A proposal for the management of software products aiming at the elaboration of innovation-based competitive strategies

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Abstract: This article presents a proposal for the application of the New Product Development (NPD) approach to support the elaboration of innovation-based competitive strategies by software development companies. The proposal is based on the joint application of *Portfolio Management, Product Platform* and *Technology Roadmapping* methods, and on the cooperation among professionals from business and technology areas. It was validated and refined at a small business. The research suggests that the application of these methods may bring about positive results for software development companies, despite the existing significant differences between this sector and the NPD methods.

Keywords: software product management, innovation, competitive strategy, NPD.

1. Introduction

This paper proposes an application of the New Product Development (NPD) approach to support the elaboration of innovation-based competitive strategies by software development companies.

Competitive strategies are actions targeting the creation of a more favorable market position to challenge the competition and obtain higher returns on investment (PORTER, 1986). The term "innovation" is used in this paper to describe the "interactive process triggered by the perception of a new market and/or new service opportunity for a technology-based invention which leads to development, production, and marketing tasks striving for the commercial success of the invention" (GARCIA; CALANTONE, 2002).

This proposal is based on the application of three methods: *Portfolio Management, Product Platform* and *Technology Roadmapping (TRM)*. They were chosen for being complementary and because they, together, cover the main aspects targeted by the most strategic dimensions of the NPD (CHENG, 2000):

i) support to competitive positioning due to innovation;
ii) alignment between business strategy and product launch;
iii) cooperation between technical and marketing areas;
iv) strategic repositioning of existing products;
v) conception of new products;
vi) prioritization of projects;
vii) balance of the product mix; and
viii) technological leverage.

The relevance of this subject of study arises from the competitive dynamics of the software sector, which is characterized by fast introduction of new products and innovations into the market, fierce competition, and high birth and mortality rates of new business (VÄHÄNIITTY, 2004). In such scenario, the ability to bring innovation into the market is considered the main competitive feature, and is a tool for the creation or overcoming of entry barriers (FREIRE, 2002; ROSELINO, 2006). Furthermore, innovating and ensuring product success have been proven to be a great challenge, with failure being the most frequent outcome (BALACHANDRA; FRIAR, 1999; COOPER, 2000).

Brazil is one of the leading global producers not ranking among central players (together with India, Ireland, Israel, China and Russia) which could develop a strong software industry (ROSELINO, 2006). Nevertheless, market data show that the software product segment – the one with the highest volume of business – is largely dominated by foreign companies (ABES, 2008). Such scenario helps to understand and justify the goals pursued by the software sector since the 1990s: improving the competitiveness of domestic companies; increasing the participation of Brazilian producers in the domestic market; and turning Brazil into a major exporter (FREIRE, 2002). Therefore,

the proposal presented herein aims at responding to the challenges faced by the Brazilian Software Industry.

The paper follows this structure: section 2 presents the research methodology; section 3 presents the background theory and the challenges and opportunities regarding the application of NPD methods by software companies; section 4 presents the proposal elaborated through this research; while section 5 describes the application of the proposal in a small business; finally, section 6 brings the main comments and conclusions.

2. Research methodology

The investigation followed the Action-Research methodology strategy, for this allows the researcher to reach the goal of generating scientific knowledge while contributing to improve the understanding of the problems addressed and of the solutions proposed (THIOLLENT, 1996). The research evaluated the three selected NPD methods and adjusted the proposal through its application in a small Brazilian software development company, which was facing problems with decreased competitiveness of its product mix.

A complete cycle of the process presented in this paper was carried out during the first eight months of 2008, through meetings and seminars promoting the interaction between the researchers and the company's main managers – responsible for the R&D, finance, sales and marketing areas.

During the intervention, the participants stressed their worries regarding the characteristics deemed indispensable for management practice in the software product field: fast-paced and in tune with the sector's dynamics and particularities. The discussions over the methods and techniques and the choice of those to be adopted took such worries into account. In certain situations, the company was resistant to or simply discarded the use of some techniques, for considering them too strict or with too many stages or controls.

The elaboration of the proposal was thus guided by the theory settings and by the understanding of the reality of a software development company.

3. Literature review

Several works point to the existence of similar and complementing features, as well as the contribution of exchange of experience between NPD and software development (NAMBISAN; WILEMON, 2000; HUH, 2001; FLEURY et al., 2006; HELFERICH; SCHIMID; HERZWURM, 2006; WEERD, 2006a, 2006b; EBERT, 2007; LEHTOLA; KAUPPINEN; VÄHÄNIITTY, 2007). For the authors, the NPD approach may help software companies to promote better integration among strategy and marketing/sales managers and technical staff, a necessary condition that enables the choice of products and their requirements be done based on a business view.

3.1. Challenges and opportunities

The existence of a yet limited number of studies relating NPD to software development is an obstacle often mentioned in the literature. However, the greater challenges are related to significant differences between product-oriented software companies and the origin of NPD techniques, as well as a number of particularities (Table 1) preventing the application of these techniques without prior consideration and occasional adjustments (VÄHÄNIITTY, 2003; WEERD, 2006a).

Several authors call attention to the importance of these particularities (BERRY; TAGGART, 1998; CUSUMANO, 2004; RAMESH et al., 2003; KAKOLA, 2003, 2006; VÄHÄNIITTY, 2004; WEERD et al., 2006a), while Kakola (2003), referring to desired characteristics for NPD approaches applied to software, pointed out: "fast, agile, and light but, at the same time, robust and scaleable practices need to be generated for software ventures, enabling them to establish efficient and effective product creation and delivery processes".

3.2. Seeking a reference framework

Seeking a starting point and a better understanding of Software Product Management (SPM) approaches, a term designing NPD applied to software companies, the research analyzed the proposals made by Kilpi (1998), Rautiainen et al. (2002), McGrath (2000) and Weerd et al. (2006a, 2006b).

Kilpi (1998) presents a framework comprising four macro-activities: development, production, marketing and distribution. These macro-activities are developed through six main processes: i) customer delivery; ii) marketing & sales; iii) product support; iv) software production; v) release planning; and vi) release project. Within this framework, it is worth mentioning the incorporation of activities of non-technical nature by the software development process. However, it does not address issues related to the selection and prioritization of projects/product, nor to the promotion of the alignment of business strategies and R&D.

Such gap is filled by Rautiainen et al. (2002), which proposes that software development processes should be coordinated by four control activities: i) *strategy*, responsible for ensuring alignment between business strategy and products; ii) *portfolio management*, to manage the company's set of products (including prioritization and schedule of releases); iii) *competence management*, responsible for identifying existing competences and those necessary for the execution of the plan elaborated; and iv) *multiple project management*, aiming at balancing and allocating the company's resources among projects.

Table 1. Context, advantages, and difficulties related to the development of new products by software companies.

Context	
• Market typically characterized by quick changes, ambiguity and turbulence; • Companies are not able to assess all information that could help them reduce uncertainties and threats involved in the development of new products, since they are not even able to get to know all issues to be addressed; and • Projects often need to be started without a clear definition of their own objectives, since flexibility and the ability to promote quick moves are the "rules of the game".	
Advantages	Difficulties
Associated to the fact that most companies are small: • Relatively simple communication, coordination and collaboration processes; • Rapid improvisation of solutions for out of routine situations; and • Ability to innovate in products, services or processes – in a quick, flexible, efficient manner without significant managerial control.	Associated to market dynamics: • Complexity inherent to the organization of requisites and recording of changes in the product, throughout time; • Need for companies to maintain and give support to old products (installed base) while developing and launching new ones; and • High frequency of launches compared to other types of product.

Source: adapted from Kakola (2003) and Weerd et al. (2006a).

The proposal presented in the work by Rautiainen et al. (2002) is succinct, but subsequent articles by the same authors, such as Vähäniitty's (2002, 2003, 2004, 2005, 2006, 2007), enlarge the understanding of the activities present in this framework and incorporate new issues, such as the treatment of product lines (platforms). Considering this set of works, the proposal built up by Rautiainen and Vähäniitty may, on the one hand, seem to have a broad scope; on the other hand, it seems rather fragmented and, consequently, difficult to be understood as a single reference chart.

The proposal presented by McGrath (2000) is at the same time comprehensive, coherent and rich in examples and guidelines for its implementation. However, it is a "generic" framework, aimed at high-technology companies, not dealing specifically with software development companies.

Among the proposals analyzed, the framework presented by Weerd et al. (2006a, 2006b) is the one that best summarizes the contribution of NPD approaches to software companies. Besides dealing comprehensively with and approaching processes both at the company level and at individual projects level, the authors add in their proposal the flow of information, the artifacts and, explicitly (as opposed to the other proposals), the players involved in each activity proposed in the reference chart.

3.3. The application of NPD methods at software companies

Notwithstanding the proposal made by Weerd et al. (2006a, 2006b), which represents a general view and a good starting point to place NPD methods within the context of software development companies, these authors do not deal with details related to the application of these methods and their respective techniques. In this regard, the research was guided by two sets of works: i) classic authors in the NPD field; and ii) proposals for the adjustment and use of NPD techniques at software development companies, especially those regarding emerging SPM literature (Table 2).

While the first group allowed a broader understanding of the objectives of each method and their main techniques, the second brought in critical elements indispensable to evaluate the applicability at software companies, and calls attention to the precautions to be taken and traps to be avoided.

Even in "classic" NPD literature, there are authors, e.g. Marc Meyer and Timothy Simpson, who propose adjustments of their methods for software companies. In SPM literature, on the other hand, apart from the objectives pursued in the NPD field, there are proposals of more specific applications, such as planning of products and versions (VÄHÄNIITTY; LASSENIUS; RAUTIAINEN, 2002; WEERD, 2006a, 2006b) or improvements in software development internal processes (FLEURY, 2007).

4. Presentation of proposal

In terms of approach, the proposal is strongly inspired by the framework presented by Weerd et al. (2006a; 2006b) and by the *Technology Roadmapping System* suggested by Phaal, Farrukh and Probert (2004). In terms of procedures, it proposes the joint use of three distinct NPD methods, and incorporates techniques consolidated in NPD literature as well as adjustments found in the emerging Software Product Management (SPM) literature.

Figure 1 shows its graphic representation. At the top, the participants are listed, highlighting main information and directives each one should bring into the process. The center of the figure shows the flow of activities and information (arrows and rectangles) and techniques (texts in red) used to execute the methods suggested (in italics). NPD methods conduct and provide tools to a process of planning and decision-making carried out through a series of seminars – meetings which create situations for interaction

Table 2. References used for the application of the selected NPD methods and techniques.

	"Classic" literature NPD Domain	Adjustments to software SPM Domain
Portfolio management	Cooper (2000); Cooper, Edgett and Kleinschmidt (2000, 2001, 2006); Cooper and Edgett (2006); Jolly (2003); Say, Fusfeld and Parish (2003); Mikkola (2004);	McGrath (2000); Vähäniitty and Rautiainen (2005); Vähäniitty (2006)
Product platform	Meyer and Utterback (1993); Meyer (1997); Meyer and Lehnerd (1997); Meyer and Mugge (2001); Jiao and Tseng (2000); Simpson (2004); Simpson et al. (2006)	Meyer (1998); McGrath (2000); Sääksjärvi (2002); Cusumano (2004); Salonen (2004): Vähäniitty and Rautiainen (2005); Helferich, Schimid and Herzwurm (2006)
Technology roadmapping	Kappel (2001); Phaal, Farrukh and Probert (2000, 2001, 2004); Probert and Radnor (2003); Phaal et al. (2002, 2003); Albright (2003)	Vähäniitty, Lassenius and Rautiainen (2002); Vähäniitty (2004); Lehtola, Kauppinen and Kujala (2005); Fleury et al. (2006, 2007); Fleury (2007)

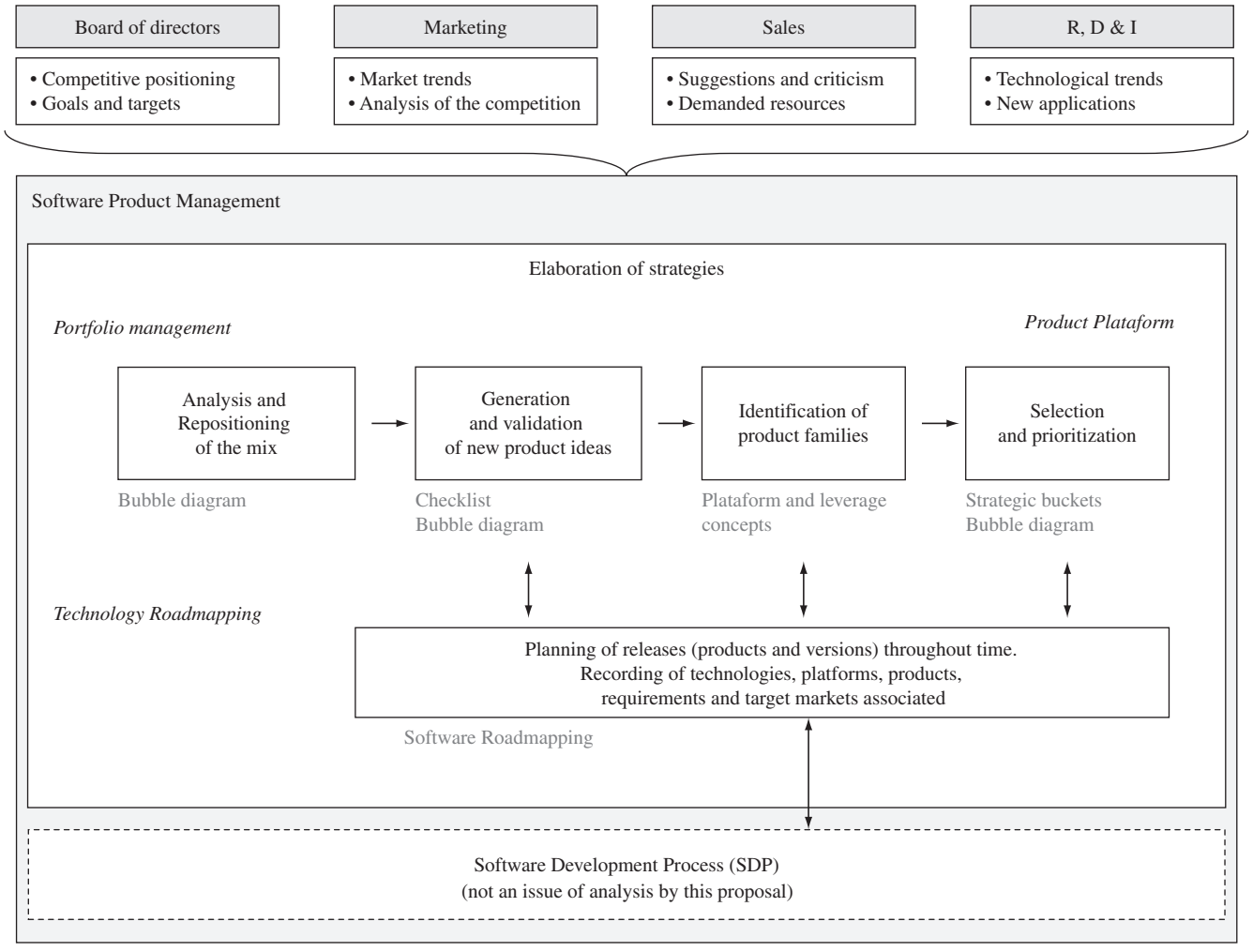


Figure 1. General view of the process of Software Product Management support. Source: Lara (2008, p. 127).

and exchange of information among participants. Each seminar represents a stage of successive refinement of product development and innovation strategies which, in the end, will be adopted by the company. It must be, thus, noted that the construction process of the map follows a logic different from the T-Plan process (PHAAL et al., 2002), often mentioned in NPD literature.

The application of this proposal is guided by a set of steps and activities, summarized in Table 3; however, the order in which the activities are executed is not strict, since the

Table 3. A guide for the application of the process proposed.

Step 1 – Diagnosis and initial planning
Formation of a multi-functional team (technical, finance, commercial and marketing areas) to participate in the process. Evaluation of the company's competitiveness. Alignment of expectations and discussion over the company's competitive positioning, its strategic planning and mid- and long-term goals.
Step 2 – Analysis and repositioning of current mix
Assessment of competitive loss/gain trends and changes likely to promote improvements in the competitiveness of existing products.
Step 3 – Generation and validation of new product ideas
Presentation, evaluation, approval or discarding of new product ideas – inspired by clients' or prospects' demands, by market or technological trends.
Step 4 – Identification of product platforms and families
Identification of candidate platforms and their construction blocks, and of most promising market niches. Evaluation of the segments, among those, where the company intends to work. Derivation of strategies based on vertical and/or horizontal leverage.
Step 5 – Definition and selection of projects
Specification of functionalities, construction blocks and other technological aspects of the proposed products and platforms. Estimates of development effort, market potential, added services, price and/or profitability, necessary resources (personnel, technological and infrastructure). Selection of most promising products and platforms.
Step 6 – Prioritization and balancing of portfolio
Distribution of company investments and resources among the proposed platforms and prioritization of related projects (construction of the platform itself, improvements in existing products or derivation/development of new products).
Step 7 – Planning of products and versions
Roadmap design, encompassing the planning horizon defined. Elaboration of an action plan encompassing the documentation produced and reflecting the strategies developed throughout the process.

Source: Summarized from Lara (2008, p. 128).

process is based on a strategy of successive refinements. The use of the Platform concept may illustrate such flexibility. In the proposal presented, Product Platforms do not come up until reaching the most advanced stages of the process, especially due to the premise that the company is not likely to guide its activities based on this concept. In some cases, however, the analysis of the platforms may occur earlier than or even guide the generation of ideas for new products, which may be possible upon small changes in the order of the activities encompassed by steps 3, 4 and 5.

The techniques used to support the methods, especially regarding portfolio management, may also vary in accordance with the context of the application. In short, small adjustments may be promoted without jeopardizing what may be called the "master-line" of the proposal.

5. Practical application

5.1. About the company

Founded in 1996, Doctor Sys is a successful company in the software development market, with a significant number of clients and a track record of several R&D projects. Since the company only sells products conceived and developed by itself, activities related to product conception and market strategy definition are inter-related and bear great relevance to the business. In 2007, the company held a family of products comprising five softwares: *Smart.Meeting*, *Smart. Seminar*, *Smart.Training*, *Smart.Learning* and *Smart. MediaCenter*. All of them were developed and launched between 2005 and 2007.

5.2. Initial diagnosis

By the end of 2007, four of the company's five products were losing competitiveness before new competitors, and were becoming technologically outdated, projecting a downswing in the company's sales curve. Table 4 lists such problems. The sophisticated product mix had been, until then, a commercial advantage. However, at this point, the company faced the need for additional effort by the technical staff and a challenge for its (low) investment capacity. The company realized that a series of decisions taken over the time had brought about additional difficulties.

The products had been conceived in terms of a family, but did not share a platform. Due to the evolution of software technologies, the latest products often did not use the components used by existing products, often demanding individual maintenance. Components were shared, when possible, on the lowest level of abstraction.

The company was facing challenges in prioritizing correctly projects and optimizing resource allocation, especially when it was necessary to choose between meeting demands of existing clients or taking advantage of opportunities related to new applications and new markets. In the absence of clear guidelines agreed on by the partners, R&D priorities were often changed due to contingencies.

In short, the initial diagnosis presented the problems widely mentioned in NPD literature: i) product obsolescence process (MEYER; LEHNERD, 1997); ii) lack of alignment between organizational strategy and project portfolio (COOPER; EDGETT; KLEINSCHMIDT, 2001); iii) non-articulated or conflicting efforts between marketing and development staff (VÄHÄNIITTY, 2006); and iv) loss in competitiveness (MEYER, 1997; SIMPSON et al., 2006).

5.3. Analysis and repositioning of current mix

A bubble diagram (a variation proposed by Jolly (2003)) helped to analyze the competitiveness of the company's product mix, also pointing out the individual trend for each product (Figure 2).

Upon positioning the current products, the main elements jeopardizing their competitiveness were reviewed (those summarized in Table 4). The team reflected on immediate changes in the products (in terms of resources as well as in pricing policies) likely to promote immediate improvements in their competitiveness (proposal by Mikkola (2004)), as well as on long term alternatives.

5.4. Generation and validation of new product ideas

The participants listed resources, technologies and products they considered promising. The business department staff brought in a point of view geared towards promoting improvements in existing products, based on demands assessed at corporate clients and on comparisons with the main competitors; while the technical staff focused on new technologies and architectures likely to facilitate the development of new products and implementation of platforms. Approximately 20 ideas were presented, half of which was discarded immediately by the exchange of impressions among participants or by a short checklist.

5.5. Selection of products and identification of platforms

In the selection of products to invest in, the process combined Portfolio Management strategies with the perspective of developing platforms. Figure 3 presents the diagram used to guide the analyses and discussions.

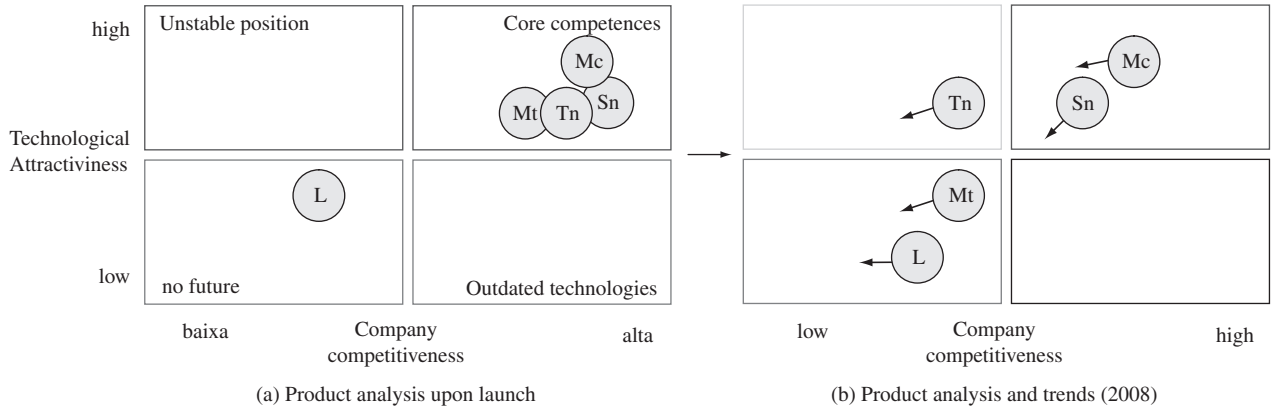
Preliminary results:

- Discontinuity of two products which had had sharp loss in competitiveness (marked "Tn" and "Mt") and

Table 4. Challenges associated to the company's product mix.

Loss in technological attractiveness
After some time, products *Smart.Seminar* and *Smart.MediaCenter* were no longer seen as pioneering. New technologies came up, as did some competitors. They were still competitive from a market point of view, since the company offered value-adding services in addition to (quality) products and (still up-to-date) technology.
Loss in competitiveness
The company's first products (*Smart.Meeting* and *Smart.Training*) came to face significant competition. Domestic competition came around with aggressive pricing. Such scenario had been pushing the company towards cutting prices (and margins), a trend which conflicted with the initial proposal: differentiated solutions with added value.
Commoditization process
The competition faced by *Smart.Learning, Smart.Meeting* and *Smart.Training* offered insignificant, or no costs. There was a trend towards applications of this kind bearing very low commercial level, and their permanence in the company's product mix would not be justified unless they helped in sales of other products with higher added value or if their costs of development, distribution and sales suffered drastic reduction.

Source: Adapted from Lara (2008, p.104).



(a) Product analysis upon launch (b) Product analysis and trends (2008)

Figure 2. Analysis of the company's current product mix. Source: Lara (2008, p.118).

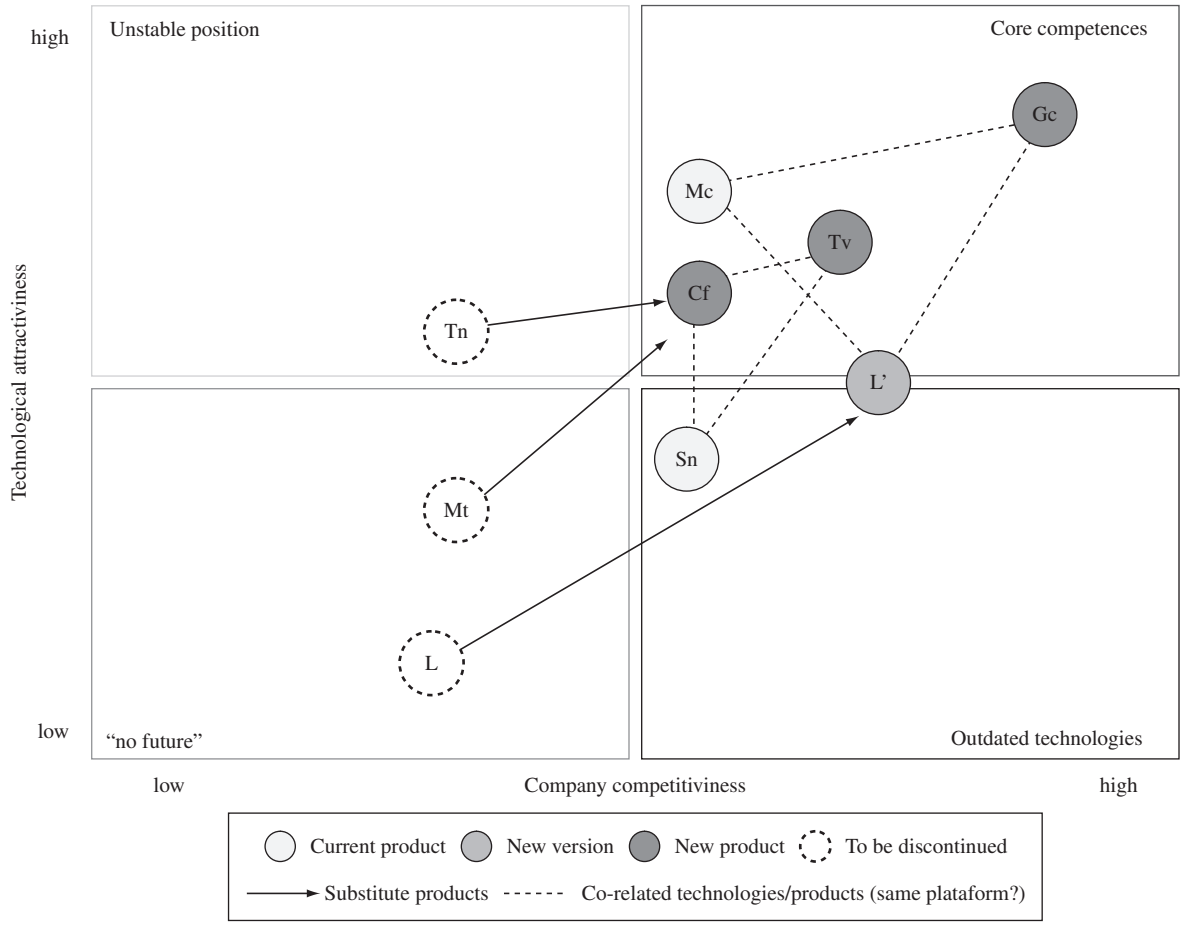


Figure 3. Analysis of the new product mix. Source: Lara (2008, p. 118).

entry of a single substitute ("Cf"), with aggressive pricing and technological differentiation elements allowing the generation of competitive advantages;

- Development of a new version for product "L";
- Construction of two product platforms (dotted lines) based on two existing products (marked "Sn and "Mc"), allowing derivation of new, promising products; and
- The mix as a whole would be moved into or close to the quadrant representing higher competitiveness.

5.6. Portfolio balancing and project prioritization

The company defined the following criteria for distribution of investment: i) using only the installed capacity; ii) prioritizing the product family with the best risk × return relationship; and iii) maintaining investments in products likely to reinforce the company's image as an innovative company with cutting-edge technology.

The discussions were preceded by market surveys and data collection. Table 5 and two other tables/figures were elaborated: one associating products to the construction blocks they use (Figure 4); and another listing, for construction blocks and products derived from the platform, an indicator of technical difficulty, estimated development effort and follow-up information of the module/product.

The results of the discussions and alignment with such criteria led to the following distribution of efforts: 60% of the investment directed to Platform I (Figure 4); 30% to Platform II; and, 10% reserved to products/services outside the platform strategy.

The resources to be allocated, within each platform, were established through consensus, with the following reference parameters: 50% of the effort for the construction of the platform; 25% for the improvement of existing products; and, 25% for derivation of new products or versions.

The development of products of higher commercial attractiveness (business area domain) and/or higher facility in implementation (technical domain) was defined as priority (Figure 5). Another criterion adopted was the contribution of the platform for product construction. Projects using the highest possible number of shared components would be prioritized. Based on the analysis of such criteria, projects

Table 5. Analysis of product offers per company's target segments.

Offer attractiveness potential (company-product-price) per segment analyzed						
Product		**Price**	**Formal education**	**Other knowledge companies**	**Health**	**Corporations**
Plataform I	Mc	$$	High	High	Medium	Medium
	Gc	$$$	High	Very High	Very High	Very High
	L'	-	Very High	Very High	Medium	High
Plataform II	Sn	$$	Medium	High	Medium	Low
	Cf	$	Medium	High	High	Very High
	TV	$$	Low	Médium	Low	Low

Source: Lara (2008, p. 121).

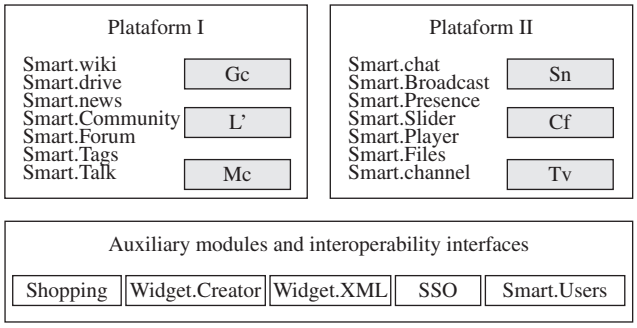


Figure 4. Architecture of Platforms. Source: Lara (2008, p. 122).

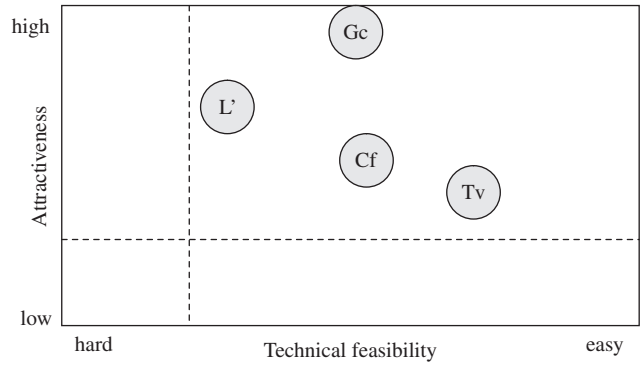


Figure 5. Analysis "attractiveness vs. feasibility" of the new products proposed. Source: Lara (2008, p. 124).

"Gc" and "Cf" were defined as the initial products for each platform.

5.7. Planning of products and versions

At this point, the company already had the distribution of investments for each platform and prioritization of projects. The comparison of such data to the resources available and the investment demanded by each project allowed the distribution of this information along time line and the elaboration of the roadmap (Figure 6).

5.8. Results

In the long run, it is observed that the new product mix brings in substantial improvement in the competitiveness and attractiveness of the company's portfolio. As more immediate results, the company experimented a series of changes pointed out in the literature arising from better integration of R&D and marketing (SMITH, 1988; GRIFFIN; HAUSER, 1996; BERRY; TAGGART, 1998; VÄHÄNIITTY, 2005; FLEURY et al., 2006), among which it is worth noting: i) clearer priorities and goals; ii) operations aligned with long-term strategies; iii) generation of new businesses; and iv) clearer process in the analysis of opportunities and generation of product ideas.

6. Conclusion

This paper presented a process a) for systemizing the elaboration of strategies for the development of new software products; and b) for promoting alignment among market needs, technological possibilities and company competences. The methods used support analyses and discussions by embodying different points of view represented by participants from the commercial, finance and technology areas.

Despite the combination of different methods and techniques, the application of the process proved itself to be simple and, given its flexibility, the proposal is believed to be applicable both to starting companies and to those already consolidated. In starting companies, it may help entrepreneurs to conceive strategies based on multiple products for multiple markets, from a single technological platform – thus increasing the return potential of an innovation. In consolidated companies, it may provide support to the active management of the product/project portfolio and to the development of strategies allowing systematic renovation in the product mix, aiming at ensuring a competitive position.

This paper may help to fill a gap located in the intersection between NPD and Software Engineering, particularly regarding the use of methods of TRM, Portfolio Management and the concept of Platform in product-

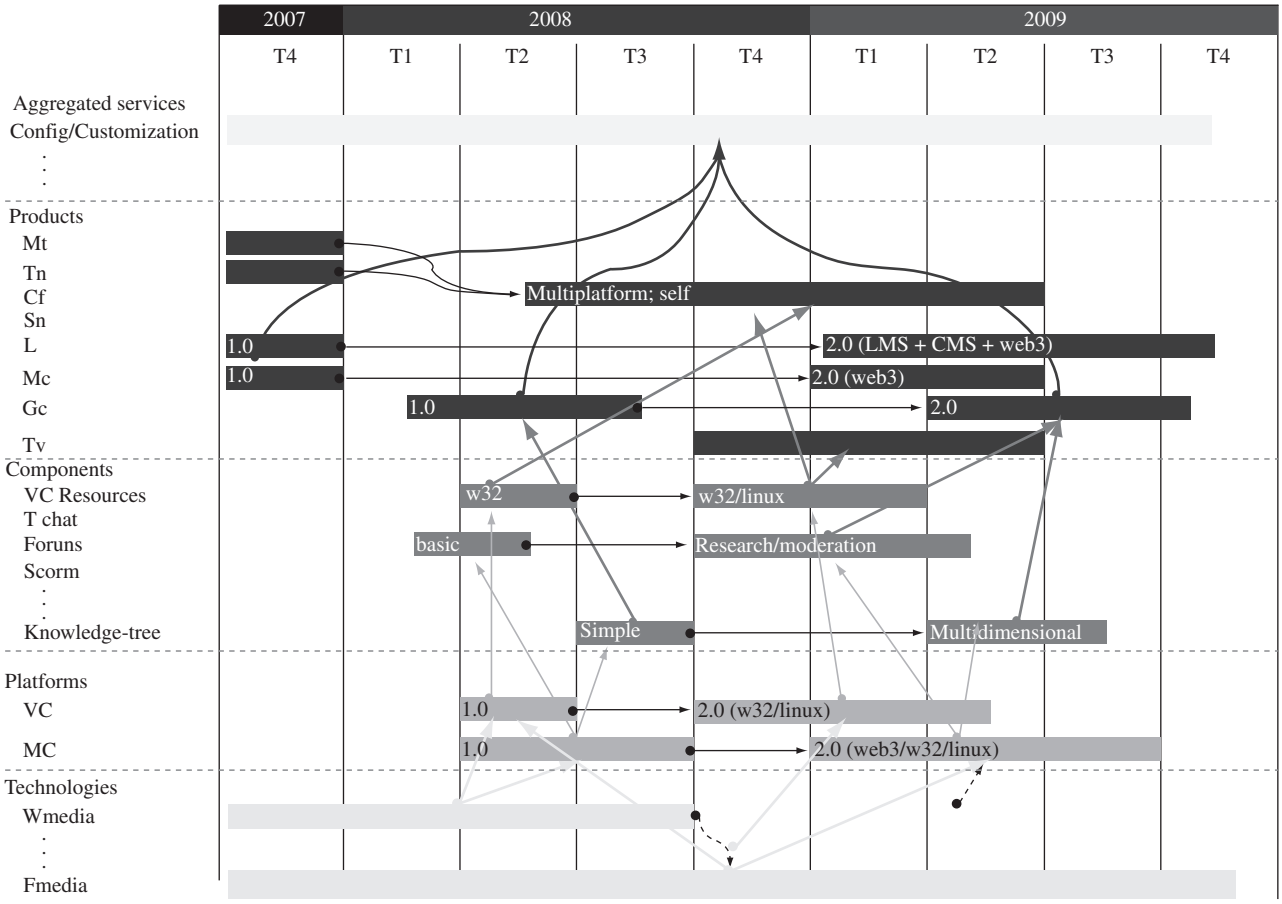


Figure 6. Product Roadmap (summarized) generated by the intervention in the company. Source: Lara (2008, p. 126).

oriented software companies, where it proved able to generate positive results – notwithstanding the existence of significant differences between this sector and the origin of NPD methods. Among the contributions made by the research, the following are also worth pointed out:

- The joint use of three NPD distinct methods;
- A case of (partial) application of the framework proposed by Weerd et al. (2006a), at a small Brazilian software development company;
- The use of TRM as a guideline for the planning process, aligned with the *Technology Roadmapping System* (PHAAL; FARRUKH; PROBERT, 2004); and
- The use of sequential stages for roadmapping refinement, replacing theme seminars suggested by the T-Plan (PHAAL et al., 2002; FLEURY et al., 2006, 2007).

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