Proposal of an Assessment Model for New Product Development

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Abstract. In last decades, New Product Development (NPD) process has become crucial for the company success. Many efforts have been paid in order to identify methods and tools able to improve NPD, but successful models are still missing or not easily followed. Companies find difficult to implement comprehensive models for improving their NPD process, and often they aren't even aware on how they actually are performing it. Which are the main critical areas affecting NPD performances inside the organization? Which are the main opportunities of improvement? Which are the gaps to be fulfilled by a company for acting as a best practice? Both at industrial and academic level, there is the need of a global assessment model able to answer to these – and similar – questions. This paper proposes a tentative model.

Keywords: New Product Development (NPD), Assessment Maturity Model, Best Practices, Benchmarking.

1 Introduction

During the last ten years, New Product Development not only has been recognized as one of the corporate core functions (Huang et al., 2004), but also as a critical driver for company's survival (Biemans, 2003) and prosperity (Lam et al., 2007). The actual uncertain and turbulent marketplace represents a tough challenge to the NPD process, which is often wasteful and not efficiently performed (Rossi et al., 2011). Companies are trying to come out with new efficient methods and techniques, able to guarantee successful products (Gonzales, 2002) in terms of quality, performance and cost. But a standardized framework, able to lead companies through an efficient and effective NPD process is very hard to introduce, due to the complexity and the variability from company to company of the NPD process itself. The first thing to do in order to improve NPD, is to perfectly understand and correctly address the object of the improvement. The problem is that literature state of the art lacks methodologies and tools capable to assess and evaluate how actually companies manage their whole NPD process. In fact the existing tools are only focused on one single aspect of the NPD process, missing the 360° perspective. This research aims to fill this gap, proposing a reference model able to entirely evaluate the NPD process performance.

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2 State of the Art of Assessment Tools

Over the years several assessment tools have been introduced to evaluate specific aspects of the NPD process. Even if they miss the global perspective, they represent a good starting point to be considered in order to develop a comprehensive method. They are listed in the following.

- *Project management maturity assessment methodology:* this method allows comparing the performance gained by similar organizations, evaluating the ratio PM/ROI (project management/ return on investments). Data are collected through a proper questionnaire (Ibbs and Kwak, 2000).
- *RACE (Readiness Assessment for Concurrent Engineering)*: this tool was developed at the beginning of the 1990s at the West Virginia University and it is used in software design and in the mechanical sector to assess the level of application of Concurrent Engineering within NPD. The model assesses two main areas, the organizational part (evaluated in 9 maturity levels) and the information technology part (5 levels are considered) (Wognum 1996). RACE is based on a questionnaire, whose data are represented through a radar chart.
- *CERAM Model (Concurrent Engineering Readiness Assessment Model for Construction)*: this method derives from RACE model; it only differs in some contents, being suited for the construction field. CERAM considers two main perspectives, the process (which is evaluated through eighth levels) and the technology (assessed in four levels) (Khalfan, 2001).
- *BEACON Model (Benchmarking and Readiness Assessment for Concurrent Engineering in Construction)*: this model has been introduced as a complement to the CERAM model. In fact it is able to assess not only process and technology, but also external elements, such as project and people. The efficiency of the organization in project management, the performance of the staff and the efficiency of the technology used in the company are evaluated with a 5 grades scale (Anumba et al., 2007).
- *CMMI (Capability Maturity Model Integration)*: this model was developed in 1987 by SEI (Software Engineering Institute) in order to define the maturity level of the development process. It integrates best practices on improving development process with product maintenance. Five maturity levels are assessed, Ad hoc, Repeatable, Characteristic, Managed and Optimising (Mark et al. 1993).
- *Mis/PyME*: this model is able to assess the processes providing the organization with tools able to facilitate the fulfilment of company's objectives. This assessment model is based on the software indicators of the small and medium enterprises. It focuses on: data, people and performance (Díaz-Ley, 2010).

These assessment tools are considered the most relevant in literature. The visual representation of RACE and BEACON through a radar chart makes them simple and intuitive in representing the AS-IS status. CMMI is valuable for its five maturity levels. The questionnaires used by the models are useful to understand which are the

main criticalities and peculiarities of each of the assessed area. But a global model for assessing NPD in its whole is still missing. Basing on the analysed contributions and on empirical experiences, this research aims to fill this gap.

3 The Proposed Assessment Model for NPD

The aim of the proposed model is to provide a "picture" of the AS-IS status of the NPD inside a company. To define the NPD maturity is a very tough task, because of the high number of elements concurring in the system, such as people, tools, and methods. For each of these area within NPD, five possible maturity levels, under the acronyms CLIMB, are considered:

- Chaos: the area is usually chaotic and slightly structured.
- Low: the area has a simple formalization and it is barely planned and controlled.
- Intermediate: the area is structured and planned. Standard solutions are normally applied.
- Mature: the area is structured, planned, controlled and measured at its different layers, often through specific quantitative techniques.
- Best practice: the organization reached all the previous stages and the area continuously improves thanks to the analysis of variance of its results. The improvement of NPD performance is reached through incremental and innovative actions.

In order to evaluate the proper maturity level of a company, a questionnaire has been developed for collecting the relevant information within the technical department and a radar chart has been created for the visual representation. They are detailed in the following sections.

3.1 The Questionnaire

The questionnaire includes 33 multiple choice questions and tables, used to analyse 3 main perspectives of NPD: Organization, Knowledge Management, Process. These are arranged in 9-areas – respectively 3, 4, and 2. Each area is then evaluated through a variable number of questions. The structure is summarized in Table 1.

Table 1. Structure of the questionnaire

Macro Area	Area	# Question/ matrix
Organization	Work Organization	1-5
	Roles and Coordination	6-9
	Skills and Competencies	10-12
Process	Process Management	13-16
	Activities and Value	17-20
	Decision Making Factors	21-24
	Methods	25
Knowledge Management	Formalization	26-30
	Computerization	31-33

The chosen areas are suitable to describe the NPD as a whole, overpassing the gap identified in the literature review. A brief description of the selected areas follows:

- *Organization.* This is a huge topic that concerns all the people involved in everyday company's activities. Core elements are division of labour and tasks *(Work Organization*); coordination of people and activities, roles of engineers and designers (*Roles and Coordination*); practitioners skills and expertise (*Skills and Competencies*). When considering NPD, designers assume relevant importance, since the coordination and cooperation between them imply the goodness of the work environment. Moreover, well defined roles and responsibilities result in better organized NPD. Finally, enhancement of individual skills and competences determine a more agile and mature organization and better product performance.
- *Process*. NPD is realized through a – more or less – formalized process, described as a series of steps, activities and tasks to be accomplished in order to define the specifications of a new product, or the upgrade of an existing product. This process can be supported by a huge variety of tools and methods (*Methods*), such as Design for X techniques, Life Cycle Analysis, etc. The strict control of the NPD process is crucial, such as its continuous monitoring and improvement (*Process Management*). Moreover the process requires a large number of decisions to be taken every day: a chain of linked choices made considering both internal (*Decision Making Factors*) and external (*Activities and Value*) elements.
- *Knowledge Management.* To maintain and protect the know-how of a company is crucial within any kind of industry. Everyday knowledge is created, shared, retrieved, and displayed; huge amount of data should be handled effectively. The better information are stored, represented, captured, and reused, the more efficient is the NPD. In order to preserve data, these should be formalized and represented in a way understandable by each practitioner inside the company, and easy to be re-used (*Formalization*). The higher the level of computerization, the faster and more precise the knowledge management process and the communication between people and departments are (*Computerization*). In order to achieve these results PLM (Product Lifecycle Management) / PDM (Product Data Management) software are suitable to be implemented.

All the 9 areas are numerically evaluated through a proper score given to the related questions, as explained in the next section. Thanks to this score, it is possible to define the maturity level reached by the company in the different areas and it is possible to represent the maturity using a radar chart.

3.2 The Radar Chart

The questionnaire is composed by multiple choice questions and tables, associated to a conveniently defined score, used to state the maturity level achieved in NPD by the analysed organization. The Radar Chart (cf. Figure 2) is the way to graphically represent this maturity level. A group of questions determines the score of the area.

Each question is answered with multiple choice descriptive options, which correspond to a numerical value, varying from 0 to 3. The minimum maturity value achievable for the area is obtained when all the answers generate 0 as a reply. Vice versa the best practice level is obtained when all the answers assume value 3. For intermediate answers the value is calculated as normalized score (% value). An example of score calculation is given in following Table (cf. Table 2).

Table 2. Example of Scoring of Area

Skills and Competencies	**Answer**	**Score**
10. Product design is heavily based on skills and competence of the actors involved (technicians, designers, managers, etc.). How does the company support training and skill development?		
a. Any engineer/designer is personally responsible for developing and maintaining his/ her skills.		1
b. The company urges the development of strong technical skills, and gives training on the job.	X	2
c. The company promotes multidisciplinary skills and supports knowledge management activities with formal programs (ex. training plans, rotation between project teams, etc,…).		3
d. Other (specify).		
11. Is there a responsible trainer that supports training activities inside the organization?		
a. No, each technician/designer is expected to build his/her skills individually.		1
b. Yes, a technician/designer is encouraged to develop his/her own skill from his/her direct supervisor.	X	2
c. Yes, there is a one-to-one correspondence for tutoring (a junior designer is assigned with a more experienced designer, as a tutor, coach, or mentor).		3
d. Other (specify).		
12. How effectiveness of training is evaluated in terms of the learning outcomes?		
a. Using 'visual' evaluation of individual behaviors.	X	1
b. Using a test before and after the training session.		2
c. Using KPIs to assess the impact of training on business performances.		3
d. Other (specify).		

Maximum Achievable Value	*Achieved value*	*Normalized value for the Area*
(3+3+3) = 9	(2+2+1) = 5	(5/9)*100 = **55.56%**

Following this procedure, for each of the 9 areas, is it possible to state the reached maturity level, considering the profiles proposed in Figure 1, and to represent the global results in the radar chart (cf. Figure 2).

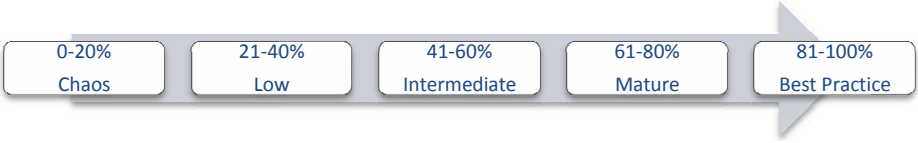

Fig. 1. Maturity Levels Profiles

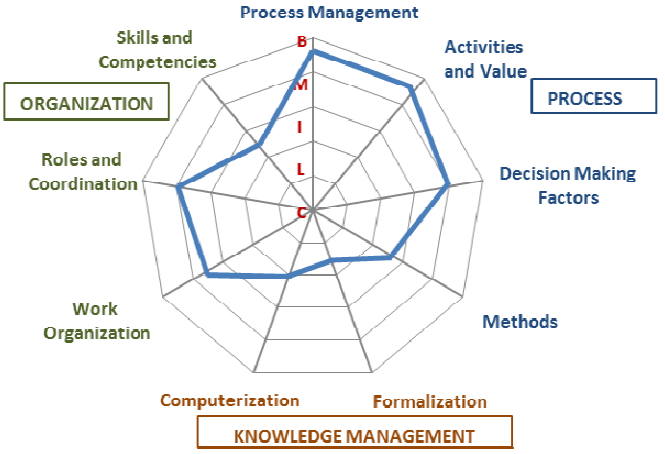

Fig. 2. The Radar Chart

4 Preliminary Results

Since February 2012 until now a sample of 30 companies has been analyzed. The variety of the sample is quite relevant, has shown in Table 3.

Table 3. The Sample

Number of employees	Small (<50)	Medium (50<= Me <=250)	Large (250< B <= 1000)	Very large (>1000)
# companies	1	6	11	12

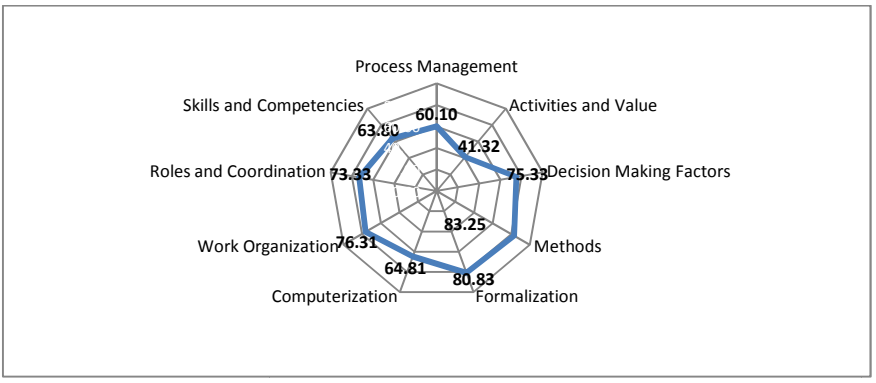

Fig. 3. Global Average

Radar chart in Figure 3 displays the average trend of the whole sample. The major criticalities are linked to the definition of the customer value, which is rarely well defined and communicated within the organization. On the contrary the attention paid to knowledge formalization is high. On average, the maturity level of the market is varying between intermediate and mature.

Figure 3 and Figure 4 show the trend of Medium and Very large Enterprises with respect of the global average of the sample. Medium enterprises are close to the global average in terms of *decision making*, *methods* and knowledge *formalization*. Major differences are in *computerization*, *value*, and *organization* macro area perspective, in which they attest under the global trend (cf. Figure 4).

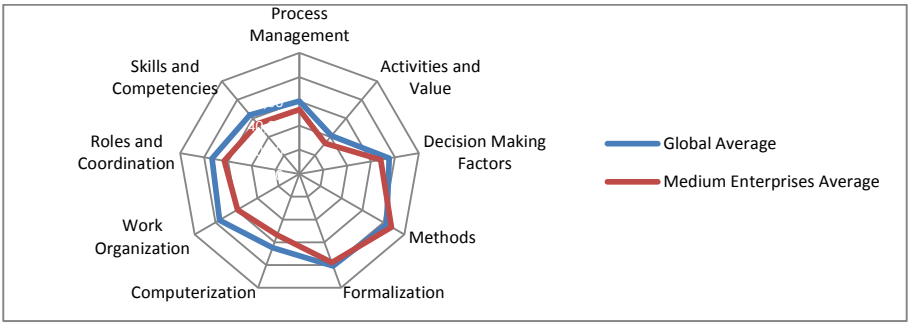

Fig. 4. Medium Enterprises vs Global Average

Apart for the *formalization* area, in which they are aligned to the global trend, Very large enterprises are over average for all the considered perspectives (Cf. Figure 5).

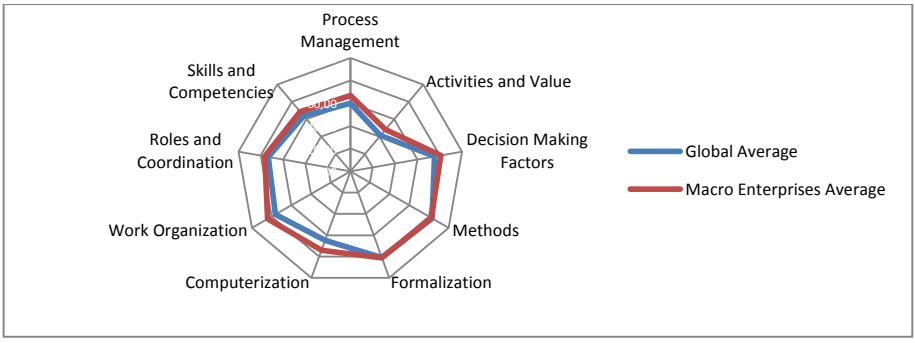

Fig. 5. Very large Enterprises vs Global Average

5 Conclusions and Future Developments

The aim of the proposed assessment model is to give the possibility to a company to assess its NPD process. Actually companies know the problems they have to face when introducing new products to the market, but they not always consider these

criticalities in a whole picture, resulting in a bad focusing of the required improvement efforts. The proposed method gives companies the opportunity to assess themselves, and also to benchmark with competitors.

Further researches will be based on the application of this method in as much companies as possible, in order to test the validity of the model.

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