INTERNATIONAL DESIGN CONFERENCE - DESIGN 2008
Dubrovnik - Croatia, May 19 - 22, 2008.

DESIGN 2008

ENVIRONMENTAL KNOWLEDGE ACQUISITION DURING THE FUZZY FRONT END OF INNOVATION – STATE OF USE OF TOOLS, METHODS AND TECHNIQUES IN THE BASQUE COUNTRY

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Keywords: fuzzy front end of innovation, knowledge management, tools methods and techniques

1. Introduction

In this communication, the state of use of different Tools, Methods and Techniques (TM&T) for environmental information acquisition during the Fuzzy Front End (FFE) of innovation in the Basque Country is presented.

It is broadly accepted that firms need to respond continuously to their changing environments. As in Nature, species able to successfully adapt to their environment are the most likely to survive [Reid and de Brentani 2004]. On the one hand, technology and innovation management literature considers environmental changes as the main source of new ideas. It has been argued that even in-house innovations have some input from external sources [Reid and de Brentani 2004], being this idea consistent with considering firms as open systems that take information from their external environments and react to them. On the other hand, taking external environment monitoring as very important, the reaction to identified changes needs to be assured. In other words, identifying relevant external information and changes can be seen as a necessary but not sufficient condition for competitive advantage. One important way that companies have to achieve this response is through the innovation process, and specially, through stages in that process where important decisions are made [Reid and de Brentani 2004]. In this sense, the FFE of innovation, that is, activities undertaken before the development decision of a new product is made, has increasingly been focusing attention in New Product Development (NPD) literature [Koen *et al*. 2002]. In fact, decisions made at this stage determine the path of the whole innovation process and set the firm's future competitive scenery [Koen *et al*. 2002].

In this context, and as formal way of scanning environmental changes, researches are trying to develop and see the advantages of different TM&T that could help companies during the FFE of innovation in terms of acquiring environmental information so that companies can successfully respond to environmental changes. However, not much research has been made in order to assess the state of use of these TM&T in companies.

The remainder of this article is organized as follows. The next section briefly summarizes the literature background of the FFE of innovation, environmental information acquisition and TM&T that could support it. In the succeeding section the research main objective is stated. Next, our research method and data collection process are shown. After presenting our research results and analysis, we conclude with a discussion of limitations and implications.

2. Theoretical background

2.1 The Fuzzy Front End of innovation

The FFE of innovation can be considered as the range of activities undertaken before the NPD process or the innovation process [Koen *et al*. 2002]. In fact, many studies related to success factors of NPD consider proficiency at this stage as an important determinant of new product success [Ernst 2002]. The importance of this stage becomes clear if one considers that activities carried out by a company during this FFE of innovation are the basis for the development decision making. These decisions will determine which new products/services are going to be developed and will, therefore, draw the firm's future competitive situation in the marketplace [Reid and de Brentani 2004, Koen *et al*. 2002].

Due to the importance attributed to all these activities, different studies focused on the FFE of innovation can be found in the literature. Koen *et al*. [2002] develop a comprehensive model for the FFE of innovation which approach was the one chosen for this study. Basically the model takes into account three different aspects of the FFE of innovation. First, five process related activities are described which include (1) opportunity identification, (2) opportunity analysis, (3) idea generation and enrichment, (4) idea selection and (5) concept definition. Second, the so called engine of the FFE of innovation (organizational culture, strategy and leadership) is conceptualised. Last, both process related activities and the engine of the FFE of innovation are highly influenced by external environmental factors (such as customers and competitors); thus environmental information processing becomes the third important part of the FFE of innovation model proposed by Koen *et al*. [2002].

2.2 Environmental information acquisition

Traditionally, market information has been acknowledged to be of great importance for NPD, according to marketing and innovation fields' literature. The word market has basically implied both customers and competitors. Therefore, companies need to generate information related to customers and competitors, in order to respond to their changing environments.

From this point of view, information about customers and competitors can be considered as very important for companies if they want to achieve a competitive advantage. However, it is not the only important information needed to achieve competitive advantage. In this sense, Porter [1999] defined the competitive forces directly affecting any firm, and that companies should take into account, as:

- Customers
- Competitors
- Suppliers
- Substitutes

In other words, the Industry Environment related Information (IEI) can be defined as information about customers, competitors, suppliers and substitutes [Frishammar and Hörte 2005]. Therefore, acquisition of the industrial sector related information is of great importance, as noted in the work undertaken by Frishammar and Hörte [2005].

General Environment related Information (GEI) has also been suggested to be highly relevant for companies, as facts and trends in the general environment affect the economic system as a whole. This environment covers aspects as regulatory, socio-cultural or macroeconomic factors. In fact, changes happening in this general environment affect all companies and industries. In this sense, it has been argued that great changes that revolution industries usually take place in unexpected directions and usually outside the industry environment [Frishammar and Hörte 2005]. Special attention should be taken to technological factors, as changes happening around technology can be root for discontinuous innovation. Frishammar and Hörte [2005] note that general environment related information also plays an important role in NPD related decisions made by companies. General environment, according to Frishammar and Hörte [2005] can be conceptualised as:

- Social factors
- Economic factors
- Political factors
- Technological factors

To summarize, information related to both the industry and general environment is highly important in order to achieve a high decision making competence in organizations [Frishammar and Hörte 2005]. That is, acquisition of industry and general environment related information are of great importance so that companies can effectively use this information for responding to their changing environments.
There are different ways of scanning, acquiring information, available to an organization. A firm may use formal techniques (f.e. market research) which have in common that activities can be planned, controlled and executed by the management of a firm. Another option is to rely on more informal means such as gatekeepers. Gatekeepers are individuals that have the ability to gather and to understand information but also the ability to translate and to make sense of it to their more internally oriented colleagues [Frishammar and Hörte 2005]

2.3 Tools, methods and techniques for environmental information acquisition during the FFE of innovation

Companies may support their NPD process, and in particular, their FFE of innovation using different TM&T [VDI 2221 1987, Val-Jauregi and Justel 2006, Koen *et al*. 2002], as a formal way of improving the activities related. In fact, different TM&T could be used by companies in order to support and improve the proficiency of environmental information acquisition during the FFE of innovation. In this section, a list of the most popular ones is shown:

- Technology scouting
- CRM - Customer Data Management -
- Technology roadmapping
- Scenario planning
- Porter's 5 forces
- S curves
- Market research
- Ethnography analysis
- Lead Users
- Technology Data Base
- TRIZ - Teoriya Resheniya Izobretatelskikh Zadatch -
- QFD - Quality Function Deployment -

3. Research objective

As described in previous sections, researchers are trying to improve proficiency of environmental information acquisition activities during FFE of innovation, as proficiency at this stage has been acknowledged as a new product success determinant [Cooper 1988]. Informal ways of environmental scanning, such as gatekeepers, have received a fair share of attention in NPD [Ernst 2002] due to the important role played by these individuals as a link between an organization and its environment.
Researchers are developing TM&T as a formal way of environmental scanning that could help companies to improve their environmental information acquisition process, as the use of TM&T is often related to highly proficient activities [VDI 2221 1987]. However, little research has been undertaken in order to analyse whether these TM&T are used by companies in their daily work.
In order to fulfil this research gap, the work presented here pursues to achieve the following:
"To evaluate the state of use of different TM&T that could be used during the FFE of innovation for environmental information acquisition."

4. Research

The research method used to achieve our main objective was the survey based method. First, and after reviewing the literature related to TM&T that could support environmental information acquisition during the FFE of innovation, we conducted a series of interviews with a panel of experts in order to asses whether most important TM&T were included in the survey. Additionally, a classification of the aforementioned TM&T was developed. The panel of experts was composed by:

- 2 marketing academics
- 2 innovation management academics
- 4 Chief Executive Officers (CEOs)

Afterwards, surveys to determine the degree to which the aforementioned TM&T were used were conducted during 2006.

4.1 The sample

Our sample was selected from the catalogue of industries and exporting companies of the Spanish region of the Basque Country administered by the Basque Government, with a focus in the primary metal, fabricated metal, machinery equipment, electrical equipment, transportation equipment and measuring instrument industries (Código Nacional de Actividades Empresariales –CNAE– or Spanish National Activity Codes 28-34). These industries were chosen according to the Innovation Survey 2004 carried out by INE (Instituto Nacional de Estadística or National Statistics Institute) that highlighted these sectors as the most innovative ones [www.ine.es 2008]. Initially, the population consisted of 1020 firms.

Due research limited budget, we randomly selected 200 firms with twenty-five or more employees and mailed one copy of the questionnaire to the R&D manager of each company. Since it seems to be accepted that top administrators provide the best information about this issue, the questionnaires were mailed to R&D managers as targeted as key informants. Of the 200 questionnaires initially mailed, and after two follow-up contacts, we obtained 86 usable responses, for an effective response rate of 43%. The profile (CNAE codes and employee size) of the final sample is given in Table 1.

Table 1. Final sample profile

Employee size	
25-100	17,39%
101-250	39,13%
250+	43,48%
CNAE activity codes	
Metal products	20,0%
Machinery and mechanical equipment	37,0%
Office and computer equipment	1,0%
Electrical and electronic equipment	15,0%
Electronic material: radio, TV and communication equipment	6,0%
Measuring instruments, photography, optics and watches	13,0%
Transportation equipment	8,0%

4.2 Measures

The appendix provides the measurements used in the questionnaire, based on a seven-point likert type scale. Basically, we measured on the one hand, Innovation Performance (IP) and, on the other hand, frequency of use of TM&T for environmental information acquisition that could be used during the FFE of innovation.

With regards to IP the frame used by Frishammar and Hörte [2005] was adopted, both in comparison with the firms´ main competitors and with the firms´ previous objectives. In this sense, high innovation performance would mean the introduction of many new products/services over time and changes in product /services being significant, both in relation to the firms´ main competitors and to the firms´ objectives.

As mentioned, frequency of use of different TM&T for environmental information acquisition during the FFE of innovation was directly asked in the questionnaire.

Additionally, companies were asked if they used any other tool, method or technique apart from the ones shown in the list.

5. Results

First we classified the TM&T for environmental information acquisition. On the one hand, we classified the aforementioned TM&T in terms of their primary focus on the Industry Environment or the General Environment. On the other hand, a second classification was made in terms of the contribution of the aforementioned TM&T to environmental understanding within a short term period of time or a long term period of time. That is, some TM&T focus on understanding the environment as it is nowadays -short term focus- , while other TM&T focus on trying to visualize trends for the future in a prospective way -long term focus-. Results from this classification can be seen in Table 2.

Table 2. Classification of TM&T to support environmental information acquisition during the FFE of innovation

	Information Focus		**Time Focus**	
	Industry Environment Information	**General Environment Information**	**Short term**	**Long term**
Technology scouting		X	X	
CRM	X		X	
Technology roadmapping		X	X	X
Scenario planning	X	X		X
Porter's 5 forces	X		X	
S curves		X	X	X
Market research	X		X	
Ethnography analysis	X		X	
Lead Users	X		X	
Technology Data Base		X	X	
TRIZ		X	X	
QFD	X		X	

Second, the state of use of TM&T was analysed (Table 3). As it can be seen from data in Table 3, companies did not regard themselves as highly innovative ($Mean_{IP}$=4,08). Additionally it can be observed that all the TM&T included in the survey had a mean value of frequency of use below 4.

Table 3. Descriptive statistics of the frequency of use of TM&T for environmental information acquisition for the Fuzzy Front End of innovation

	N	**Mean**	**Std. Deviation**	**Std. Error Mean**
IP	86	4,08	0,862	0,093
Technology scouting	86	3,85	1,732	0,187
CRM	86	3,45	1,577	0,170
Technology roadmapping	86	2,60	1,521	0,164
Scenario planning	86	2,65	1,326	0,143
Porter's 5 forces	86	1,86	1,170	0,126
S curves	86	1,81	1,112	0,120
Market research	86	3,16	1,672	0,180
Ethnography analysis	86	3,31	1,625	0,175
Lead Users	86	2,98	1,511	0,163
Technology Data Base	86	3,53	1,877	0,202
TRIZ	86	1,81	1,090	0,118
QFD	86	1,90	1,158	0,125

In order to test whether TM&T were frequently used, we performed a T test for each of the studied TM&T using a test value of 5 (slightly above the medium value of 4 in a 7 point likert scale). The one sample T test procedure tests whether the mean of a single variable differs from a specified constant. Results of this analysis are shown in Table 4.

Table 4. T test of the frequency of use of TM&T for environmental information acquisition for the Fuzzy Front End of innovation

	Test Value = 5					
	T	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
IP	-9,947	85	0,000	-0,924	-1,11	-0,74
Technology scouting	-6,163	85	0,000	-1,151	-1,52	-0,78
CRM	-9,096	85	0,000	-1,547	-1,88	-1,21
Technology roadmapping	-14,608	85	0,000	-2,395	-2,72	-2,07
Scenario planning	-16,423	85	0,000	-2,349	-2,63	-2,06
Porter's 5 forces	-24,888	85	0,000	-3,140	-3,39	-2,89
S curves	-26,581	85	0,000	-3,186	-3,42	-2,95
Market research	-10,188	85	0,000	-1,837	-2,20	-1,48
Ethnography analysis	-9,620	85	0,000	-1,686	-2,03	-1,34
Lead Users	-12,421	85	0,000	-2,023	-2,35	-1,70
Technology Data Base	-7,239	85	0,000	-1,465	-1,87	-1,06
TRIZ	-27,102	85	0,000	-3,186	-3,42	-2,95
QFD	-24,855	85	0,000	-3,105	-3,35	-2,86

In general terms, the frequency of use of all the TM&T analysed in the present study could be considered as low. In all cases, TM&T showed mean values of frequency of use under 4 in a 7 point likert scale (1 never – 7 always). The most frequently used TM&T showed mean values between 3 and 4. This was the case of "Technology scouting", "Technology Data Base", "CRM", "Ethnography analysis" or "Market Research". However there were TM&T which, in general terms, were almost never used. This was the case, for instance, of "S curves", "TRIZ", "Porter's 5 forces" or "QFD". These results showed that TM&T penetration in surveyed companies is still limited. This result is coherent with the mean value showed by IP. As it can be noticed, the mean for IP in this study was slightly above 4. That is, companies that took part in this research did not consider themselves with a high performance in terms of innovation.

With this main evidence in mind, the most frequently used TM&T were, as mentioned, "Technology scouting", "Technology Data Base", "CRM", "Ethnography analysis" or "Market Research". According to the classification showed in Table 2, a couple of evidences could be highlighted. On the one hand, these TM&T cover both IEI and GEI. That is, companies seemed to be equally worried about acquiring information about their industry environment (customers, competitors, suppliers and substitutes) and about their general environment (primarily about technological factors). On the other hand, environmental information acquisition for the companies surveyed in this study, would have a short term time focus. That is, scanned information would be in terms of how both industry and general environment were established in a specific period of time. No attempt of long term or future predictive information seemed to be pursued.

6. Conclusions, limitations and future research

Overall, this study highlights the low frequency of use of TM&T for environmental information acquisition during the FFE of innovation. The use of TM&T during a process can be considered as an

indirect bearing of proficient execution of the process [VDI 2221 1987], at least, from the lens of formal execution. Therefore, results obtained in this research suggest that companies surveyed, overall, did not execute formal environmental information acquisition during the FFE of innovation in a proficient way (regardless these companies may rely on informal scanning such as gatekeepers). This evidence is coherent with the fact that companies that took part in this study did not regard themselves as highly innovative. In fact, external environments´ related information is one important factor to consider when planning for innovation. Since environments change over time, the present study's result support the idea that monitoring these changes may pay off in terms of increased IP. Possible explanations, although truly expeculative, are that TM&T penetration in industry is related to several adoption factors. One may think, for instance, that TM&T are not so frequently used because training and education are required. In fact, TM&T might be seem as "time consuming" or "too complex to use" because experience about TM&T play an important role when using them. Another possible reason for low TM&T adoption might be that upper management support is needed. This reason might be related to perceived effectiveness or usefulness for TM&T. In fact, management might need to recognize "tangible benefits" related to the application of TM&T. Additionally, the results clearly demonstrate the gap between academic proposition and industrial reality. It is clear that academics need to increase and channel more effort in transferring such TM%T to industry rather than developing new ones with little prospect of real use in industry.

Surveyed companies, however, seemed to focus on scanning both their industry environment and technological factors. However, they seemed to concentrate their efforts on the present state of those environments, while leaving aside future possible evolution of environmental factors. In fact, the most frequently used TM&T can be considered to be primarily focused on a short term period of time.

The findings in this study, however, should be interpreted with caution for some reasons. First, TM&T that are best known seemed to be used most widely. Not necessarily, however, are the aforementioned TM&T the most efficient ones, as it is possible that people tend to apply what it is best known. Further studies with an ethnographic approach could be used in order to clarify this aspect. Additionally, casual applications of tools, methods or techniques may rest effectiveness to the TM&T could also be considered. Second, the FFE of innovation is highly influenced by other factors apart from the environmental information acquisition related ones that have not been analysed in the present research, such us, organizational culture, leadership, strategy or proficient process execution [Koen *et al*. 2002]. In other words, managers should bear in mind that scanning the environment can be considered as a necessary but not sufficient condition for being proficient at the FFE of innovation [Ernst 2002]. A highly proficient FFE of innovation should also consider an organizational culture that enhances innovation, leaders compromised with innovation or the existence of a clear business strategy, as well as proficiency at process related activities. The case study approach could be used to an in-depth analysis of this question. Third, it is necessary to keep in mind that data analysed in this study are cross-sectional. Therefore, it is difficult to ascertain whether frequent use of TM&T during the FFE of innovation leads to increased IP. In fact, one could visualize a reverse direction of causality: that is, those most innovative firms have excess resources to spend on using, trying and getting to know new TM&T that could help them support the FFE of innovation. Future studies with a longitudinal design may shed light on this question. Understanding how and why firms´ support their FFE of innovation in different TM&T may be enhanced by additional research. One approach would be to examine the use of different TM&T in highly innovative firms using in depth case studies or studies with ethnographic design. Finally, the study presented here has been carried out in the Basque Region, which is located in the North of Spain and which has a very strong manufacturing tradition. According to the classification put forward by Porter in his famous book The Competitive Advantage of Nations [Porter 1999], it could be said that the Basque economy is in transition from a growth phase based on efficiency to a growth phase based on innovation. Therefore, similar studies carried out in other regions might show different results, according to their particular competitive level.

Acknowledgement

The authors acknowledge the collaboration of Mondragon Corporación Cooperativa (MCC) and Mondragon Goi Eskola Politeknikoa (MGEP).

APPENDIX

INNOVATION PERFORMANCE (IP)	FREQUENCY OF USE OF TOOLS, METHODS AND TECHNIQUES
New products/services can be classified in terms of degree of newness to the market and newness to the firm, so that it covers from cost reductions to new to the world products or services. Compare your firm's and your main competitors´ results in terms of: • Number of new products/services marketed in the past 5 years • Degree of change in products/services marketed in the past 5 years Response format 1-Far below our main competitors´ 7-Far over our main competitors´ Compare your firm's performance to the previous objectives set by your firm in terms of: • Number of new products/services marketed in the past 5 years • Degree of change in products/services marketed in the past 5 years Response format 1-Far below our previous objectives 7-Far over our previous objectives	Rate how frequently you use the following TM&T during the Fuzzy Front End of innovation in your firm Technology scouting CRM Technology roadmapping Scenario planning Porter's 5 forces S curves Market research Ethnography analysis Lead Users Technology Data Base TRIZ QFD If you use any other tool, method or technique, please, note it here and rate its frequency of use……. Response format 1-Never / 7-Always

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VDI 2221 (1987).

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