models), which translate from higher to lower perspectives. In addition, six categories of enterprise architecture components, and the underlying interrogatives that they answer, form the columns of the Zachman Framework and these are: 1) what? -The data description, 2) How? The function description, 3) Where? The Network description, 4) who? The people description, 5) When? The time description and 6) Why? The motivation description

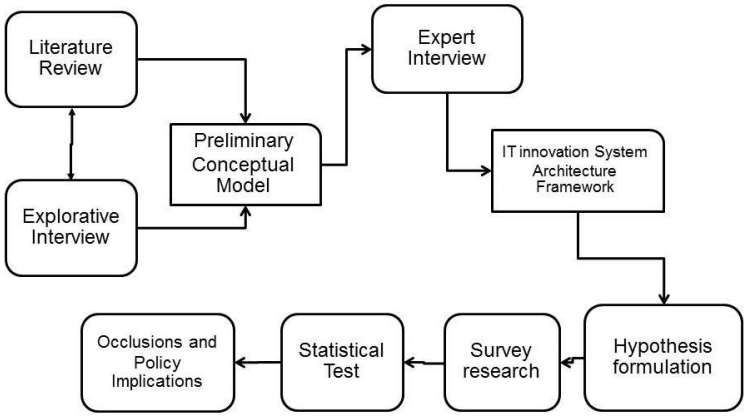
Figure 1:Zachman Framework- Adapted from (O'Rourke, Fishman et al. 2003)

	What (Data)	How (Function)	Where (Locations)	Who (People)	When (Time)	Why (Motivation)
Scope {contextual} Planner	List of things important to the business	List of processes that the business performs	List of locations in which the business operatses	List of organizations important to the business	List of events/ cycles important to the business	List of business goals/strategies
Enterprise Model {conceptual} Business Owner	e.g. Semantic Model	e.g. Business Process Model	e.g. Business Logistics System	e.g. Workflow Model	e.g. Master Schedule	e.g. Business Plan
System Model {logical} Designer	e.g. Logical Data Model	e.g. Application Architecture	e.g. Distributed System Architecture	e.g. Human Interface Architecture	e.g. Process Structure	e.g. Business Rule Model
Technology Model {physical} Implementer	e.g. Physical Data Model	e.g. System Design	e.g. Technology Architecture	e.g. Presentation Architecture	e.g. Control Structure	e.g. Rule Design
Detailed Representation {out-of-context} Subcontractor	e.g. Data Definition	e.g. Program	e.g. Network Architecture	e.g. Security Architecture	e.g. Timing Definition	e.g. Rule Definition
Functioning System	e.g. Data	e.g. Function	e.g. Network	e.g. Organization	e.g. Schedule	e.g. Strategy

3. Research Method

Becouse of the goal of this paper, designing a framework and testing it in a pilot domain, we conduct a Mixed method as our research methodology. The goal of mixed methods research is to tackle a given research question from several relevant angles, making use of previous researches and/or more than one type of investigative perspective. Sometimes referred to as mixed methodology, multiple methodology or multi-methodology research, mixed methods research offers the best of both worlds: the in-depth, contextualised, and natural but more time-consuming insights of qualitative research coupled with the more-efficient but less rich or compelling predictive power of quantitative research(Creswell 1999).

In the designing context, we employ a qualitative approach based on previous litrature review and explorative interviews with experts as well as synthesysing two well known frameworks from two distinct descipline (EA and NIS desiplines) to form a analytical framework. In the emprical investigation context, we have done a survey research in a cell of our architectureal framework as an instance for practical use of designed architectural framework. It is done on the case study of the IT diffusion in Iran.



The population of this research in the quantitative stage is all of the IT related experts in Iran. Becouse of the extent of this population we consider numerous other factors such as related experience, related academic field of study and managerial experience in IT sector to narrow the population. Sampling were coducted through a unaccidential snow-ball method.

About 467 questinares were sent manually and electreonically to the experts and 375 completed ones received and among them 259 questainare considered reliable for analysis. The validity of questionaires was assessed through a Cronbaugh test. For this aim, the questionnaires wre sent to 19 experts and the responses were analyzed by SPSS software. The results are represented in table 2.

Table1: results of Validity test for reserch questionnaire

	Items	**Number of Questions**	Cronbaughα
	Physical Institutions	23	94.3
	Regulatory Institutions (Rules and regulations)	12	89.8
	Norms (Cultural norms)	7	85.6

4. A Framework for IT Innovation system architecture

We chose Zachman framework as a basis for developing ITISA. The main reasons for this choise are as follows:

- Zachman freamework is a generic framewirk which can be applied for system architecture in which the type of system is not a matter (technical, social or socio technical system).
- Many other architectureal frameworks in the field of Enterprise Architecture have been based on this framework.
- Other architectureal frameworks in the field of Enterprise Architecture mostly are technology oriented and have been defined in information systems.

Becouse the origin of Zachman Framework is in the information system descipline, applying this framework to IT innovation system field, needs some modifications and costomization of new concepts and deffinitions in this new field. For this aim, we should focus on elements and constructs of Zachman Framework in columns and rows. Columns in which different views to an information system are resting, are generic and not only restricted to IT systems but also applicable to any socio-technical systems. So we just redefine these views in the innovation system context as follows:

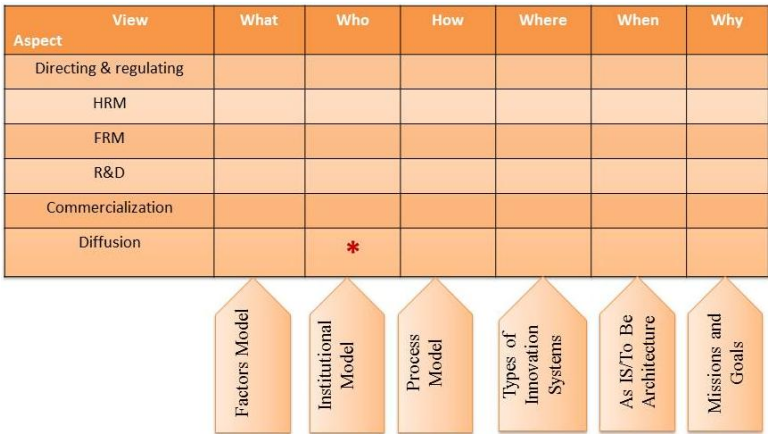
- What: what factors are affecting the innovation system? These factors could be traced in economy, politics, social, culture and technological fields. Identifying these factors, reveals the leveraging point for promoting innovation in a specific context. Answering this question form diferent perspectives(6 rows) totally lead to some important factors which are affecting innovation system. We call these factors as the "Factors Model".
- Who: who plays the roles in an innovation system? Answering this question form diferent perspectives (6 rows) totally lead to some important actors, organizations, firms, and in a broad difinition "institutions" which play some specific roles in an innovation system. We call the resulting model of this column as the "institutional Model".
- How: how is the process of innovation in any perspectives. Answering this question reqires identifying activities and processes related to different roles in an innovation system. We call the resulting models of this column as "Process Model".
- When: this view shows the state of the architecture: As-Is or To-Be Architecture
- Where: wehre are the borders of system? The answer of this questions defines the limits of underlying system which could be local, reginal, national, or even global. In this paper we focus on national level at our case study.
- Why: infact, this view concerns the philosophy and logics underlined the institutional involvement in an innovation system. Answering this question reveals the reasons behined policies and behaviors of actors in an innovation system. . We call the resulting models of this column as "Policy Model".

Columns, in which the many views on system are arranged in ZF, we can not apply them becouse an Innovation systems is not a propriotory system and has not any specific owner. We could borrow the concept of "role" from innovTion system descipline and arrang The views on ITinnovatio n system based on roles that are involved in an Innovation system.So, we define the different views on an innovation system as follows:

- **Directing and Policy making view**: include aspects of an innovation system related to policy makers and strategies in the innovation system.
- **Human resource development view:** includes those factors related to preparing skilfull people, training and education and empowerment of peaople in the innovtion system.
- **Financial Resources view:** includes elements related to financing innovation, research and pruduction financial support and even financing usage of innovation.
- **Research and development view:** includes knowledge creation, R&D and innovating activities.
- **Commercialization view:** includes elements related to prototyping, testing, production and entreprenurship activities.
- **Diffusion view:** includes elements related to informing, promoting and diffusing of an innovation.

Like the ZF, crossing these two dimensions (Aspects and Perpectives on an innovation systems) shape a matrix that we call it Information Technology Innovation System Architectural Framework (ITISAF). Each cell of this matrix defines a part of a complex IT innovation systems. Each cell should be modeled, in other words each cell contains a model of an IT innovation system with different level of abstraction and generality and from different aspect and view. Modelling of each model in each cell could be in the form of text, flows, relational models and etc according to the posision of the cell. For example, cell 6,2 (row 6, column 2) represents the institutional model in diffusion of IT innovation in which we determine which institutions are involved in IT diffusion in an specific geogrphical border. The sum of these 36 cells, totally explaine a comprehensive schema of an innovation system which could be specific to a technology (here Information Technology) or to a geografical entity such as overal national innovation system.
As the focus of this paper is on the information technology, as an instance, we extract the institutional model for IT diffusion in a specific geographical border (IRAN) based on this framework (Cell 6,2).

Figure 2: An Architectural Framework for IT innovation system



5. A Case Study:Institutional Factors of IT diffusion in Iran

Since the late of 1990s, Iran started to bring Information technology as a main driver in its 5 year economic plans. To address this issue, Iran has made efforts to facilitate diffusion of technological innovations to effectively direct the economy to information and knowledge based economy. For this aim an special initiative on diffusion of IT applications has been made and run over 4 years ending to 2004 which was called TAKFA[1].

In spite of many developments in IT applications in different national domains such as e-government, e-learning, IT based SMEs, e-health and so on, the contribution of IT in national economy of Iran is not yet satisfying compare to other regional countries. Although there is not any reliable comprehensive statistics on contribution of IT sector in national economy, it is estimated that only lower than 0.5% of GDP relies on IT industry. It seems that, there are some missed blocks in the process of IT innovation diffusion in iran.

Recently, many researches have been involved in investigating of barriers, pitfalls and shortcomings in IT development in Iran (Albadvi, 2004; Asemi, 2006, Tabatabaian and al, 2007).

Tabatabaian and et al (2007), in a study on national IT Strategy of iran, investigated bariers on IT development in iran, and argued that 'institutuinal weaknesses on IT development' was one of the major barriers. They found that IT development in both sides of industry innovation and diffusion of applications needs some institutional support specially in an economy that is mainly a planned economy and Governemntal, so through an institustional mapping, they showed some shortcommings

[1] TAKFA is a abriviated form of " Development of ICT aplication" in Persian

in institutions, functions and cooperation among institutions in IT field from policy making bodies to research institute and production companies. However, there are some reasons that make the results of their study less comprehensive: first, the focus of research only was on physical institutions whilst other studies show that the cultural and regulational weaknesses would be involved in demonstating IT diffusion. Second, for this research they have used a framework called NIS (National Innovation System) which is not an IT spesific framework while other variant of system approach to Innovation concentrating on Technology called Technology innovation systems or even Sectoral Innovation Systems are more apropriate.

We applied the ITISAF as an analytical faramework to investigate the institutions involved in IT diffusion in Iran (Institutional Model). In afct, we focus on cell of 6,3 in the framework and search to answer the following questions:

- Which institutions are important in IT diffusion?
- What is the current state of performance of these institutions in Iran?

To answe these questions, at first we should define the meaning of "institution" precisely because this concept has meanings in to ways: in a narrow way it means just as physical entities like organisations but in a broder definition, it points on rules or policies (Edquist and Johnson 1997). we aquire this broader difinition here and define the institution as a concept in three level:

1. Physical level: refers to organization and phisycal entites
2. Regulatory level: refers to ruls, regulations and laws
3. Norms: refers to cultural norms and traditions.

5.1 Survey Study

According to the broader deffinition of "institution", after an in depth review on prior reserch on institutions in IT innovation systems and through a pre-interview with experts, we gathered a list of different institutions in three levels of physical, regulational and Noramative. Then, using cross-analysis, we classified them based on functinal similarity and finally we reached a set of 42 institutions acting in the IT diffusion domain. (Table 2 shows these institutions in theree levels.)

Table2: List of Institutions affecting IT diffusion

Physical institutions (Entities)		
ICT technology parks	Television Peograms in ICT field	Advertizing and Promoting medias
ICT industrial clusters	National ICT Policy maker bodies	Cyber space security institutes
IT firms	ICT service centers	Informal market of ICT
Standardization Bodies	ICT stores and Malls	IT Kiosks and coffee nets
Venture Capitals	IT general Skills institutions	Internationa organizations related to ICT eg. ITU
ICT fairs	IT Conferences	IT proffecional Skills institutions
IT academic Departments	IT Research Centers	IT publications and publishers
Regulative institutions (Rules and regulations)		
Digital Signature	Filtering regulations	Subside laws on IT related activities

IP right laws	Tax related laws	Anti trust laws
Cyber space security laws	Insurance facilities regulations	National IT strategic plan
Laws against cyber Crimes	Laws related to IT diffusion e.g e commerce initiative, e government and	Financial Support policy on IT activities
Normative institutions (Norms and traditions)		
Trust on Cyber space	Feminin or masculine culture	Tendency for Sharing Knowledge
Intelectual property Right	Tendency for newness and innovation	Religius values
	Globalizm	

Then to answer the research questions, we desined a questionaire with two sides, one side asking the opinion of the responder about the degree of importance on institution "X" on IT diffusion and the other side asking the level of current performance of institution "X" on IT diffusion in Iran. Likhert spectrum was used to answer 42 questions. About 467 questinares were sent manually and electreonically to responders in which 375 were completed and received and among them 259 questainare considered reliable for analysis. The validity of questionaires was assessed through a Cronbaugh test. For this aim, the questionnaires were sent to 19 experts and the responses were analysed by SPSS software.

The first research question has converted to statistical hypothesis as follows:

H0: The average importance of effect of "institustion X" for IT diffusion is equal or less than 3.5.

H1: The average importance of effect of "institustion X" for IT diffusion is more than 3.5.

And the second one has converted to statistical hypothesis as follows too:

H0: The average current performance of "institustion X" for IT diffusion in Iran is equal to or less than 3.5.

H1: The average current performance of "institustion X" for IT diffusion in Iran is more than 3.5.

One tailed T test was applied for data analysis using SPSS software.

5.2 Data Analysis

Data was gathered through questaonnaires in two main sections: first question: which are institutions are more important in IT diffusion in Iran, and the second question: how is the current state (in terms of performance) of those institutions in iran.

5.2.1 The more important institutions

The hypothesis related to this question was formulised as follows:

H0: The average importance of effect of "institustion X" for IT diffusion is equal to or less than 3.5.

H1: The average importance of effect of "institustion X" for IT diffusion is more than 3.5.

In fact, responders were asked to express their opinion about importance of effect of each physical institutions (23 institutions), regulations (12 regulatory institutions) and norms (7 norms) in IT diffusion. The results are presented in tables 3 and 4 accordingly.

Table 3: T test for "importance of effects" for three class of institutions

Types of Institutions	Quantity	Mean	Variance	Standard error
Physical Institutions	259	4.47	0.578	0.48
Regulatory Institutions (Rules and regulations)	259	3.84	0.521	043/0
Norms (Cultural norms)	259	4.32	640/0	052/0

Types of Institutions	T	Degree of	Confidence	Deviation

		freedom	level	from mean
Physical Institutions	19.91	258	0./001	0.97
Regulatory Institutions (Rules and regulations)	25.56	258	0./001	0.34
Norms (Cultural norms)	16.70	258	0./001	0.82

The results show that for physiucal institutions, as the computed level of confidence is lower than determied level (0.05), therefore H1 is accepted meaning that in the mean (= 4.47) representing responders opinion about "importance of effects" for physical institutions in IT diffusion is more than the predefined value (3.5) so we can state that in experts opinion, physical institutions are important for IT diffusion. But this conclusion is confirmed for each of the physical institutions seperately except the "informal market of IT".

Also, for the regulatory institutions, becouse the computed level of confidence is lower than determined level (0.05), therefore H1 is accepted and meaning that the mean (= 3.84) of the responders opinion about "importance of effects" for regulatory institutions in IT diffusion is more than predefined value (3.5) so we can state that in population opinion, nominated regulatory institutions are important for IT diffusion. But this conclusion is not confirmed for all of nominated regulations seperately. "Filtering regulation" with the mean of 3.48, "Tax regulations" with the mean of 3.48, "Insurance fascilities for IT companies" with the mean of 2.75, "Anti-trust rules" with the mean of 3.49, and "Financial supporting policies" with the mean of 3.19 are those that rejected the H1 hypothesis, so we can not conclude that they have important effect on IT diffusion.

For the third level of institutions, Norms and cultural institutions, H1 is accepted with a T value of 16.70 but in a seprately manner, this is not true for "Religious values" with the mean of 3.00, "Tendency to sharing knowledge" with the mean of 2.99, "The masculine culture" with the mean of 2.45, and "Universalism" with the mean of 3.28 and it means that in experts opinion, these institutions do not have important effect on IT diffusion.

5.2.2 The current state of institutions

Responders were asked to state their opinion about the As-Is state of performane of each physical institutions (23 institutes), regulations (12 regulatory institutions) and Norms (7 norms) in IT diffusion in Iran. The hypotheses related to this question were formulated as follows:

H0: The average current performance of "institustion X" for IT diffusion in Iran is equal to or less than 3.5.

H1: The average current performance of "institustion X" for IT diffusion in Iran is more than 3.5.

The results are represented in tables 5 and 6 accordingly.

Table4: T test for "current satet performance" for three class of institutions

Types of Institutions	Quantity	Mean	Variance	Standard error
Physical Institutions	259	2.65	-0/95	0.42
Regulatory Institutions (Rules and regulations)	259	2.26	0.521	041/0
Norms (Cultural norms)	259	2.32	640/0	054/0

Types of Institutions	T	Degree of freedom	Confidence level	Deviation from mean
Physical Institutions	19.91	258	0./001	-0/95
Regulatory Institutions (Rules and regulations)	25.56	258	0./001	-1/24

Normative Institutions(Cultural norms)	16.70	258	0./001	-1/18

The results show that for physical institutions, as the computed T value (19.91) is more than the standard T value, therefore H1 is rejected meaning that the mean (= 2.65) of the responders opinion about "current state performance" for physical institutions in IT diffusion is lass than predefined value (3.5) so we can state that in population opinion, physical institutions are not performong well for IT diffusion in Iran. But this conclusion is not true for some instances of these institutions as "General IT skils educational institutes" with the mean of 3.63, as "Iranian IT special journals and publications" with the mean of 3.64 are more than predefined value (3.5)

Also, for the regulatory institutions, as the computed T value (25.56) is grater than standard value so, H1 is rejected meaning that the mean (= 2.65) of the responders opinion about "current state performance" for regulatory institutions in IT diffusion is less than predefined value (3.5) in so we can state that in population opinion, rules and regulations are not performong well for IT diffusion in Iran. This is true for all nominated regulations except for "IT diffusion national programs" with the mean of 3.54 which shows an acceptable performance for IT diffusion in Iran.

For the third level of institutions, Norms and cultural institutions, H1 is rejected too with a T value of 16.70 meaning that in experts opinion, the dominated norms and cultural perceptions in Iran are not supporting IT diffusion. Among these categories "Tendency for new things" with the mean of 3.51 is the only normative institution that perfoms satisfactorily as a support for IT diffusion in Iran.

5.2.3 Discussion

The result of Hypothesis test on the importance of the role of different institiutions in IT difusion in iran was confirmed in our list of institutions except ten instances as follows: "informal market of IT", "filtering regulation", "Tax regulations", "insurance fascilities for IT companies", "anti trust rules", and "financial supporting policies", "religious values, "tendency to sharing knowledge", "The masculine culture" and "universalism". It means that among 23 phisycal institutions all except one and among 12 regulatory institutions all except 3, and among 7 normative institutions all except 4 have been confirmed as important to diffusion of IT.

The cause of this rate of importance confirmation is due to the way of extracting the list of institutuons. As we prepared the list after a broad litrature review alongside of expert interviews, it is acceptable that the most of the list itema are those that are important institutions in IT diffusion.

What was unexpected through results was the rejection of importance of "religius values" on IT diffusion, however we have many different evidence showing the important effects of religious perception on diffusion of Information Technologies. For example, the 4G technology of Mobile communication has encountered many challenges from religious leaders in Iran. They mention that the posibility of facial communication through mobile phones may lead to expansion of unacceptable types of relationships among males and females. It seems that the intangible and long term effects of normative institutions neglected them from visions while in fact they are fundamental institutions which most of upper level instititutions are based on these. Fore example, religues values and cultural concerns force the establishment of some kinds of filterring regulations and consecuently lead to formation of some physical institutions (control and monitoring centers).

Among regulatory institutions, those related to financial support of IT companies and anti-trust laws are not mentioned as very important. We investigated this through interviews with experts and realised that because the nature of IT industry is more knowledge intensive rather than money intensive as well as the low price of IT products comparing to other technological products, if other market factors (free competition) are provided, then diffusion of IT does not need so much of special financial supports. Indeed, becouse of the lack of any large and dominated company of IT industry in Iran, the anti-trust regulations are not considered important for IT diffusion in Iran.

Analysing data which was gathered about current state of effective institutions on IT diffusion in Iran also reveals interesting findings. Hypothesis tests confirmed the poor performance of institutions in IT diffusion in Iran. Although, this hypothesis confirmed in all of three classes of institutions (Physical, Regulational and Normative institutions), in some instances this is not true. At physical

level of institutions, "General IT skils educational institutes" and " IT profissional journals and publications" are those that are considered well performing institutions in IT diffusion in Iran. This is the same for "IT diffusion national programs" at regulational level and "Tendency for new things" at the normative level. To justify these finding we can argue that since Iran has a governmental economy then the main market of IT resides on governmental sector as well as the fact that the main bottleneck of innovation supply in IT sector such as research centers, large companies and universities are in control of governments so any government action directly affects IT diffusion in country. For example, a national program on IT development (Known as TAKFA) in the beginning of 2000 made a huge diffusion of IT applications in both government and private sectors.

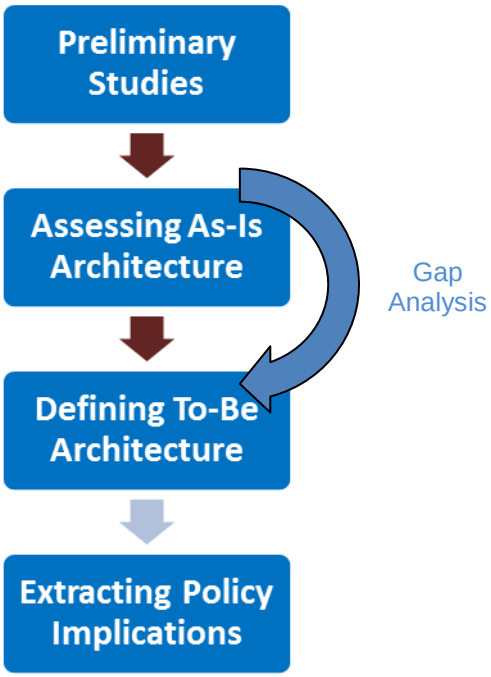
About the "tendency for newness", it seems that the demographical factor act as a mediating variable becouse the big rate of youth in populition of Iran and their corresponding threats on exploring new thigs and fashions as technology demanders play a critical role on IT diffusion in public sector. It must be mentioned that this situation has a potencial threat where if the population grow older, it may lead to decline in the speed of IT diffusion. Hence, policy makers should pay attention to technology transfer policies to accelarate IT diffusion as tommorow is late.

6. Policy Implications

6.1 A Tool for policy making

IT Innovation System Architectural Framework (ITISAF) can be used as a tool for analysing and formulating related policies to promote and diffuse innovations in ICT field. It could be done by a gap analysis between As-Is and To-Be architectures. To do this, we propose a 5 step methodology as illustrated on Figure 3.

- **Preliminary Studies-** Some topics would be investigated and studied in different depth depending on case such as: Gathering basic data related to ICT situation in national scope e.g contribution of IT in economic Growth, Innovations occurred in IT at national and global scope, the rate of ICT sector growth in national economy, contribution of ICT in employment, Also, attaining a big picture about the trend of ICT as a sector as well as an enabler in national and global level, the role of ICT in national economy.
Identifying other macro trends and socio economic factors that would affect the ICT position in national level should be considered.
Generally, these preliminary studies should bring a rich picture of ICT situation in national level and related macro data and policies.



- **Assessing As-Is Architecturetors that would-** Assessing the As-Is Architecture means that identifynig various institutions that currently act in the field of information and communication technology in national level as well as those who are directly affecting it beyond the borders. This could be done through search in formal databases of industries, Government, Bussinesses as well as survey researches.
Also, qualitative researches should be conducted to diagnose current strenghts, weacknesses, oppurtunities and threats sorrounding ICT sphere in both national and international level.

- **Defining To-Be Architecture-** To-Be architecture can be extracted from refference architecture introduced in this paper with reqiered adjustments depending on the case. Consider that,

the refernce model is not the To-be architecture, however it is just a ropository of entities, functions and relations which could be useful to develop a context dependent To-Be architecture.

- **Gap Analysis**- Comparing As-Is Architecture with To-Be architecture leads to identify some gaps and discomplyings. This may come frome different sources: (i) some specific entities do not exist in current situation (ii) some specific functions are not coverd by exitent entities (iii) some requierd relationships do not exists among specific existing entities (iv) other indirect shortcommings. Each of these situations should be treated as through Gap Analysis which needs to analyse policies and practices.

Extacting Policy Implications- Gaps identified in previous phase are the baseline of policy recommendations. Due to the network relations between actors, factors and policies sometimes a gap analysis in shold be conducted in many different fields even not directly related to ICT.

7. Conclusion and Furthet Researches

Policies and strategies are key issues in promoting information technology which are involved by many developed and developing countries to bring IT in national economic growth strategies' agenda. What is agreed on is that the diffusion of IT innovation in any country could offer new opportunities for economy in terms of increased productivity, job creation and new businesses. The diffusion of innovations are studied under various theories within which Innovation System theory is one of the wellknowns. In this theory, innovation creation and diffusion is caried out in relation with many institutions through a process not an stand alone event. Applying this diffinition alongside diffusion theory in a framework from Enterprise Architecture descipline, enabled us to introduce a new concept as: "*Architecture of IT innovation system*" depicting a comprehencive schema of innovation systems in answering 36 different questions (ITISAF framwork questions).

The introduced architecture for IT innovation and diffusion system was a prelimenary attempt to bring insights from more distinct and also related discipline together to shape a framework for promoting ICT in any scope specially at national level. Therfore, it needs more theorical critisism as well as emperical research to strengten and complete this new topic.

One of the main required researches should be additional investigation on what instituitions(entities) are reqired or and their role in IT innovation diffusion system in other five perspectives which are not coverd in our servey study. Indeed, if these institutions are context dependent and differ in any country comparing to other, whereupon scholars mention that innovation systems are path dependent and could not be copied from one country to another, the question is whether this issue could also be applied to IT innovation system.

Although the concept of institution can be applied to some physical on organizational entities, it carries broader meaning including norms, rules and accepted policies which could bring more items in the list of IT innovation system entities. One research area to deepening this architecture and broadening their analysis strength is to take into account this meaning of entity. Of course, to afford this, enterprise architecture modelling needs to be readjusted to be able to demonstrete soft entities such as norms and cultural factors as well as hard entities such as organizations and projects.

Stregntening this architecture as a refference architecture for IT innovation system needs some studies on best practices in successful countries in the development of IT applications and innovations in their industries as well as other socio-economical sphere. These types of studies should be performed not only on the developed countries but also in less developed and developing ones becouse of the differences between conditions and requirements of them. May be, these studies lead to a more contingent approach to prescribe the institutes for IT innovation system architecture according to the conditions of each country.

Applying this architectural framework (ITISAF) in other real cases is another field of future research which may lead to some practical perscriptions for IT development in countries under study. Section 6, tried to provide a meta-methodology for doing this type of case study.

References

Agapitova, N. (2003). Social Networks, Innovation and Industrial Organization: The Lessons of Russian Industrial Conversion. A Conference in honor of Keith Pavitt. SPRU - Science and Technology Policy Research, Freeman Centre, University of Sussex, Brighton, U.K.

Albadvi, A. (2004). "Formulating national information technology strategies: A preference ranking model using PROMETHEE method." European Journal of Operational Research**153**(2): 290-296.

Arun, S., et al. (2004). ICT initiatives, women and work in developing countries: reinforcing or changing gender inequalities in South India?, Institute for Development Policy and Management, University of Manchester.

Asemi, A. (2006). Information technology and national development in Iran. Hybrid Information Technology, 2006. ICHIT'06. International Conference on, IEEE.

Creswell, J. (1999). "Mixed-method research: Introduction and application." Handbook of educational policy: 455-472.

Dewan, S. and K. L. Kraemer (2000). "Information technology and productivity: evidence from country-level data." Management science**46**(4): 548-562.

Dosi, G. (1982). "Technological paradigms and technological trajectories." Research Policy**11**: 146.

Dutta, S. and B. Bilbao-Osorio (2012). The Global information technology report 2012: Living in a hyperconnected world, World Economic Forum and INSEAD Business Schoo.

Edquist, C. and B. Johnson (1997). "Institutions and organisations in systems of innovation." Systems of innovation: Institutions and organisations: 41-63.

Edquist, C. and B. Johnson (1997). Institutions and organizations in systems of innovation, Univ.

Freeman, C. (1995). "The 'National System of Innovation'in historical perspective." Cambridge Journal of economics**19**(1): 5-24.

Freeman, C. and F. Christopher (1987). Technology policy and economic performance: lessons from Japan, Pinter Publishers London.

Galli, R. and M. Teubal (1997). "Paradigmatic shifts in national innovation systems." Systems of innovation: Technologies, institutions and organizations: 342-370.

Hekkert, M. P., et al. (2007). "Functions of innovation systems: A new approach for analysing technological change." Technological Forecasting and Social Change**74**(4): 413-432.

Hilliard, R. (2000). "Ieee-std-1471-2000 recommended practice for architectural description of software-intensive systems." IEEE, http://standards. ieee. org.

Jacobsson, S. and A. Johnson (2000). "The diffusion of renewable energy technology: an analytical framework and key issues for research." Energy policy**28**(9): 625-640.

Johnson, A. (2001). "Functions in Innovation System Approaches". in Paper for DRUID‟ s Nelson-Winter Conference. Aalborg, Denmark."

Kshetri, N. (2008). "Barriers to e-commerce and competitive business models in developing countries: A case study." Electronic Commerce Research and Applications**6**(4): 443-452.

Liu, X. and S. White (2001). "Comparing innovation systems: a framework and application to China's transitional context." Research Policy**30**(7): 1091-1114.

Lundvall, B. (2000). Introduction, in Edquist, Charles and Maureen McKelvey (eds.). Systems of Innovation:Growth, Competitiveness and Employment. Cheltenham, UK, Edward Elgar Publishing

Lundvall, B. A. (1992). "National innovation system: towards a theory of innovation and interactive learning." Pinter, London.

Lundvall, B. A. (2010). National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning, Anthem Press.

Mansell, R. and U. Wehn (1998). Knowledge societies: information technology for sustainable development, United Nations Publications.

Marquis, D. G. (1969). "The anatomy of successful innovations." Innovation**1**(7): 28-37.

McKelvey, M. (1997). "Using evolutionary theory to define systems of innovation." Systems of Innovation - Technology, Institutions and Organizations, p 200-222.

Metcalfe, S. (1995). "The economic foundations of technology policy: equilibrium and evolutionary perspectives." Handbook of the economics of innovation and technological change**446**.

Nelson, R. and S. Winter (1977). "In search of a useful theory of innovation." Research Policy**6**.

Nelson, R. R. (1993). National innovation systems: a comparative analysis, Oxford University Press, USA.

Nelson, R. R. and N. Rosenberg (1993). "Technical innovation and national systems." National innovation systems: A comparative analysis: 3-21.

Niosi, J. (2002). "National systems of innovations are "x-efficient"(and x-effective): Why some are slow learners." Research Policy**31**(2): 291-302.

Niosi, J., et al. (1993). "National systems of innovation: in search of a workable concept." Technology in society**15**(2): 207-227.

O'Rourke, C., et al. (2003). Enterprise architecture using the Zachman framework, Thomson Course Technology.

OECD (1997). National Innovation Systems, Organization for Economic Cooperation and Development.

Ohkawa, K. (1978). Initial conditions: Economic level and structure. Papers and proceedings of the conference on Japan's historical development experience and the contemporary developing countries: issues for comparative analysis. Tokyo: International Development Center of Japan.

Patel, P. and K. Pavitt (1994). "The nature and economic importance of national innovation systems." STI review**14**.

Pavitt, K. (1984). "Sectoral patterns of technical change: towards a taxonomy and a theory." Research Policy**13**(6): 343.

Pohjola, M. (2000). Information Technology and Economic Growth. A Cross-Country Analysis.

Porter, M. (1990). The Competitive Advantage of Nations. London, Macmillan.

Porter, M. (2000). "The value chain and competitive advantage." Competitive Advantage: Creating and Sustaining Superior Performance.

Rao, M. T. (2004). "Key issues for global IT sourcing: country and individual factors." EDPACS**32**(4): 1-11.

Rogers, E. M. (1995). Diffusion of innovations, Simon and Schuster.

Rosenberg, N. (1976). The directions of technological change: inducement mechanisms and focusing devices, Cambridge University Press, Cambridge.

Rothwell, R. and P. Gardiner (1985). "Invention, innovation,re-innovation and the role of the user." Technovation**3**: 168.

Sachs, J. D., et al. (2001). "The geography of poverty and wealth." Scientific American**284**(3): 70-75.

Schöenherr, M. (2009). Towards a common terminology in the discipline of enterprise architecture. Service-Oriented Computing–ICSOC 2008 Workshops, Springer.

Schott, A. (1981). Industrial Innovation in the United Kingdom, Canada, and the United states. London., British-North America Committee.

Sharif, N. (2006). "Emergence and development of the National Innovation Systems concept." Research Policy(35): 745–766.

tabatabaian, S. H. and e. al (2007). Study on IT master plan in Iran. Iran, Ministry of ICT.

Tidd, J. and J. Bessant (2011). Managing innovation: integrating technological, market and organizational change, Wiley.

Vonortas, N. S. and S. P. Safioleas (1997). "Strategic alliances in information technology and developing country firms: recent evidence." World Development**25**(5): 657-680.

Voss, C. A. (1994). "Significant issues for the future of product innovation " Journal of Product Innovation**11**: 460.

Wegmann, A. (2003). On the systemic enterprise architecture methodology (seam. SEAM). Published at the International Conference on Enterprise Information Systems 2003 (ICEIS 2003, Citeseer.

Wilson, E. J. (2004). The information revolution and developing countries, The MIT Press.

Zachman, J. A. (1997). "Enterprise architecture: The issue of the century." Database Programming and Design**10**(3): 44-53.