

# Defining the concepts of technology and



While the term technology itself is difficult to interpret, observe or evaluate, as argued by many scholars, this review attempts to provide in-depth discussion and enhance understanding on these concepts from various perspectives, research background and disciplines. This review could shed some dynamic ideas for future researchers to further identify, conceptualize and understand the underlying theories and perspectives which Keywords: Definitions, Concept, Technology, Technology transfer, Malaysia 1 .

**Introduction** The dynamic nature of technology has contributed to the existence of various definitions and concepts of technology by the previous studies which are related to technology transfer. The discussion on the concept of technology is crucial in getting a clear understanding of the nature of technology and examining what the technology consists of. Past studies have shown that defining the concept of technology is not easy (Reedy and Shoo, 1990); therefore technology has been defined from different perspectives.

Existing studies on technology transfer and international technology transfer have attracted researchers from cross-section of disciplines including organizational management, political science, economics, sociology, anthropology, marketing and recently management of technology (Cushman and Eleanor, 1994; Shoo and Irishman, 1992). The term technology is inherently abstract concept which is difficult to interpret, observe and evaluate (Blossom and Kook, 1998).

Regardless of the extensive research done on this subject, many of the literatures are fragmented along different specialties and generally there is

no commonly accepted paradigm (Reedy and Shoo, 1990). Lana and Young (1996) stress that the technology definition is varied according to authors and context of disciplines. Because of this the concepts, variables and measures relevant to the study are different from one study to another (Kumar et. L, 1999).

Therefore, the main objective of this paper is to contribute to the existing literature by and technology transfer. 2. The Definition and Concept of Technology Past researchers have viewed and defined the term technology from many perspectives and this has influenced the research design and results, negotiations around a transfer and government policies in general (Reedy and Shoo, 1990). Published by Canadian Center of Science and Education 61 www. Essence. Org/birr volt. , NO. 1; January 2012 Thus, the term technology has been given various definitions by previous literatures. According to Kumar et. L (1999) technology consists of two primary components: 1) a physical component which comprises of items such as products, tooling, equipments, blueprints, techniques, and processes; and 2) the informational component which consists of know-how in management, marketing, production, quality control, reliability, skilled labor and functional areas.

The earlier definition by Shall (1981) views technology as ‘ configuration’, observing that the transfer object (the technology) The current studies on the technology transfer have connected technology directly with knowledge and more attention is given to the process of research and placement (Dunning, 1994). By scrutinizing the technology definition, there are two

basic components that can be identified: 1) ' knowledge' or technique; and 2) ' doing things'.

Technology is always connected with obtaining certain result, resolving certain problems, completing certain tasks using particular skills, employing knowledge and exploiting assets (Lana and Young, 1996). The concept of technology does not only relate to the technology that embodies in the product but it is also associated with the knowledge or information of it use, application and the process in developing the product (Lovely, 1998; Baseman, 2000). The early concept of technology as information holds that the technology is generally applicable and easy to reproduce and reuse (Arrow, 1962).

However, Reedy and Shoo (1990) contend that the early concept of technology contradicts with a strand of literatures on international technology transfer which holds that “ technology is conceived as firm-specific information concerning the characteristics and performance properties of the production process and product design”. They further argue that the production process or operation technology is embodied in the equipment or the means to produce a defined product. On the other hand, the product design or product technology is that which is manifested in the finished product.

Apatite (1985) suggests that technology is mainly differentiated knowledge about specific application, tacit, often unconfined and largely cumulative within firms. Thus, based on this argument, technology is regarded as the firm's ' intangible assets' or firm-specific' which forms the basis of a firm's

competitiveness and will generally release under special condition (Dunning, 1981). Tinny and Roth (2002) propose that technology can include information that is not easily reproducible and transferable.

Based on this argument technology is seen as “ tacit knowledge (Plainly, 1967) or firm-specific, secrets or knowledge known by one organization” (Monika, 1994). Technology as the intangible assets of the firm is rooted in the firms routines and is not easy to transfer due to the gradual learning process and higher cost associated with transferring tacit knowledge (Roadsides, 1999). Valuable technological knowledge which is the intangible assets of the firm is never easily transferred from one firm to another because the technological learning process is needed to assimilate and internalized the transferred technology (Line, 2003).

Rosenberg and Friskiest (1985) also consider technology as firm-specific information concerning the characteristics and performance properties of production processes and product designs; therefore technology is tacit and cumulative in nature. Bargeman et al. (1996) refer technology as the theoretical and practical knowledge, skills, and artifacts that can be used to develop products and services as well as their production and delivery systems. Technology is also embodied in people, materials, cognitive and physical processes, facilities, machines and tools (Line, 2003).

Based on Sisal’s (1981) concept, Baseman (2000) argues that technology and knowledge are inseparable simply because when a technological product is transferred or diffused, the knowledge upon which its composition is based is also diffused. The physical entity cannot be put to use without the

existence of knowledge base which is inherent and not ancillary. Objects or artifacts, the process of making the objects and the meaning associated with the physical objects. These elements are not distinctive and separable factors but form a 'seamless web' that constitutes technology (Woolgather, 1987).

In defining the term technology, all the three elements must be understood as being inter-connected to each other and a change in one element will affect the other two elements. The latest definition given by Mucus (2003) has broadened the concept of technology where technology is defined as the information necessary to achieve a certain production outcome from a particular means of combining or processing selected inputs which include production processes, intra-firm organizational structures, management techniques, and means of finance, marketing methods or any of its combination'.

Other scholars such as Tapster and David (1985) suggest that technology as a cultural system concerned with the relationships between humans and their environment. From the systems perspective Prairie (1988) defines technology as encompassing: 1) the basic knowledge sub-system; 2) the technical support system (software); and 3) the capital-embodied technology (hardware). This perspective views that technology recognizes the need to identify the different elements of a particular country technology that are complementary and mutually reinforcing.

The previous studies done by the researchers have offered various functions and concepts of technology from different disciplines, contexts and

perspectives. Table 1 below shows a list of definitions and concepts of technology (in a chronological order) which was gathered from the previous literatures. 62 SINS 1913-9004 E-SINS 1913-9012 Insert Table 1 Here Apart from understanding the concept of technology, the classification of technology is also crucial in explaining the various kinds of technologies that embody in the product, production processes and human capital of the firm.

Reedy and Shoo (1990) in their extensive review of technology transfer literature have constructed economies of technology from the previous literatures. The early taxonomy of technology was developed by Mansfield (1975) who used “embodied” and “disembodied” technology classification. The classification was later further extended by Madame (1984) to include capital embodied, human embodied and disembodied technology. Hall and Johnson (1970) suggest the use of “product-embodied”, “process-classification based on “general”, “system-specific”, and “company specific” technology.

General technology includes technical information which is common to companies in the same activity. System specific technology corresponds to knowledge ND know-how develops for solving particular industrial problems. Company specific technology covers the corporate skills and capabilities from general activity and experience of each individual firm. Rebook (1980) and Judson (1971) have constructed technology taxonomy by separating product designs, production techniques and managerial functions. Madame (1984) suggests a distinction between “alienated’ technology and “socialized” technology.

Alienated technology includes information which is not free such as secret know-how. Conversely, “socialized technology” does not imply any specific transaction. 3. Defining the Concept of Technology Transfer The definitions and concepts of technology transfer have been discussed in many different ways based on the disciplines of research and according to the purposes of the research (Baseman, 2000). Gibson and Similar, (1991) view technology transfer is often a chaotic, disorderly process involving groups and individuals who may hold different views about the value and potential use of the technology.

According to them technology often has no definitive meaning or value. Researchers, developers, and users are likely to have different perceptions about the technology. A review of literature on technology transfer reveals that technology transfer is a complex, difficult process even when it occurs across different functions within a single product division of a single company (Coalman et al. , 1973; Kidder, 1981; Smith and Alexander, 1988). Technology transfer is commonly acknowledged to be a complex process that needs time to evolve (Gammon and von Ogling, 1981).

Nevertheless, the economic theories for example Slows (1957) growth model, have often treated technology as given that is embodied in products or processes; where technologies that resemble blueprint, machines, or materials are easily replicated and transferred (Line, 2003). The literatures on technology transfer and international technology transfer are extensive and varied in perspective from various disciplines which include political science, economics, sociology, public policy, marketing and management of technology (Kumar et al. , 1999).



The issues that have been investigated, among other, are technology transfer process, appropriateness of technology, cooperation and conflict between transfer countries, the success of technology transfer, and the social and economic benefits of technology transfer for both suppliers and recipient countries (Katz, 1985; All, 1982). Past literatures have referred technology transfer as the transmission of know-how to suit local conditions, with effective absorption and diffusion both within and across countries (Chung, 2001; Kenya, 1985).

Other early researchers for example Abramson (1970) defines technology transfer as transmission of know-how (knowledge) which enable the recipient enterprise to manufacture a particular product or provide a specific service. As compared to the sale of machinery and equipment, the transfer of technology requires a sustained relationship between two enterprises over a period of time to enable the receiving enterprise to produce the product with the desired level of quality standards and cost efficiency (Reedy and Shoo, 1990).

This is consistent with not only transfer the technical know-how (knowledge) required to produce the product to the recipient but also the capacity to master, develop and later produce autonomously the technology underlying the products. In the context of developing countries, Hoffman and Agrarian (1990) argue that technology transfer needs to be received in terms of achieving three core objectives: 1) the introduction of new techniques by means of investment of new plants; (2) the improvement of existing techniques and (3) the generation of new knowledge.

Since the term “ technology transfer” provides many dimensions, it has often been used to describe the process by which ideas and concepts are moved from the laboratory to marketplace (Phillips, 2002; Williams & Gibson, 1990), the transfer and knowledge and concept from developed to less technologically developed countries (Tarnishing, 1983; Patrons et al. , 2003) and the transfer of inventive activities to secondary users (Van Sigh, 1978).

Cautious and Laymen (1995) suggest a broader definition by proposing that technology transfer involves an intentional, goal-oriented interaction between two or more social entities, during which the pool of technological knowledge remains stable or increases through the transfer of one or more components of technology. Levin (1996) considers technology transfer as the application of scientific principles to solve practical problems. From the social science perspective Levin (1993) defines technology transfer as a socio-technical process implying the transfer of cultural skills accompanying the movement of machinery, equipment and tools.

This definition includes the transfer of the physical movement of artifacts and the embedded cultural skills. Majority of the previous studies have defined technology transfer as the transmission or movement of knowledge as a process. It involves the process how an organization or a country transfers scientific or technological achievements, new uses for technology, designs, and the technical knowledge that can be used in production (Chunk 2007).

Technology can also be transferred from one place to another or from a university to an enterprise (Solo and Rogers, 1972). The process hat involves

does not only concern about the transmission of knowledge but it is also relate to a learning process where technological knowledge is continually accumulated into human resources that are engaged in production activities. A successful technology transfer will eventually lead to a deeper and wider accumulation of knowledge (Ostentation, 1991).

The technology transfer concept is also the technology recipient's capability to learn and absorb technology into the production function (Mask's, 2003).

Ads (1987) argues that technology transfer can be of two types: 1) production of new product (product or embodied technology ranches); and 2) more efficient production of existing products (process or disembodied technology transfer). Hall and Johnson (1970) define technology transfer as technology system in terms of whether it is embodied in people (person-embodied), things (product-embodied) or processes (process-embodied).

Farming (1997) suggests that transfer of technologies in cases of manufacturing processes requires not only the transfer of technological knowledge in the form of process sheets, blueprints, products, and materials specification but also the transfer of know-how of high-caliber engineering and technical personnel. In their extensive review on technology transfer literature from various disciplines, Shoo and Irishman (1992) view that economists often define technology transfer on the basis of the properties of generic knowledge where the main focus is on variables that relate to production and design (Arrow, 1969; Doss, 1988).

For the sociologist, they tend to link technology transfer to innovation and view technology as ' a design for instrumental action that reduces the

uncertainty of cause-effect relationships involved in achieving a desired outcome' (Rogers, 1962; Rogers and Shoemaker, 1971). The anthropologists tend to broadly view technology transfer within the context of cultural change and how technology affects changes. Shoo and Irishman (1992) identify that bulk of the technology transfer literatures have also been contributed by the management researchers.

They argue that business disciplines tend to concentrate on issues such as stages of technology transfer, design and related stages and sales (Tease, 1976; Lake 1979). On the other hand, the management researchers tend to focus on intra-sector transfer and relationships between technology transfer and strategy (Rabin, 1989; Cheese and Amazing, 1996; Laymen ND Cautious, 1996; Lambs and Spokesman, 1997). Most of the literatures on management have shifted their focus to alliances among enterprises and how alliances are crucial to the development of technology transfer (Shoo and Irishman, 1992).

Table 2 below shows a list of technology transfer's definitions and concepts which was gathered from various literatures on technology transfer. Insert Table 2 Here 4. Technology Transfer and Knowledge Transfer Based on the above definitions and concepts gathered from various literatures, the area of technology transfer is wide and dynamic. The numbers of literatures on the object are voluminous, extensive and varied in perspectives (Kumar et al. , 1999; Shoo and Irishman, 1992).

A review of literature reveals that past studies have made little attempt to explain the difference between knowledge transfer and technology transfer.

Many of the studies do not draw a clear line between knowledge and technology transfer because most of the studies have regularly applied the term interchangeably in both technology transfer and knowledge transfer literatures; where majority have treated knowledge transfer and technology transfer as having similar meaning.

Based on various definitions from different disciplines of research and background, majority of the researchers have affirmed that technology transfer is closely associated with the transfer of information, know-how, technical knowledge because of the critical element of knowledge that underlies technology transfer (Hall and Johnson, 1970; Kenya, 1985; Ostentation, 1987; Ads, 1987; Williams and Gibson, 1990; Hayden, 1992; Gibson and Rogers, 1994).

Other definitions of technology transfer, for example Grosser (1996) makes direct reference to knowledge as elements underlying technology transfer of product technology, process technology and management technology. There are many researchers who have attempted to explain, directly or indirectly, the relationship between technology transfer and knowledge transfer and some even tried to draw distinction between the two concepts.

Gout and Gander (1992, 1993), in their study on knowledge transfer within the multinationals (Mans), use both terms interchangeably to establish a close association between technology transfer and knowledge transfer when suggesting that technology transfer within Mans can be explained by the attributes of knowledge such as tackiness, justifiability and testability. Asian' and Meyer (2004), when studying the spillovers of technology transfer from

FED in Estonia, make no distinction between technology transfer and knowledge transfer.

Sung and Gibson (2000), in their study on levels and keys factor in knowledge and technology transfer, connote technology and knowledge transfer to have similar meaning. They suggest that knowledge and technology transfer as the movement of knowledge and technology through some channels from one individual or organization to another. Past studies have suggested that technology and knowledge are inseparable. For example Shall (1981, 1982) argues that technology as 'configuration', observing that the transfer object, the technology must rely on a subjectively determined but specifiable set of processes and products.

It is no longer sufficient to simply focus on the product because it is not only the product that is being transferred but the knowledge of its use and application which are embedded in the products. Baseman (2000), in his study on technology transfer and public policy, states that the approach by Shall (1981, 1982) has resolved a major analytical problem in distinguishing the technology and knowledge transfer.

Both technology and knowledge transfer are inseparable because when a technological product is transferred or diffused the knowledge upon which its composition is based is also transferred (Baseman, 2000). A recent study by technology will not occur without knowledge transfer as knowledge is the key to control technology. Simon (Bibb), in the study of transfer of marketing know-how in strategic alliance, suggests that study on knowledge transfer

turn almost invariably to technology transfer when empirical investigation is in order.

Studies have shown that the tendency of the current studies have connected technology directly with knowledge (Dunning, 1994). In the context of technology transfer through FED, Gout and Gander (1993) have explicitly indicated foreign direct investment is the transfer of knowledge, which embodies a firm's advantage, underlies technology, production, marketing or other activities. Although technology transfer and knowledge transfer has been regularly used interchangeably in many literatures since they are highly interactive, however, they serve different purposes.

Supranational and Cantors (2004) distinguish technology transfer and knowledge transfer in term of their reposes when they argue that knowledge transfer focuses on a broader and have more inclusive construct which is directed more towards the “ why’ for change, whereas technology transfer focuses on a narrow and more targeted construct that usually embodies certain tools for changing the environment. Even though there are distinctions between their purposes, majority of researchers agree that knowledge is the critical element that underlies technology transfer. .

Conclusion Based on the above discussion, both technology and technology transfer concepts encompass many different interpretations and views depending on the organizations' objectives, research background, researchers, developers, users, research areas and disciplines and underlying perspective (theories). Therefore, various parties are likely to hold different views and perceptions on these two concepts.

This review could shed some dynamic ideas for future researchers to further identify, conceptualize and understand the underlying theories and perspectives which strongly influence the previous, current, and future concept of technology transfer. Such understanding is necessary to enable the interested parties (such as private sectors, government apartments, academics, researchers and students) to relate with the practical and empirical aspects of various relevant theories which explain technology transfer concept.