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SEVERAL DIMENSIONS FOR CHARACTERIZING INNOVATION: A TECHNICAL AND AN ECONOMICAL APPROACH

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Abstract

As far as new organisations, new engineering product, new economical product, etc. are concerned, it looks like interesting to formalize what is really innovative in those concepts. In this sense, it is first necessary to structure and define what could be the object of innovation. Secondly, an assessment of innovative solutions should also lead industries policy.

This paper aims at giving some first specifications to characterize what could be an innovative solution in order to later on lead the market in studying new ones. The research has been realised according to both technical and economical approach that emphasize the fact that innovation is currently defined with several points of view. More discipline could be involved in this research to even more enlarge the validity of the results.

The enounced results concern a set of attributes that characterize what is an innovation. A matrix is then described that spot innovation solutions on an object, newness and success scale. Some indicators are then defined to assess the innovation level of those solutions. They are thus related to innovation risks that should be very useful in industries to lead what could be each one's investment in innovation approach.

Keywords: drivers of innovation, competitive products concept generation/assessment, innovative products, technical and economical approaches, risk evaluation

1 Introduction

Beyond new organisations, related to concurrent engineering, that have been set in industries for 10 years, the market place is now in constant movement. This dynamic change forces every one to be more reactive, to always propose new solutions that would be competitive. Innovation is then a new objective in each industry that aims at be leader on the market place.

Among the different scientific communities (mechanical engineering, business science, etc.), several approaches of innovation have been presented. The literature presents a lot of definitions, examples and analysis of innovation as [1], [2] or [3]. In such a context, misunderstanding occurs as soon as several persons, coming from different functions in firm, discuss about the concept of innovation.

The research work presented in this paper has been initiated to investigate what could be a common reference and with the aim in further work to assess the performance of innovation. The context of this work and the real interest and objectives are detailed in part 2.

The first objective of this work is to propose a structure that could characterize innovations (cf. part 3). Several attributes have then to be defined in order to spot innovative solutions respect to each others. Section 2.1 presents the methodology adopted to set such a characterization.

The second objective, detailed in part 4, is to present a way to evaluate innovation. In fact, it would be very interesting to give an idea of what is a really radical innovation or on the contrary what is a minor one. Therefore, some risks indicators have been defined to scale an innovative solution from different points of view.

Conclusions and specification for further work are enounced in part 5. The acknowledgments finally list the whole participants of the research group that contribute to this proposal on innovation concept.

2 Research context and objectives

This research work has been initiated two years ago according to several discussion issues on innovation. Indeed, the GRP[1] and AIP/Primeca[2] research groups nowadays gather a wide scientific community that covers several research fields as engineering design, economist and management researchers. The community then needed to clarify several concepts related to innovation in order to understand each other and to really work in the right sense to have this research thematic evolved.

2.1 Objectives of the research work

From our point of view, both characterization and evaluation of an innovative solution seem to be very interesting in order to analyse the market places.

The first benefit of characterization is to really know in which sense an institution is providing a new solution that could be considered as innovation. Indeed, an innovation can currently touch different objects from different sectors of activity. It is thus very difficult to compare an innovative solution with another without classifying them in the same way.

Once this classification achieved, such a characterization could help the identification of potential market places that offer a lot of possibilities to provide innovative solutions. It could at least show that some places are (or are not) really investigated by industries.

An assessment of new solutions would finally allow institutions to scale their level of innovation and then to lead them towards new policy. An industry could for instance struggle to keep the leader ship on a specific sector of activity whereas it could have a comfortable ranking in another one that is not so much crowded.

2.2 Methodological approach

In order to reach the previously presented objectives, a research method has been set in order to cover a wide scope of concepts from the whole scientific community. The method has been therefore presented in three main points:

- To create a work group issued of different communities as presented before. Currently the research group is composed of mechanical engineers whose specialities are related to engineering design and manufacturing as it is defined in [4] and innovative design based on TRIZ method. A researcher from business science is also involved in the group to provide a non engineering point of view.
- To analyse the literature of the different communities. From this analysis the common structure of the characterization matrix (cf. part 3) has been defined. Several points

[1] www.univ-valenciennes.fr/GRP/
[2] www.aip.net/

(objects, newness, etc.) were indeed commonly admitted in several references. The major problem remained in giving an accurate definition of each concept to later on objectively classify what is an innovative solution.

- At the beginning of this work, each partner of the group had his own objectives and ideas on what was innovation, creation, design, creativity, research process, invention, invention process, creation process, etc. To clarify those concepts and thus to understand each other, the third point of the method is to link all those processes, and the associated objects. This is done using an activity representation for processes (invention, creation, innovation, etc.) that manage objects (design solution, creation solution, etc.) as input and output results.

The following parts mainly present the results issued from the second step of the methodology. Some results on the last step have been formalized through MindManager® and can be seen at www.ec-lille.fr/grp6. Those ones will be detail in further work.

2.3 Hypotheses

The methodology adopted (cf. 2.2) is also based on several hypotheses that set the real field of our investigations on innovation:

- Innovation cannot be studied from a single point of view. As previously explained, several scientific communities have their own definition. This mix of approaches is essential to have a global vision of innovation in the whole market and not only in a specific sector as could be automotive industries, social institution, etc.
- The innovation (i.e. innovative solution) is studied as the result of the innovation process (cf. 3rd point of the method). Indeed, the innovation process has been identified as a complex process that cannot therefore be described. It is then easier to characterize the result than the process itself.

3 Characterizing an innovative solution

As presented in the first objective (cf. 2.1), characterizing innovative solutions aims at really knowing why this solution is discerned as original.

Two different projects can indeed on the one hand be identified as the same innovative concept whereas the first two industrial objectives were not the same at all. On the other hand, those two different projects can be identified as the same innovative solution whereas the new concept is not concerning exactly the same object.

This part of the paper describes what are the three proposed attributes (and associated scale values) to characterize innovation. This allows the definition of a characterization matrix to spot innovative projects respect to each other. Thus, two different innovative projects could be compared with a global and common agreement (cf. Figures 1&2). As already-introduced, this definition takes into account multiple scientific fields: engineering design, business science.

3.1 Characterization matrix

The three attributes presented just below are mainly issued of the literature [5], [6], and [7] and accepted as defining what an innovation is.

3.1.1 “Object” attribute

First of all and according to the second hypothesis, an innovation is always related to a resulting object of a process (what is the new concept of the solution?). This object can be described with different points of view according to the first hypothesis. Thus, an object can be valued as:

- A **social or institutional object** related to a global organisation of the society. *For instance: VAT that contributes to the whole society organisation.*
- A **method** used to manage institutions behaviours. This behaviour can be related to human resource (*ex: the Taylorism*) or to technological resources (*ex: production management*) as well.
- A **technological product** designed from specified requirements. *Ex: the compact disk, the digital cam-coder, etc.*
- A **service** to people. *Ex: door-to-door delivery, guarantee related to car selling, etc.* This service is not always related to a technological product.
- A **process** as a technique that adds value to a product from an initial state to a final state. *Ex: laser cutting as manufacturing process, etc*.

3.1.2 “Success” attribute

Secondly, an innovation is characterized by its success degree (is the project a real success on the market place?). This success is not at all studied as a commercial one. An innovation is defined as successful as far as a group of persons adopts it. This group then defines the reference and as consequence the different values of the success attribute.

The authors decided to focus on industrial market. A group is then defined by a set of industries. Three levels have currently been chosen:

- The **whole economical market** that involves all the industries. This is the wider reference for an innovative project.
- An **activity sector** that involves all the industries related to a given kind of products (*ex: automobile sector, aeronautic sector, food sector, etc*.).
- A **single firm**. This is the thinnest reference for characterizing if a project has a real success or not. The boundary is limited by the know-how of the industry. (*Ex: Schneider electric, Renault, IBM, McDonald, etc.*).

Those three levels of reference could later on be detailed to allow the characterization of a project inside an already-defined one (ex: mono-space, sports or 4 wheels drive cars sector). This does not change the concept presented in the paper.

Nevertheless, it would not be justified to detail a thinner level than the “single firm” one. Indeed, as far as adoption is concerned among the industrial market, a single firm is then the thinnest element.

3.1.3 “Newness” attribute

Finally, an innovation exists because the innovation process delivers something new for industry. This concept of newness is then the third attributes to characterize an innovation. As presented in [8] and [9], the newness can be valued as ex-nihilo, an adaptation or a minor evolution. Actually, the difference between an adaptation and a minor evolution is not really

clear. In the definition of our structure, a minor evolution is then considered also as an adaptation. The two values for newness are then:

- An **ex-nihilo concept**. The innovative concept is totally new (*We do not know anything about that*).
- An **adaptation** from something already existing. The innovative concept is issued from another one (*We do already know the concept but the use and/or the context are original*).

This concept of newness is seen as an improvement of knowledge that allows the classification as ex-nihilo or adaptation. Obviously, the knowledge patrimony is related to the industrial market reference ("success" attribute). Those two attributes are then both in the characterization matrix (cf. Figure 1).

Of course, knowledge evolves with time. The newness of an object thus strongly depends on time to market aspect. To be really new, a product has to arrive at the right place at the right time. A product is not identify as innovative (matrix characterization) if a similar one (according to similar object attribute) has invested the market some time before. The matrix gives thus a picture of innovation at a specific time (cf. Figure 2).

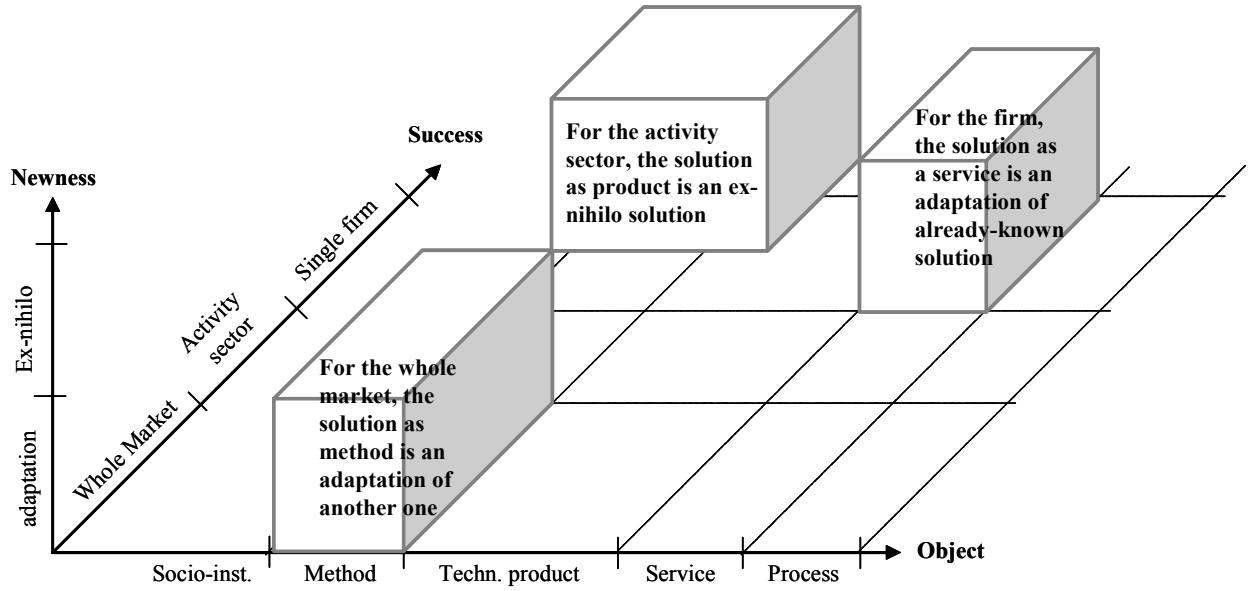

Figure 1. Characterization matrix

3.2 Illustration: the cellular phone

The paper briefly proposes to describe an example in order to validate the classification method. It will also illustrate how the characterization matrix assists the assessment of how the solution is really innovative.

3.2.1 Presentation

"Millions of people in the United States and around the world use cellular phones. They are such great gadgets. With a cell phone, you can talk to anyone on the planet from just about anywhere. These days, cell phones provide an incredible array of functions, and new ones are being added at a breakneck pace."[3]

[3] www.howstuffworks.com/cell-phone.htm

This sentence is quite attractive and shows that cellular phones provide new solutions for people to make a call. The presented characterization (and the attributes defined in section 3.1) assists the classification of what is really new in such a product. Figure 2 presents what could be the spot of cellular phone in the matrix according to different point of views.

3.2.2 Multiple dimensions assessment

1 Cellular phones have not been designed in order to really impact the social behaviour. However it is obvious that it does. Some examples of the daily life confirm that teenagers usually write and send useless message, let the ring on in public areas disturbing the neighbourhood.

2 Concerning the technical aspect, cellular phones does not provide very new technology. At a "whole market" level, any electronics component has been new for such an application. It was an adaptation to another product (cf. Figure 2). At a "firm" level, the first cellular phone had its knowledge increased. It was there an ex-nihilo product.

3 Cellular phones have also (and mainly) designed in order to provide new functions. It then offers new services to people (store contact information, make task or to-do lists, keep track of appointments and set reminders, use the built-in calculator for simple math, send or receive e-mail, etc.). Those are, from a service point of view, an ex-nihilo innovative functions. Indeed, phones already existed in every home.

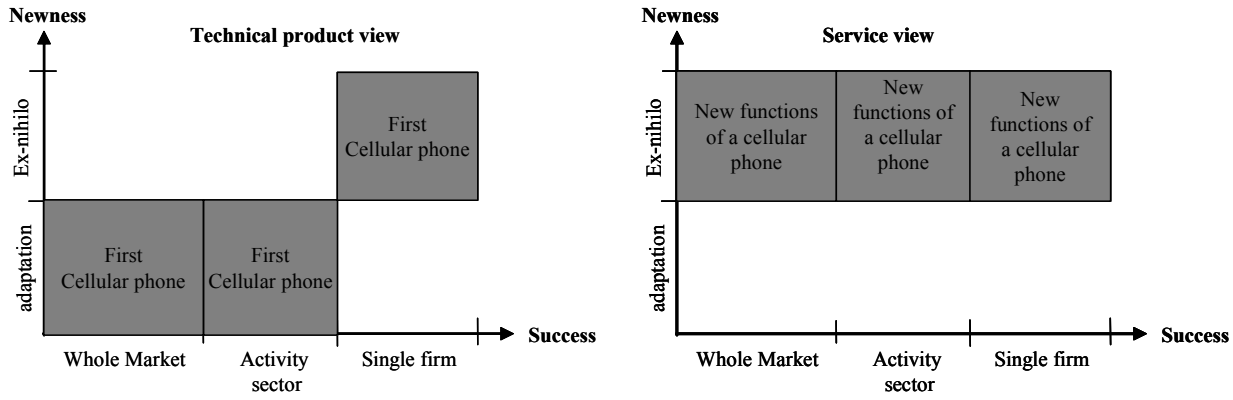

Figure 2. Cellular phone characterization

4 Risk indicators to scale an innovative solution

So far the results present the structure defined to characterize an innovation. According to the second objective (cf. 2.1), it seems also very interesting to link the concept of innovation to the design process performance [10]. Such an approach deals to both the evaluation of process efficiency that provide the innovative result and the evaluation of the result characteristics themselves. Design process is there seen as multiple decisional tasks that involve strong or weak incertitude factors [11].

The literature offers several approaches for a global innovation assessment. They are mainly based on design process assessment as presented in [12]. Innovation is also an incertitude provider as its attributes (object, success, and newness) are not too much defined and related to study context [13].

One mean to assess incertitude related to innovation design process and result is to asses the associated risks referred in the literature [14]. Thus, the authors did not try to straight link innovation and performance assessment but to introduce the concept of risk in innovation. Risk has been studied according to the three attributes previously defined for the characterization (object, success, newness). For each one, four kinds of risk that have been defined in the literature [14] have been used: commercial, technological, financial and human risk.

Indeed, it is not enough to reach the technical, social and economical requirements to talk about innovation. Industries have also to be able to provide specific technical and human resources despite of the involved risk of this process. For instance:

- During an innovation on a "technical product" object, industry runs a technological and commercial risk.
- Innovation on "process" object involves much more technological risks but a fewer economical one. Indeed, such innovation is often kept confidential in the industry.
- Industry runs very strong human and financial risks during an innovation on "organisational" object. On the other hand, technological and commercial risks are not present.

4.1 Risk definition

The four kinds of risk are then detailed as the following:

- **Commercial**: risk linked with the market. This risk has two dimensions: a risk linked with the inputs the firm needs (in terms of quality and price levels) and one linked with the outputs (in terms of the ability for the market to accept novelties). As Thietart claims [15], innovation is undoubtedly one of the activities which external outcomes are the most important. The impact of innovation strategies is of even more consequence. They can lead to boost (or on the contrary to hinder) the growth of not only a specific firm but of a whole economic sector.
    - First dimension: is the market as a supplier able to provide the firm with the inputs at the level of quality required and at an acceptable price?
    - Second dimension: will there be a real market of consumers for the product? Will the product match the consumers' needs?
- **Technological**: risk related to technology. Is the used technology and process techniques really well-known and well-controlled in the industry? Is it safe for environment?
- **Financial**: risk related to money market. Is the project a good investment (compared to already-controlled project)? Have every cost been taken into account?
- **Human**: risk related to people involved in the project. Is the group enough engaged in the project? Are the employees already-qualified or do the industry have to assure the training for new techniques? Does the industry have to look for new ones?

4.2 Risk indicators

The approach proposed in this paper aims at linking an innovation and its associated risk level. The risk is then described according to the previously described categories. This assessment could be summarized by indicators as presented on Table 1. A note (1=low risk, 5=high risk) could value each cell of the table.

The result does not aim at assessing an innovation degree related to every industry that used such characterization. On the contrary it gives on the one hand, some new elements to know in which sense the industry "think" innovation (cf. 3.1). On the other hand it proposes some guidelines to identify if the innovation prevision is worthwhile and risky.

Table 1. Risk indicators for innovative solution.

		Commercial Risk	Technological Risk	Financial Risk	Human Risk
Object	Service				
	Etc.				
Success	Whole market				
	Activity sector				
	Firm				
Newness	Adaptation (minor improvement)				
	Adaptation (major improvement)				
	Ex-Nihilo (new concept)				

INDICATORS

Scaling the risk with a note is not very easy and remains subjective. A risk-lower would underestimate the risk where as a risk-adverse would overestimate it. The approach has then not to be used as a scale guideline among all the industrial market but a scale guideline in an industry that would like to assess its own policy of innovation. Is it more worthwhile to invest in "adaptation" innovation than "ex-nihilo"? Which market places are still free to initiate innovative investigation?

5 Conclusion and further work

The first conclusion of this work concerns the structure defined for characterizing an innovation. The attributes are quite pertinent but it results very important to be very accurate in defining the object of innovation. On the contrary, a lot of mistakes can occur in valuing the attributes object of the innovative solution.

Several dimensions have been proposed (object, success, newness). The literature indeed proposes some mono point of view assessment of innovation. Very new technical product can be perceived are largely innovative but it cannot be definitely an innovation without the "success" assessment.

Secondly, some indicators are proposed to set a risk assessment "guideline". This approach is a first step in assisting firms in scaling its own policy on innovation. This would be interesting to investigate new market places, new way of dealing with innovation. Those risks are again estimated according to several points of view that concern technical, commercial, financial and human aspects.

Further work would aim at consolidating the approach on study cases and further on industrial situations. A link with the third step of the methodology approach (cf. 2.2) would have to be realised in order to widely set a common approach of innovation. This approach will then be based on common semantic concepts (i.e. ontology approach), a common guideline to characterize and assess innovations.

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