

Nº 30

AD-MINISTER

UNIVERSIDAD EAFIT · MEDELLÍN · COLOMBIA · JANUARY-JUNE 2017 · ISSN 1692-0279 · E-ISSN: 2256-4322

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JEL: M15, O35

DOI: 10.17230/ad-minister.30.2
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SOCIOLOGY OF INNOVATION: SOCIAL CONSTRUCTION OF TECHNOLOGY PERSPECTIVE

SOCIOLOGÍA DE LA INNOVACIÓN: CONSTRUCCIÓN SOCIAL DE LA PERSPECTIVA TECNOLÓGICA

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RECEIVED: 5-09-2016

MODIFIED: 23-11-2016

ACCEPTED: 22-12-2016

DOI: 10.17230/ad-minister.30.2

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ABSTRACT

This theoretical paper describes the effect of social action on technological artifacts and explores how innovation may flourish or be diminished in society. Using the Social Construction of Technology (SCOT) perspective, three main elements namely, flexibility of interpretation, relevant social groups and technological frame are described and their impact on innovation is discussed. The paper proposes that in developing societies, flexibility is hardly pressed by technological frames and concrete social norms do not allow the alternative designs and the useage of artifacts. This paper proposes that innovation might flourish in a society if technological frame change, and entrepreneurship become technological frames that can change the fixed meaning of artifacts and create a path for alternative designs and interpretations.

KEYWORDS

Innovation; Sociology of Technology; Social Construction of Technology; Innovation policy; Entrepreneurship Promotion.

RESUMEN

Este artículo académico de tipo teórico describe el efecto que tiene la acción social sobre los artefactos tecnológicos y explora cómo la innovación puede florecer o reducirse en la sociedad. Utilizando la perspectiva del modelo de Construcción Social de la Tecnología (SCOT, por sus siglas en inglés), se describen y se discute el impacto que tienen en la innovación tres importantes elementos, a saber: flexibilidad de la interpretación, grupos sociales relevantes y marco tecnológico. Este artículo propone que en las sociedad en desarrollo, la flexibilidad es difícilmente motivada por los marcos tecnológicos y las normas sociales concretas no admite diseños alternativos ni el uso de artefactos. Este artículo propone que la innovación puede surgir en una sociedad donde se presente un cambio en el marco tecnológico y el emprendimiento se convierta en el marco tecnológico que puede modificar el significado fijo que tienen los artefactos y crear una ruta para diseños e interpretaciones alternativas.

PALABRAS CLAVE

Innovación; Sociología de la tecnología; Construcción social de la tecnología; Política de la innovación; Promoción del emprendimiento.

INTRODUCTION: THE MAN AND TECHNOLOGY

Technology is inextricably bound with social conditions (Burns et al, 2015a,b; Baalen et al, 2016; Surry et al,2016). Brück (2006, p. 37) interprets technology

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as the enactment of people's idea about the world. This is because the people's understanding of materials and substances and their notions of the relationship between cause and effect, impacts on technology. She expresses that, at the same time, the relationship between man and technology is "linked through a complex web of concepts, definitions and explanations of relationships."

Sillar (1996) links technology with human feelings which enables humans to use artifacts and substances. This "feeling" and "imagery" plays an important role in the interaction between human and technology. As Brück explained, in a beautiful manner, "people do not work with a 'real' environment, but with their understanding of it as constituted through a particular cultural tradition." (2006, p. 37).

Bejker (1992) identified three layers of technology. These includes a physical layer, activities and processes layer and a social layer. Based on Ghandian's school of thought, an artifact or a technological practice is contextually situated and is inherently linked to the social, political and economic spheres of life (Ninan, 2005, p. 187).

The sociological approach to the study of innovation attempts to examine the way that social structure influences both the process and products of an innovative activity (Sharif, 2005, p 87). He explains that the sociology of technology extends the application of theories and the models of the sociology of science to technology.

This paper is a response to the neglected importance of the social aspects of technology in developing countries. The paper reasons that as far as societies engage with technology, the importance of the social aspects of technology increases. Thus, based on the provisions of a perspective from the social construction of technology, the aim of this paper is to theoretically explain the obstacles and challenges of developing societies with regards to the fostering of innovation.

The dichotomy of technology determinism and social construction of technology would be a good starting point for this discussion. The technological deterministic argument suggests that technology is the driving force for social and cultural change (Humphreys, 2005). According to technology determinism view, the interaction between society and technology is that society and technology are separated spheres and technical changes happen autonomously within the technological sphere. In this view society does not have an influence on society, but technology influences society and determines its direction towards development (Elle et al, 2010).

By Olsen et al, (2009), technological determinism is based on the two main factors of the autonomy of technology and the determining role of technology on societal development. This approach entails a linear and one-dimensional view of technological development. They argue that, to criticize the technological determinism, it should be shown that the workings of technology is a social construct.

MacKenzie and Wajcman (1999) confirms that technological determinism contains a partial truth. They explain that technology matters, not just for the material condition of our lives and to our environment, but also to the way we live socially.

SOCIAL CONSTRUCTION OF TECHNOLOGY

It would be productive to start this section with a long but educating definition of Technology and its elements by Olsen and Engen:

“The term ‘technology’ is a slippery one. The common perception is that technology is machines, devices, and tools used for some purpose. Technology is also understood as artefacts. The Concise Oxford Dictionary defines technology as the “science of practical or industrial arts; ethnological studies of the development of such arts; application of science.” Here, technology is understood as knowledge. However, this definition misses the hardware aspect that is the commonly held perception of technology in everyday language. Maybe the most common way of defining technology is to integrate artefacts and knowledge, for example ‘artefacts and knowledge about their operations.’ But these definitions are missing the context in which all technologies exist. SCOT [...] expands these definitions by including what we normally consider as “social” elements of technology.”

The Social Construction of Technology (SCOT) argues that human action shapes technology. In the construction of the technology determinism theory, there is this believes that technology determines human action (Leonardi and Barely, 2010; Burns et al, 2016) and technology is a product of the social, political, economic, and cultural environment in which it is situated (Humphreys, 2005). Supporters of this approach, referred to as social constructivists, believe that without the understanding of the social context, a technology cannot be understood (Burr, 2015). This theory, that is within the field of science and Technology Studies, and has roots in the sociology of science, is a response to the technological determinism that identifies the technology as the determiner of human acts (See Table 1).

Table 1. The literature of the SCOT.

Pinch and Bijker (1984)	Known as the early founders of Sociology of Technology (Sharif,2005), suggested that Social Construction of Technology is an explanation of the effects of a social system. They emphasized on the interpretative flexibility which is attributed to technological artefact by relevant social groups.
Fulk (1993)	In a research paper on the subject of Social Construction of Ccommunication Technology, she showed that in organizations, work group members share identifiable patterns of meaning and action. She showed that social learning influences on technology-related attitudes and behavior patterns are stronger when individual are attracted into a group
Ramos and Berry (2005)	In a case study of a Portuguese company in an automobile industry, they showed that workers resisted the introduction of software systems and either misused or rejected them. They showed that social interpretation of a technology is a determining factor in the success of a company in the adoption of a technology.
Rowland (2005)	Interestingly, Rowland implies on difficulties in drawing a distinction between society and its institutions in one hand and technology in other hand. He then, introduces a new concept: Social Construction of Technology as a novel form of technological determinism which pays due attention to the role of large business corporations.

Humphreys (2005)	She expanded the original the SCOT model to create a framework with which to approach this model over time or on a larger economic, political, and social scale. The four broad categories of relevant social groups were introduced that allow for larger social and cultural trend to emerge from our analyses of technological innovations.
Bartis (2007)	Technological frames are presented as extension to the social construction of technology.
Olsen and Engen (2007)	They discussed how and under what conditions SCOT and the theory of technological paradigms (TTP) can be used as complementary tools for analyzing technological development. By presenting some basic assumptions of most social theories about technological development, they showed complementarities between SCOT and TTP.
Elle et al (2010)	In an action research, they compared the pro-active use of the Social Construction of Technology with the traditional use of SCOT and explored the challenges, advantages and limitation of the pro-active usege. They found that the pro-active use of SCOT might be a solution to fill in the communication gaps in the boundaries of various professional groups.
Burns, Corte, Machado (2015-2016)	In a three-part article they deeply described sociology of creativity. In part 1, they introduced a general model of innovation and creative development by stressing on the factors of the agents. In part 2, the context of creativity was investigated and in part 3, the context of receptivity and institutionalization were analyzed in areas where the innovations are socially accepted, legitimized and institutionalized, or even rejected.

INNOVATION IN SCOT PERSPECTIVE

Daniel and Klein (2014) in a general view, believe that the concept of innovation still remains abstract and ambiguous, but Hill (2010) clarifies that the term “innovation” from the perspective of sociologists is the concept that refers to new organizational forms (such as enterprises, firms, stores, etc.), new organizational processes and routines (such as rule systems for appointing civil servants that are resistant to corruption), and new products and services (like antibiotics and computer chips). He explains that the sociological approach towards the study of innovation attempts to examine the way social structures influence both the process and products of an innovative activity. Dahlin (2014) argues that the sociology of innovation highlights the nature of innovation and its structural arrangements (such as characteristics of social networks, organizations, and institutions that influence innovation).

While the traditional focus of sociology of innovation was on products. A revolutionary paradigm change happened when Utterback (1997) moved the focus of sociology of innovation from product innovation to process. The important notion for him is that process innovation is social and managerial rather than physical. Hill (2010) follows Utterback by discussing that form has an effect on process and innovation at the organizational form level leads to innovation at the organizational routines and processes level. Thus as far as organizations engage in technological

innovations, their concern with the social aspects will increase. Schlesinger (2017) stresses on the importance of innovation in process by explaining that productivity at the manufactory level is not sufficient to create competitive advantage, so what is needed is a kind of thinking beyond production. Adolf et al (2013) suggests that knowledgeable or a bundle of social and cognitive competencies is an integral part of the process of innovation and innovative thinking.

NATIONAL SYSTEMS OF INNOVATION

The concept of national system of innovation has also attracted a large amount of literature of the field. Lundvall et al (2002) are one of the leaders of this concept. They classified the resources of innovation in tangible-intangible and reproducible-less reproductive resources, and then suggested national styles of innovation based on available resources. Lundvall (2009, p. 22) stressed on the link between society and economy and that the source of product innovation is society and diversity and variety of innovation system, which in its ideal manner creates a knowledge and learning society. Sharif (2005, p. 87) recognized national system of innovation as a source of diversity between countries. Khajehheian (2014) follows him by showing the extent countries are different in their sources of innovation and how different national systems of innovation may serve the situation and contingent natures of societies. Sharif (2005) explained national systems of innovations based on SCOT. By using SCOT he showed that different relevant social groups, as important actors, play a role in a national innovation system and the outcomes of a national system of innovation depends on the use of social groups from that framework. As national systems of innovation are both a whole social and no physical system, SCOT explains the mechanism of those systems in a meaningful way.

Ninan (2008) uses the Gandhian idea as a basis for the rejection of technology determinism. Rather than finding science and technology as autonomous and technically pre-designed system of knowledge and operation, Gandhian ventured to exert varying strategies towards approaching it. The concepts were criticized at one level, redefined at another and appropriated at a different plane. Further, they attempted to view it as a process corollary to daily life, socio-economic relations, political choices and all pervasive national identity and the nation's development (Nina, 2008, 186).

Daniel and Klein (2014) inquires on the influence of 'sociology of innovation' on value creation? They explored how the various socio-contextual frameworks and dominant outcome intentions were involved in value creation in the development of new biotechnological innovations.

Harty (2005) argues that successful innovation requires the consideration of the social and organizational contexts in which it is located. The complex context of construction work is characterized by inter-organizational collaboration, a project-based approach and power distributed amongst collaborating organizations. The second is that innovations can be divided into two modes: 'bounded', where the implications of innovation are restricted within a single, coherent sphere of influence, and 'unbounded', where the effects of implementation spills over beyond this.

THEORETICAL MODEL

Elle et al (2010), inspired by Pinch and Bijker, articulate three main elements of SCOT. These elements are flexibility, relevant social group and technological frame.

ARTIFACT

Artifact may be used interchangeable with technology, product, solution, routine. In our definition, an artifact is the subject of innovation. By using Galtung's description, where artefact and knowledge elements are the visible tip of a huge iceberg, Olsen and Engen argue that maybe the most common way of defining technology is to integrate artefacts and knowledge. For example "artefacts and knowledge about their operations." (2007, p. 457).

Pinch and Bijker (1984) clarified by saying that technological artifacts are culturally constructed, it means that there is flexibility in people's interpretation of artifacts, and it also means that there is flexibility in the design and make of artifacts. "There is not just one possible way or one best way of designing an artifact". Relevant social groups are constituted with users that shape an artifact by their view. They are not pre-defined and appear in an unstructured way toward the use of an artifact (Elle, et al, 2010). Technological frame as Bijker defines it, comprises all elements that influences the interaction of relevant social groups with an artifact. With technical frame, users give meaning to the product that they are using. Such elements include goals, key problems, problem-solving strategies, theories in hand, tacit knowledge, design methods, etc. (Bijker, 1995)

Elle et al (2010) described technological artifacts with an interesting interpretation: they did overcome over other approaches in a complex and reciprocal interaction between the technology and various social relevant groups. In their approach, which is inspired fully by social construction of technology, relevant social groups decide if a technology is workable.

INTERPRETIVE FLEXIBILITY

Flexibility is a centric element in SCOT and the most important concept from SCOT's perspective (Sharif, 2005). Based on Pinch and Bijker (1984), there is more than either one interpretation, design or meaning behind an artifact and to identify those interpretations, that are sources of innovation, we should go beyond the technological aspects of an artifact and explore its social aspect.

According to Orlikowski, interpretive flexibility is "an attribute of the relationship between humans and technology, and is a function of the material artefact, the characteristics of the human agents, and the institutional context in which technology is developed and used" (1992, p. 409).

Humphreys (2005) introduces three kinds of flexibility. Flexibility of language refers to the interpretive flexibility of an artifact. Flexibility of language refers to the interpretive flexibility of an artifact. Flexibility of use implies the idea that users can

appropriate artifacts differently, and more open an artifact, more possible uses it may have. Flexibility of structure is associated with how we think about an artifact's design and engineering.

RELEVANT SOCIAL GROUPS

Key question: who define problem facing with an artifact? The social groups have different approaches towards doing so.

Social groups are connected with artifacts to decide what problems are relevant and therefore “a problem is defined as such only when there is a social group that constitutes a problem” (Bijker et al., 1987). Different interpretations of social groups about the concept of an artifact indicates different problem definition, and thus a diverse range of developed solutions.

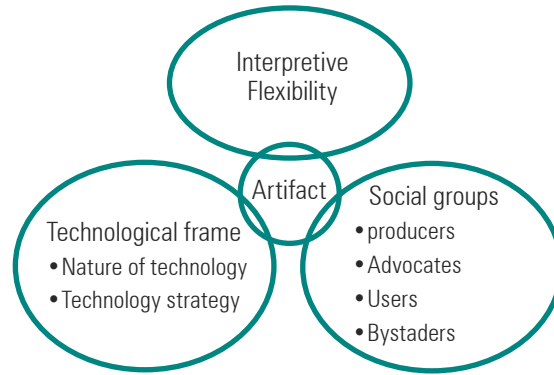
A major contribution in understanding of social groups has been presented by Humphreys (2005) with identification of four relevant social groups, including producers, advocates, users and bystanders. Producers, who are engineers, designers, marketers, financial investors, have a direct relationship with technology and develop an artifact. Advocates who are policymakers and lobbyist, are indirectly related with technology and work on policy making, lobbying and academic research on an artifact. Users, with direct and individual relationship with technology, talk, buy and use the artifact; and finally bystanders who are neighbors, family members and friends. The agreement on the meaning and interpretation of an artifact and technology is aggregated by collective interaction of these groups.

TECHNOLOGICAL FRAME

Orlikowski and Gash explained technological frames as “the subset of members' organizational frames that is concerned with the assumptions, expectations and knowledge they use to understand technology in organizations” (1994, p. 178). They suggested that there are shared frames that explain the social dynamics at the organizational level, which has an effect on the individual interpretation of socialization and training. They suggest that such social dynamics reinforce the production of similar meanings, rather than to create opportunity towards the exchange of the different meanings. Their contribution is that individuals make their social meaning of artifacts based on a collective shared frame.

Using Orlikowski and Gash's seminal work, Bartis explained three main domains of technological frames: 1) Nature of technology, that implies on the image of technology and its capabilities and functions in the minds of users, 2) Technology strategy, that is the motivation or vision behind implementation of that technology, 3) Technology in use, that refers to understanding of how to use the technology on day to day basis (2007, p. 129).

Figure 1. Three interactive elements of SCOT.



CLOSURE: STOPPING POINT OF CREATIVITY

Using the SCOT approach, our framework is able to describe the obstacle of innovation. Closure (or stabilization in SCOT terminology) is the point of agreement of the relevant social groups about a solution. At that point, the problem is perceived as solved. In other words, the problem disappears and no more tries will be made to find an innovative alternative (Bijker et al., 1987).

As Elle et al (2010, p. 137) describe, in most cases interpretive flexibility diminishes when relevant social groups approach an agreement on an interpretation. It can be said that such a consensus, that might be reached based on interests and actions, is the stopping point of innovation and creativity. At this point the flexibility of an artifact in the minds of user fades and a fixed, concreted meaning that lower the chance of creative thinking and change of interpretation is established. At this point, alternative meanings and interpretations are eliminated and one dominant, socially accepted design remains.

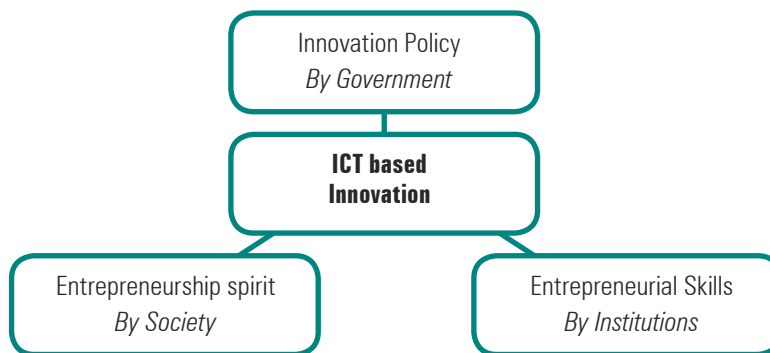
A PROPOSED FRAMEWORK FOR INNOVATION IN SERVICE SECTOR

By using the knowledge from SCOT and based on the interplay of its elements with actors in the society, a proposed framework is presented to suggest the fostering of innovation in a developing society, based on ICT service sector of . Based on this model, the infrastructure would not lead towards development, as it didn't already, unless the supporting social elements are in existence. The three main supplementary proposed: 1) Innovation Policy (from government side), 2) Entrepreneurial spirit (from Society Side) and 3) Entrepreneurial Skills (from civil society and institutions). This framework might be subject to expansion towards a model with further research. What developing societies experience is that social aspects of technology are normally underestimated in the policy making process. By the entry of technology into the society, a concrete, pre-defined meaning has been set and the flexibility of interpretation has been stopped before it started. For this reason, even the policy making organizations and institutions follow the fixed design and interpretation of the origin of technology.

The proposed model, emphasizes on the interplay between the three levels of actors in a society. The Government at macro level, civil institutions at meso level and individuals in the society at micro level are considered as relevant social groups that could be encouraged to find an alternative meaning for technological artifacts based on the change in the technological frame. This interplay is very important because based on the experience of developing societies, governments, as dominant powers, could never succeed in fostering innovation despite their best effort. González and Healey (2005) studied the capacity of government for innovation. They showed that the interplay of government with civil society and institutions provides a way for a wider governance processes and culture. Geels (2004) emphasized that Institutions should be used to conceptualize the dynamic interplay between actors and structures. Such interplay of civil institutions, government and individual, however, should be focused on change of “technological frames”.

Entrepreneurship performs as a suitable frame for such creative destruction in the society. The framework proposed that the entrepreneurial spirit accompanying entrepreneurial skills will provide the technological framework for innovation in the society. As Hill (2010) stressed that social structure influences behavior, thus the government’s role in the promotion of entrepreneurship would be to provide a structure for an entrepreneurial spirit, by the approval of encouraging bills that will decrease the cost of entrepreneurship in society. It is expected that promotion of entrepreneurship creates new technological frameworks for social groups to change the established meaning of an artifact and to flourish the innovation by creativity.

Figure 2. Proposed framework of promotion of innovation.



CONCLUSION

Douglas (1990) suggested that identifying a framework for legitimation within the Social Construction of Technology is an important and necessary step in understanding the relationship between technology and society. This theoretical paper, contributes to the field of sociology of innovation based on the provision of a framework and an explanation of innovation from the SCOT perspective. With proposition of a framework that is adapted from literature of the field, the author

stressed on the importance of technological frame in the stimulation of innovation in a society. It has been discussed that in the interplay of an interpretation, social groups and technological frame, the determining element is the technological frame. Based on the technological frame, the perception of actors from the artifact shapes that artifact and as this understanding is the basis of creativity, it can be concluded that for innovation the technological frames should be changed. The first and most important change is to leave the socially agreed meaning and interpretation.

The contribution of the paper is the proposal of a process of technological frame renewal. By using Schumpeter's creative destruction, technological frames must be destroyed by the diminishing of previously agreed meanings and interpretation that will result in a new agreement among relevant social groups. The change in social groups could be mentioned as a strategy to prevent from the repeat of previous agreements and it is possible, based on the entry of new actors into the social groups. The entry of the new actors is as a result of new problem definition.

As it can be seen in Figure 3, the process of technological frame renewal starts by the entry of a new beneficiary - that is a new actor. The entry of such an actor changes the balance of the social groups and creates a new problem definition. Solving this problem implies finding a new agreement in newly changed balance within the social groups. In order to reach new agreement, there is the need to destroy the previously established technological frame. It is similar to Schumpeter's creative destruction that is based on change in supply and demand by introduction of radical innovation (Fuduric, 2008). Based on the renewal and reset of technological frames, a new agreement appears, that is a new interpretation of an artifact.

Figure 3. The process of Technological frame renewal.



The findings of this paper could be used by policy makers as well as organizational leaders to foster innovation in the society or organization by the creation of a situation for the change of the technological frames. The entry of a new actor with a new demand would be a specific suggestion from this theoretical article. New ways to stimulating an innovation socially would be explored and introduced in further researches on this subject.

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