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USE OF TOOLS, METHODS AND TECHNIQUES DURING THE FUZZY FRONT END OF INNOVATION: THEIR IMPACT ON INNOVATION PERFORMANCE – A SURVEY BASED EXPLORATORY STUDY OF COMPANIES IN THE BASQUE COUNTRY –

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ABSTRACT

In this communication, the use of different tools, methods and techniques that support the Fuzzy Front End of innovation and its impact on innovation performance is presented.
Successful new product and service ideas are generated and selected in the so called Fuzzy Front End of innovation stage – activities undertaken before development decision is made –. The Fuzzy Front End of innovation appears, therefore, as especially important in the innovation process, since decisions made during this stage will determine the path for the whole innovation process. In fact, proficiency during this stage has been specially acknowledged as a critical influencing factor in the challenge of successful innovation. Tools, methods and techniques often appear to be as good supporters of proficiency in any process.
In this sense, this paper aims at dealing with one main objective. Having analysed the literature related to different existing tools, methods and techniques that may be used during the Fuzzy Front End of innovation, their state of use in 85 companies set in the Basque Country has been studied, using a survey-based research method. The aforementioned tools, methods and techniques have been analysed in terms of their impact on innovation performance. Furthermore, this research intends to clarify whether the use of tools, methods and techniques during the Fuzzy Front End of innovation positively impacts on innovation performance.

Keywords: Fuzzy Front End | Innovation | Tools, methods and techniques

1 INTRODUCTION

In recent years, the Fuzzy Front End of innovation (FFE), 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 [1-7]. In fact, it is broadly accepted that decisions made at this stage determine the path of the whole innovation process and set the firm's future competitive scenery [4].

Therefore, researches are trying to develop and see the advantages of different tools, methods and techniques that could help companies during the FFE of innovation [8-25]. However, not much research has been made in order to assess the state of use of these tools, methods and techniques in companies, and most of all, their impact on innovation performance [12] [13].

The remainder of this article is organized as follows. The next section briefly summarizes the literature background of the FFE and tools, methods and techniques 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 analysis and research results, we conclude with a discussion of limitations and implications.

2 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 [5]. In fact, many studies related to success factors of new products consider proficiency at this stage as an important determinant of new product success [7]. The importance of this stage becomes clear if one considers that activities carried out by a company during this FFE 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 [4] [6].

Due to the importance attributed to all these activities, different models of FFE and even different names to refer to it can be found in the literature. Cooper and Kleinschmidt [3] use the name "predevelopment activities" and consider that three main activities are covered within it: idea generation, preliminary evaluation and concept definition. Smith and Reinertsen [1] are the first ones to use the term "Fuzzy Front End" to refer to this stage in allusion to its characteristic uncertainty. Khurana and Rosenthal [2] use the name "Front End" to cover activities that go from opportunity identification to project definition. Koen et al. [5], use the term "Front End of Innovation" and develop a model of five interrelated elements which include opportunity identification, opportunity analysis, idea generation and enrichment, idea selection and concept definition.

This study follows the approach used by Koen et al. [5]. This model describes five main process related activity blocks. The activity blocks considered as covered during the FFE will include:

- Opportunity identification: this is where the organization identifies both business and/or technological gaps that the company might want to pursue.
- Opportunity analysis: opportunity analysis involves making early and often uncertain technology and market assessments in order to translate the identified gaps or opportunities into specific business and technology opportunities.
- Idea generation and enrichment: genesis can be considered as the birth, development and maturation of the opportunity into a concrete idea. Many iterations and changes may be examined, studied, discussed and developed with any idea. The output of idea generation and enrichment typically implies a more completely developed description of the idea or product concept.
- Idea selection: selecting among different new product/service ideas is a critical activity related to choosing or picking up those ideas that may achieve highest business value.
- Concept definition: finally, and before the developing decision is made, a well defined concept is needed. That involves both a written a visual description of the new product/service concept, including its primary features and customer benefits combined with a broad understanding of the needed technology.

According to Koen et al. [5], these five activity blocks would be highly influenced by, on the one hand, the external environmental factors (such as customers and competitors) and by, on the other hand, the engine of the FFE (culture, strategy or leadership).

2.1 Tools, methods and techniques applied during the FFE

Companies may support their NPD process, and in particular, their FFE of innovation using different tools, methods and techniques [24] [25]. In fact, different tools, methods and techniques could be used by companies in order to support and improve the proficiency of the aforementioned five main activity blocks that cover the FFE. In this sense, a literature review of the most popular and familiar tools, methods and techniques that may be helpful during the FFE [8-25] has been made. In this section, a list of the most popular ones is shown.

- Technology scouting
- Customer Data Base - CRM -
- Technology roadmapping
- Scenario planning
- Formal groups for opportunity identification
- Porter´s 5 forces
- S curves
- Market research
- Ethnography analysis
- Lead Users
- Creativity techniques
- TRIZ
- Portfolio based idea selection
- Specification sheet
- QFD
- Project management tools
- Formal process for idea generation and selection
- Idea storage
- Innovation measurement
- Idea suggestion scheme

3 RESEARCH OBJECTIVE

As described in previous sections, researchers are trying to improve proficiency of the activities covered by the FFE of innovation, as proficiency at this stage has been acknowledged as a new product success determinant [26]. Researchers are also developing tools, methods and techniques that could help companies to improve their FFE, as the use of tools, methods and techniques is often related to highly proficient activities [24].

However, little research has been undertaken in order to analyse whether these tools, methods and techniques effectively contribute to increase the number of new products launched to the market or the degree of newness of the launched ones [27] [12].

In order to fulfil this research gap, the work presented here pursues to achieve the following:

“To evaluate the impact of the use of different tools, methods and techniques that could be used during the FFE of innovation on Innovation Performance.”

4 RESEARCH METHOD

The research method used to achieve our main objective is the survey based method. First, and after reviewing the literature related to tools, methods and techniques that could support the FFE of innovation, we conducted a series of interviews with a panel of experts in order to asses whether most important tools, methods and techniques were included in the survey. 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 tools, methods and techniques were used and their influence on innovation performance were conducted during 2006.

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.

4.1 The sample

Our sample has been 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). Initially, the population consisted of 1020 firms.

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. Of the 200 questionnaires initially mailed, and after two follow-up contacts, we obtained 85 usable responses, for an effective response rate of 42,5%. 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 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 tools, methods and techniques that could support the FFE.

With regards to IP the frame used by Frishammar and Hörte [28] has been adopted, both in comparison with the firms´ main competitors and with the firms´ previous objectives. In this sense, high innovation performance means 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 tools, methods and techniques was directly asked in the questionnaire.

5 RESULTS

In order to achieve the research objective, correlations among Innovation Performance and the frequency of use of different tools, methods and techniques, the level of significance and sample size are shown in Table 2.

Table 2: Frequency of use of tools, methods and techniques during the FFE vs Innovation Performance correlations

		Innovation Performance
Technology scouting	Pearson Correlation	,219(*)
	Sig. (2-tailed)	,044
	N	85
Customer Data Base - CRM -	Pearson Correlation	,098
	Sig. (2-tailed)	,373
	N	85
Technology roadmapping	Pearson Correlation	,108
	Sig. (2-tailed)	,325
	N	85
Scenario planning	Pearson Correlation	,241(*)
	Sig. (2-tailed)	,026
	N	85
Formal groups for opportunity identification	Pearson Correlation	,283(**)
	Sig. (2-tailed)	,009
	N	85
Porter´s 5 forces	Pearson Correlation	,056
	Sig. (2-tailed)	,614
	N	85
S curves	Pearson Correlation	,068
	Sig. (2-tailed)	,537
	N	85
Market research	Pearson Correlation	,074
	Sig. (2-tailed)	,504
	N	85
Ethnography analysis	Pearson Correlation	,260(*)
	Sig. (2-tailed)	,016
	N	85
Lead Users	Pearson Correlation	,237(*)
	Sig. (2-tailed)	,029
	N	85
Creativity techniques	Pearson Correlation	,224(*)
	Sig. (2-tailed)	,039
	N	85
TRIZ	Pearson Correlation	,044
	Sig. (2-tailed)	,690
	N	85
Portfolio based idea selection	Pearson Correlation	,170
	Sig. (2-tailed)	,121
	N	85

Specification sheet	Pearson Correlation	,130
	Sig. (2-tailed)	,234
	N	85
QFD	Pearson Correlation	,030
	Sig. (2-tailed)	,785
	N	85
Project management tools	Pearson Correlation	,255(*)
	Sig. (2-tailed)	,018
	N	85
Formal process for idea generation and selection	Pearson Correlation	,280(**)
	Sig. (2-tailed)	,010
	N	85
Idea storage	Pearson Correlation	,199
	Sig. (2-tailed)	,068
	N	85
Innovation measurement	Pearson Correlation	,110
	Sig. (2-tailed)	,318
	N	85
Idea suggestion scheme	Pearson Correlation	,347(**)
	Sig. (2-tailed)	,001
	N	85

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

In general terms, and according to the results, the use of all the tools, methods and techniques analysed in the present study has a positive correlation with innovation performance. Hence, we can say that the use of tools, methods and techniques that support the FFE of innovation seems to have a positive influence on innovation performance. In fact, the use of tools, methods and techniques to support any activity, could be seen, as expected, as a way of proficient process execution [24].

As it can be seen from the results, highly significant positive correlations have been found between IP and "Formal groups for Opportunity Identification", "Formal process for idea generation and selection" and "Idea suggestion scheme". This fact may let us think that these three tools, methods and techniques are the best ones to apply if a firm wants to improve its innovation performance by improving activity proficiency in the FFE of innovation. However, it can be highlighted that the aforementioned tools, methods and techniques have quite a holistic approach in terms of managing the FFE of innovation. This is the case, for instance, of "Formal process for idea generation and selection". Under the expression "Formal process for idea generation and selection", one might, in fact, find specific uses of other tools, methods and techniques when needed. On the other hand, it can be highlighted that highly correlated tools, methods and techniques tend to work on two specific activities in the FFE: the opportunity identification activity and idea generation activity. These two activities can be seen as a way of open-mindedness or divergent thinking within the FFE. One can suggest, therefore, that enhancing divergent thinking related activities during the FFE may have a positive influence on innovation performance.

Significant positive correlation has been found between IP and "Technology Scouting", "Scenario Planning", "Creativity Techniques", "Ethnography Analysis", "Lead Users" and "Project Planning Tools". Most of these tools, methods and techniques can be understood as a way of scanning the environment so that companies can focus on how to adapt successfully to their specific changing environments. That is the case, for instance, of "Technology Scouting", which can be seen as a way of scanning technology so that companies can take advantage of changing technology. The same can be argued about "Scenario Planning", which take into account different factors related to the environment such as customers, competitors, or even economical or demographical factors. Exactly the same argument can be used in the case of "Ethnography Analysis" or "Lead Users", which have a specific

focus on customers as an important input for innovation. This idea is highly consistent with the model assumed in this study. In fact, according to the model proposed by Koen et al. [5], activities executed during the FFE of innovation are influenced by changes in the environment. Therefore, it makes sense to suggest that companies using tools, methods and techniques in order to scan their environments and use that information during the FFE of innovation could lead to higher innovation performance.

Fourth, tools, methods and techniques that are best known and, therefore, most widely used, are also considered to be the most successful ones. However, this result of the surveys is by no means an objective yardstick by which those tools, methods and techniques would be the most efficient ones. Rather, one may think that people – mostly by intuition – tend to apply what they know best [12].

Finally, one could also expect to see greater impacts of the use of tools, methods and techniques on innovation performance. However, it should be borne in mind that not all companies which said they often use one tool, method or technique may apply it according to its rules. It could well be possible a casual application of the tool, method or technique. In fact, the form of best practice may be followed while the content is largely ignored. Additionally, innovation performance is highly influenced by other factors apart from the process related ones that have not been analysed in the present research. These other factors are, for instance, organizational culture, leadership or strategy – known as the FFE engine [5] –. This means that, being proficiency at the FFE activities an important determinant of new product success [26], a highly proficient FFE is not only related to executing activities proficiently but also about promoting an organizational culture that enhances innovation, leaders compromised with innovation or the existence of a clear business strategy [2].

6 CONCLUSIONS, LIMITATIONS AND FUTURE RESEARCH

Overall, this study indicates that a positive relationship exists between using tools, methods and techniques to support the FFE of innovation and innovation performance. Hence, it can be suggested that the use of tools, methods and techniques during the FFE of innovation could improve companies´ innovation performance. Further, the use of tools, methods and techniques in order to support any activity can be seen, as expected, as a way of proficient process execution [24]. Therefore, the use of tools, methods and techniques during the FFE of innovation can be understood as a way of proficiently executing activities covered in the FFE of innovation.

Furthermore, among all the tools, methods and techniques analysed, the most influencing ones seem to be those that show a holistic approach to the FFE. In other words, tools, methods and techniques that take into account the five activities suggested in the model proposed by Koen et al. [5] seem to have a greater impact on innovation performance. Additionally, the findings further suggest that a special focus on enhancing divergent thinking related activities during the FFE of innovation could be beneficial for innovation performance.

The results, also, indicate that scanning the external environment during the FFE of innovation may lead to higher innovation performance. 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 will pay off in terms of increased innovation performance.

The findings in this study, however, should be interpreted with caution for some reasons. First, tools, methods and techniques that are best known and most widely used, are also considered to be the most successful ones. Not necessarily, however, are the aforementioned tools, methods and techniques the most efficient ones, as it is possible that people tend to apply what it is best known [12]. Further studies with an ethnographic approach could be used in order to clarify this aspect.

Second, greater impacts of the use of tools, methods and techniques on innovation performance could have been expected. Nevertheless, casual applications of tools, methods or techniques may rest effectiveness to the tools, methods and techniques. Additionally, the FFE of innovation is highly influenced by other factors apart from the process related ones that have not been analysed in the present research, such us, organizational culture, leadership or strategy [5]. In other words, managers should bear in mind that, being proficiency at the FFE activities an important determinant of new product success [26], a highly proficient FFE should also consider an organizational culture that

enhances innovation, leaders compromised with innovation or the existence of a clear business strategy [2]. 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 is cross-sectional. Therefore, it is difficult to ascertain whether frequent use of tools, methods and techniques during the FFE invariably leads to increased innovation performance. 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 tools, methods and techniques 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 tools, methods and techniques may be enhanced by additional research. One approach would be to examine the use of different tools, methods and techniques 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* [29], 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.

APPENDIX

INNOVATION PERFORMANCE (adapted from Frishammar and Hörte, [28])

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*

FREQUENCY OF USE OF TOOLS, METHODS AND TECHNIQUES

Rate how frequently you use the following tools, methods and techniques during the Fuzzy Front End of innovation in your firm

- Technology scouting
- Customer Data Base - CRM -
- Technology roadmapping
- Scenario planning
- Formal groups for opportunity identification
- Porter´s 5 forces
- S curves
- Market research
- Ethnography analysis
- Lead Users
- Creativity techniques
- TRIZ
- Portfolio based idea selection
- Specification sheet
- QFD
- Project management tools
- Formal process for idea generation and selection
- Idea storage
- Innovation measurement
- Idea suggestion scheme

Response format *1. Never*

7. Always

REFERENCES

[1] Smith P.G. and Reinertsen D.G. *Developing products in half time*, 1997 (Van Nostrand Reinhold Book, New York).

[2] Khurana A. and Rosenthal S.R. Integrating the fuzzy front end of new product development, *Sloan Management Review*, 1997, 2, 103-120.

[3] Cooper R.G. and Kleinschmidt E. Benchmarking firms´ new product performance and practices, *IEEE Engineering Management Review*, 1995, 23(3).

[4] Cooper R.G. From experience: the invisible success factors in product innovation, *Journal of Product Innovation*, 1999, 16, 115-133.

[5] Koen P. et al. Providing clarity and a common language to the "fuzzy front end", *Research Technology Management*, 2001, 4(2), 46-55.

[6] Reid S.E. and de Brentani U. The Fuzzy Front End of new product development for discontinuous innovations: a theoretical model, *Journal of Product Innovation Management*, 2004, 21, 170-184.

[7] Ernst H. Success factors of new product development: a review of the empirical literature, *International Journal of Management Reviews*, 2002, 4(1), 1-40.

[8] Urban G.L. and von Hippel E. Lead User analyses for the development of new industrial-products, *Management Science*, 1998, 34 (5), 569-582.

[9] Groenveld P. Roadmapping integrates business and technology, *Research-Technology Management*, 1997, 40 (5), 48-55.

[10] Phaal R., Farrukh C.J.P. and Probert D.R. Technology roadmapping - A planning framework for evolution and revolution, Technological forecasting and social change, 2004, 71 (1-2), 5-26.

[11] Souder W.E. and Ziegler R.W. Review of creativity and problem-solving techniques, *Research Management*, 1977, 20 (4), 34-42.

[12] Geschka H. Creativity techniques in product-planning and development - a view from West-Germany, *R & D Management*, 1983, 13 (3), 169-183.

[13] Moehrle M.G. How combinations of TRIZ tools are used in companies - results of a cluster analysis, *R & D management*, 2005, 35 (3), 285-296.

[14] Tottie M. and Lager T. QFD - linking the customer to the product development process as a part of the TQM concept, *R & D Management*, 1995, 25 (3), 257-267.

[15] Paulus P.B. and Yang H.C. Idea generation in groups: A basis for creativity in organizations, *Organizational Behavior and Human Decision Processes*, 2000, 82 (1), 76-87.

[16] Foster, R.N. Working the S-curve - assessing technological threats (reprinted from innovation, 1986), *Research Management*, 1986, 29 (4), 17-20.

[17] Koen P. et al. Fuzzy Front End: effective methods, tools and techniques. In Belliveau, P., Griffin, A. & Somermeyer, S. (Ed.) *The PDMA toolbook for new product development*, 2002 (John Wiley & Sons, Inc., New York).

[18] Buttle F. *Customer Relationship Management – concepts and tools*, 2004 (Elsevier Butterworth-Heinemann, Burlington, MA).

[19] Crawford M. and di Benedetto A. *New products management*. (7ª ed.), 2003, (McGraw-Hill, New York).

[20] Curry J. and Curry A. *CRM: cómo implementar y beneficiarse de la gestión de las relaciones con los clients*, 2002 (Gestión 2000, Barcelona).

[21] Kohn S. From innovations strategy to product concept - Mastering the Fuzzy Front End of Innovation, *Seminario en Mejores Prácticas en Innovación y Desarrollo de Nuevos Productos y Servicios*, Mondragón (Spain), November 2003.

[22] Rosenau M.D., Griffin A., Castellion G.A. and Anschuetz N.F. (Ed.). *The PDMA handbook of new product development*, 1996 (John Wiley & Sons. Inc., New York).

[23] Koen, P. et al. (2005). FEI SPI Survey, www.stevens.edu/cce/NEW - May 2006

[24] VDI 2221 (1987)

[25] Val E. and Justel D. Fuzzy front end de la innovación y el pensamiento divergente y convergente. In *X Congreso Internacional de Ingeniería de Proyectos*, Valencia, September 2006.

[26] Cooper R.G. Predevelopment activities determine new product success, *Industrial Marketing*

Management, 1988, 17(3), 237-247.
[27] Booz, Allen & Hamilton. *New Product Management for the 1980´s*, 1982, (Booz, Allen & Hamilton Inc., New York).
[28] Frishammar J. and Hörte S.A. Managing external information in manufacturing firms: the impact on innovation performance, *Journal of Product Innovation Management*, 2005, 22, 251-266.
[29] Porter M.E. *The competitive advantage of nations*, 1999 (The Free Press, New York).

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