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What Fields Can Technology Management be Applied to?

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There are two types of technology management definitions. The narrow ones only refer to business organizations, the broad ones refer to any kind of organizations, including non-profit and governmental organizations. By using the narrow definitions, the interest of the non-profit and governmental organizations cannot be attracted, they could think that they do not need to deal with technology management, but in reality they obviously use it. To avoid the undue failing to utilize technology management knowledge outside the business world the broad definitions are recommended.

Introduction

Over the past three decades several different definitions of technology management have been published. We found that these definitions are not always just different wordings of the same concept but sometimes mean different things. They can be classified into two types based on their relevance to different types of organizations. We would like to point at an important difference between these two types and at the root of this difference in the various definitions of technology itself. We think that this difference is important because it largely determines what one considers the scope of technology management, i.e. to whom it can be interesting and useful in education, research, consultancy and in the everyday practice of various organizations.

Our aim is not to cite the utmost quantity of different definitions but to show only some typical examples of the basic types to make their conceptual differences clear. (For several more definititons and for the etimology of the word "technology" see e.g. Dussauge, Hart, Ramanantsoa, 1992, or Thierer, 2014.) Our aim is to explain the importance of choosing from the two types we have identified, to propose one of these types for general usage, and to reason our proposal.

1. Two types of definitions

1.1. Two types of technology management definitions

The earliest definition of technology management we have found in the literature is the following one: "Management of technology links engineering, science, and management disciplines to plan, develop, and implement technological capabilities to shape and accomplish the strategic and operational

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objectives of an organization." (National Research Council, 1987) According to this definition technology management is pursued for any kind of organizations.

One year later another type of technology management definition was published: "Technology management is the integrated practice, i.e. process, between business and the technical disciplines that are required to plan, develop, apply or install technological capabilities for products or services to form and achieve, successfully, the strategic and operational objectives in an enterprise." (Cory, 1988) This definition narrows down the scope of technology management to enterprises only, i.e. to the 'for profit' sector, to the business world.

These are the two basic types of technology management definitions: the broader ones refer to any kind of organizations while the narrower ones only to companies and business enterprises.

It is interesting that Cetindamar, Phaal and Probert (2016) cited the National Research Council's (1987) broad definition (see above) with different wording: "The definition of TM includes planning, directing, control and coordination of the development and implementation of technological capabilities so that firms can shape and accomplish their strategic and operational objectives". They wrote about "firms", i.e. business concerns, companies, enterprises, not about "an organization" in general, like the original text. This is not only a different phrasing of the same thing but the original definition and its rephrasing belong to the two different types of definitions. The theoretical framework proposed by Cetindamar, Phaal and Probert (2016) comprises both technological and commercial perspectives inside the firm and such external elements in the firm's environment like customers and competitors. So they obviously narrowed down the meaning of the original broad definition.

Let us see some more examples for both types of definitions, at first for the narrower type: "… technology management simply defined is: the 'process of effective integration and utilization of innovation, strategic, operational, and commercial mission of an enterprise for gaining competitive advantage'." (Badawy, 2009) This definition applies to business enterprises only, it is about competitive advantage, it does not apply to non-profits or administration.

The next one is narrow and broad at the same time: "Technology management is concerned with the improvement of the existing and longer term competitiveness (or effectiveness) of an organization, within its business, social and physical environments through the application of concepts, methods, and techniques to the tasks of operating, improving, and integrating an organization's existing product, transformation, and administrative and control systems, and the introduction of innovatory systems." (Hughes, Fox, 1991) Although the word "competitiveness" suggests business organizations only, the "(or effectiveness) of an organization" phrasing broadens the meaning of this definition for any kind of organizations in general, not only for competing enterprises in the business world.

A similar, but perhaps even broader one: "… technology management is about getting people and technologies working together to do what you want. Technology management is a collection of systematic methods for managing the process of applying knowledge to extend the range of human activity and produce defined products (goods or services)." (Kanz, Lam, 1996) Although "products (goods or services)" could suggest business, but not necessarily: non-profit organizations, governmental or non governmental organizations, or public administration offices etc. also provide goods and services.

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"Working together to do what you want" and "human activity" are valid wordings for any kind of organizations, not only companies.

1.2. The proposed type of technology management definition

By choosing the narrow definition, in which it is implied only the for profit sector, the nonprofit and the administrative sector are ruled out.

Thus the appropriate definition is the broad one, because of the necessity of using technology.

1.3. Two types of technology definitions

The same kind of dichotomy characterizes the different definitions of technology itself as those of technology management. Our first example has a narrow business scope: "By technology I mean several things. In some cases it's a specific process that produces a specific product. In this case it's hard to distinguish the product from the technology. More broadly, technology can mean a manufacturing process. [...] We can think of technology even more broadly as the way a company does business or attempts a task." (Foster, 1986)

The next quotation begins with a broad scope of technology and after that it narrows down the scope to business enterprises: "In fact, one short and arguably valid definition of technology is 'knowledge of how to do things.' A somewhat more extended definition, and the one that will underline all of this discussion, is that technology is 'the system by which a society satisfies its needs and desires.' […] When applied to an individual enterprise, it means the capability that an enterprise needs in order to provide its customers with the goods and the services it proposes to offer, both now and in the future. […] Since 'knowledge of how to do things' is the foundation from which a business satisfies the needs of customers, the choice of technology strongly influences the basic structure of the business. It is so intimately entwined with the very concept of an enterprise that one must consider them together. An enterprise with no technology is a virtually meaningless concept. (Steele, 1989) This explanation includes both approaches, distinguishing them very clearly.

"Technology refers to 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 can be embodied in people, materials, cognitive and physical processes, plant, equipment, and tools." (Burgelman, Christensen, Wheelwright, 2008) This approach is similar to the technology management definition by Kanz and Lam (1996) cited above. Non-profit organizations, governmental or non governmental organizations, or public administration offices etc. can also provide "products and services", and they all have "people, materials, cognitive and physical processes, plant, equipment, and tools" as well. So we can consider this definition valid to any kind of organizations, not only to business enterprises.

Exactly the same can be said about the next one: "Technology can be described in different ways:

Technology is the means for accomplishing a task—it includes whatever is needed to convert resources into products or services.

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Technology includes the knowledge and resources that are required to achieve an objective.

Technology is the body of scientific and engineering knowledge which can be applied in the design of products and/or processes or in the search for new knowledge." (Gaynor, 1996a)

There are several technology definitions that even do not mention any products, goods, or services at all. For example, technology can be defined as: " … man's efforts to cope with his physical environment - both that provided by nature and that created by man's own technological deeds […] and his attempts to subdue or control that environment by means of his imagination and ingenuity in the use of available resources …" (Kransberg, Pursell, 1967). Let us see some other similar definitions.

"Technology denotes the broad area of purposive application of the contents of the physical, life and behavioural sciences. It comprises the entire notion of technics as well as the medical, agricultural, management and other fields with their total hardware and software contents." (Jantsch, 1967)

"… the role of technology is taken to be the application of scientific knowledge for the generation of improvements in, and benefits from, the societal subsystems, individually and collectively." (Lock, 1975)

"Technology is how a task is accomplished. It may involve machines, tools, paper and pen, computers, procedures, knowledge utilization and information transfer. Technology also refers to the rationale and knowledge underlying the utilization of these means." (Randolf, 1981)

"A technology is the structured application of scientific principles and practical knowledge to physical entities and systems." (Lowe, 1995)

"Technology includes the tools, the techniques, the processes, and the knowledge required to accomplish a task." (Gaynor, 1996b)

"Technology is knowledge of the manipulation of nature for human purpose." (Betz, 2003)

If we narrow down the meaning of technology to the for profit area, i.e. the world of business enterprises then it is evident that we will also narrow down the scope of technology management in the same way. Which approach is the better choice for general purpose usage, i.e. considering technology and its management in its entirety?

1.4. Managing technology outside the business world

Let us set some examples from the non-profit and the administrative sector. The effective treatment (collection, storaging, identification and distribution) of the offered donations at a charitable organization requires process technology. Since one of the main objectives of these organizations is to take the donations to the needy people, and the broad definition of the management of technology is to develop, adapt, and exploit technological capabilities to accomplish the goals of an organization, thus we cannot rule out the non-profit organizations from the definition.

At Charity Hungary Non-profit Ltd. there was a need to know the stock of each type of the donated objects in the warehouse, to track the donations for the planning of the delivery. To reach this aim, the organization had chosen one of the inventory softwares available on the market, and implemented the

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system. The implementation included buying the software and the hardware (computers, bar code printer and scanners), educating the colleagues, and changing to a different selection method.

The result is reduced warehouse space by 30%, it means reduced warehouse costs, because of the optimized processes based on the new information. Furthermore, it led to a professionally designed operational framework in the warehouse, thus the co-workers feel more comfortable and more honoured in their workplace.

During the implementation of the system, the organization made the usual steps of technology management, like the way it is in the business world. The manager, the operative director and the warehouse manager identified the problem in the operation. They specified the budget, and went over the possibilities, examined the advantages and disadvantages of each solution, then made a decision and chose the one which fits best with the expectations. In the end, the outcome of these efforts is a better process technology, just like it is in the business world.

Our next example is taken from the world of governance: the industry-level application of technology roadmapping. The industry roadmapping is a flexible management technique that can be widely used for technology foresight not only at organizational but at national and industry level as well. It can be a very useful tool for laying the foundation of the industry policy of a country or a region. There are numerous good examples of using technology roadmapping for establishing industry policies. The Canadian government, for instance, uses this technique successfully for a long time, see e.g.: Industry Canada, 2011. As a result of the strategic planning process, the technology roadmap itself is a complex diagram containing several bars and a timeline that shows the market, product, technological and other information, and their relationships. In our example the realisation conditions of the Hungarian residential energy saving investments can be represented on an industry level technology roadmap by taking into account the macro environmental factors, the sustainability criteria and the technology development tendencies. The developed technology roadmaps provide practical guidelines primarily for national strategy-making, and the market participants of the building energetics products and services. (Bíró-Szigeti, Pataki, 2012; Bíró-Szigeti, 2014)

The topic requires much more elaboration, and our previous work can serve as a guide and methodological basis for future research. After the industry map shows a process, we built some (a decade) look back at the industry road map. The technological roadmap for residential energy saving investments in Hungary - similar to the corporate level - has a lane structure, the lane structure of which is shown in Figure 1. The individual lanes follow the usual structure of macro-environmental analyzes:

- Technological: high efficiency of lighting, use of natural light, HVAC: heating, ventilation, air condicioning, hot water supply, construction material
- Energypolitical: share of renewable energy sources, share of electricity, wired energy services, energysaving, CO2 emission
- Social: consumer classes, enviromental awareness, number of inhabitants, energy demand
- Economical: oil and gas yield, residential energy consum, energy prices
- Natural: rebound effect, ecological footprints, change in temperature

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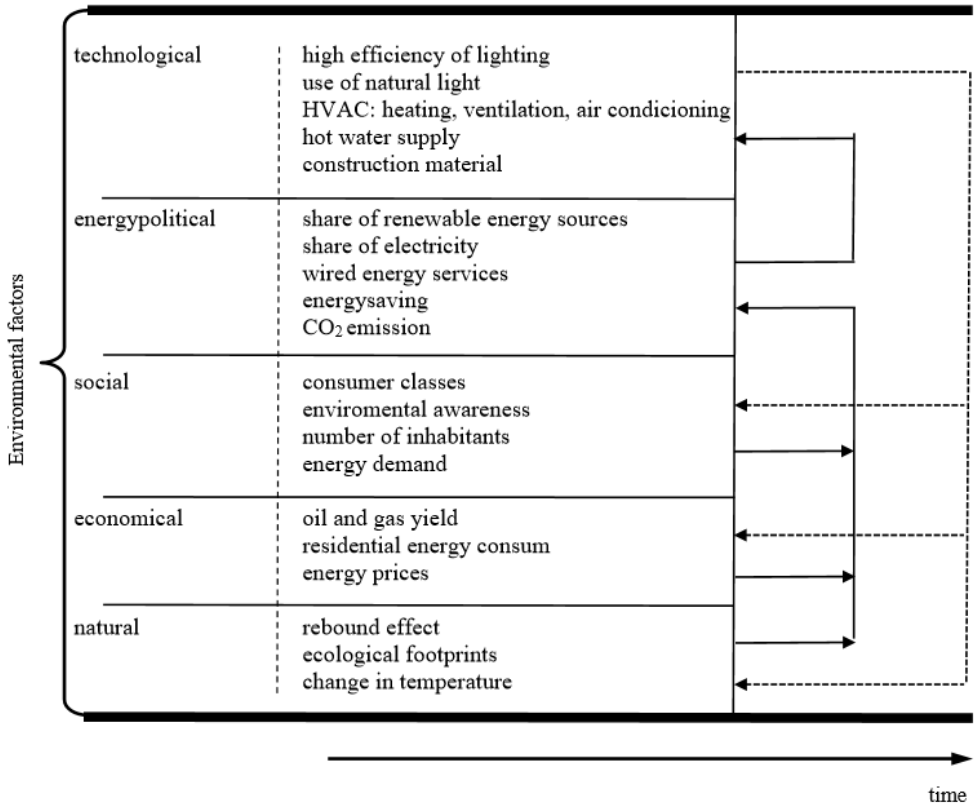

Figure 1. Lane structure of technology roadmap on the Hungarian residential energy saving

The political factor is attributable to each element, since the (residential) energy sector of industry highly dependent on state regulation. The relationships between each lane of the map and their effects on each other are shown by arrows. The effects, indicated by a forward solid line, indicate that a combination of natural, economic and social factors form the energy policy directives and that energy policy regulations shape technological developments and trends. Subsequently, new technological developments and applications, by way of feedback, repeatedly affect the natural, economic, and social factors, showed by dotted lines in Figure 1. This cycle is continuous.

However, the Hungarian state and industrial coordination of implementation of the residential energy saving investments is burdened with numerous problems. There is an incomplete strategic plan and state guidelines that contain concrete goals and comprehensive to the building energetics industries (NeFMi, 2011). The available guidelines and concepts are not adequate.

The regulating and coordinating role of the state, as well as the market liberalisation and centralization are essential for the next steps. The state has to be the top-level owner of the industrial roadmap, without which no serious result can be achieved. The work of a multidisciplinary expert team would be necessary to develop both a complete energy strategy plan for Hungary and to develop the complete and actual technology roadmap on the Hungarian residential energy saving, which can be used as a source of a more detailed elaboration in the future.

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The examples above demonstrate that technology management is a must in non-profit organizations and in governance as well, not only in business enterprises.

2. The proposed types of definitions

Because of the obvious necessity of using and managing technology in every type of organizations we need such definitions that do not limit the scope of their meanings only to business enterprises. In our technology management MBA and MSc courses we use the following definitions.

Technology is a system of expertise and instruments that enables us to fulfill our needs by exploiting nature's potentials.

Expertise is the software side, and instruments are the hardware side of technology. They have to form a system, not only a set of elements. Technology is for fulfilling needs with such possibilities that are hidden in nature. If something is offered by nature ready for usage or consumption then technology is not needed for using or consuming it.

Technology management is a cross-functional activity that makes technology serve the effective and efficient operation of an organization.

Technology management is not just a functional but a cross-functional activity because technology is needed to every kind of jobs in any kind of organizations. Technology must serve the organization, „the technological tail cannot be allowed to wag the corporate dog" (Twiss, Goodridge, 1989) - „corporate", or any other kind of organizational „dog" in general, as we clarified it. Technology can and has to serve both effectiveness and efficiency.

We do not think that our proposed definitions are the best possible ones. These are just a number of possible wordings of the broad interpretations of the meaning of technology and its management. Our point is not to push our phrasings but to emphasize the importance of not limiting the meanings of these two concepts only to for profit organizations, business enterprises, regardless of the particular wordings of the definitions. If we use narrow definitions that relate only to the for profits, then we cannot attract the interests of non-profit and (local) governmental organizations to study and apply technology management on their fields. They could think that technology management is for business enterprises only, so they have nothing to do with it. But it would be a false assumption, as we showed it using some practical examples. Utilizing technology management body of knowledge is vitally important for non-business organizations as well, and to make it clear we should use such definitions that relate to them, too.

3. Conclusion

As it was shown with some practical examples, technology must be managed outside the business world as well, it is no less important in other kinds of organizations at all. We would rather call the definitions with narrow for-profit sector scope definitions of technology or technology management *in business* than definitions in general. By choosing the narrow definition of either technology or technology management, in which it is implied only the for profit sector, the non-profit and the administrative

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sector are ruled out, and we cannot attract the interests of non-profit and (local) governmental organizations to study and apply technology management in their fields. They could think that technology management is for business enterprises only, so they have nothing to do with it. Thus the appropriate definitions for general purposes are the broad ones, because of the necessity of using technology in any kind of organizations. By using broad definitions we can avoid the undue failing to utilize technology management knowledge outside the business world more easily. That is why the proper choice of definition is so important not only in theory but in practice as well.

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