RESEARCH IN LOGISTICS & PRODUCTION

PROJECT/PRODUCT DEVELOPMENT PROCESS CRITICAL SUCCESS FACTORS: A LITERATURE COMPILATION

Henrique Rocha* and Mauricio Delamaro**

* Department of Industrial Engineering, Rio de Janeiro State University – UERJ,
Resende, RJ, 27537-000, Brazil,
Email: prof.henrique_rocha@yahoo.com.br
** Department of Industrial Engineering, Universidade Estadual Paulista - UNESP,
Guaratinguetá, SP, 12516-410, Brazil,
Email: delamaro@feg.unesp.br

Abstract Project/product development process is a strategic activity related to customer needs fulfilment, achieved through the identification of their desires and needs, responding with innovative products, with adequate characteristics of performance, cost, and distribution. Different authors propose factors in the development processes as being critical. In this article, a list of common findings is presented, concluding that, based on the existing literature, the critical success factors for project and product development processes are: cost and budget management, time and deadline management, product positioning, customer needs fulfilment, organizational alignment, development team characteristics, development process, and organization and work environment management.

Paper type: Research Paper

Published online: 30 July 2012
Vol. 2, No. 3, pp. 273-293

ISSN 2083-4942 (Print)
ISSN 2083-4950 (Online)

Keywords: *critical success factors; project; product development process*

1. INTRODUCTION

Focus of attention in the academic and business literature (Araujo Junior, 2000); (Senanayake & Little, 2001); (Tesch, Kloppenborg & Stemmer, 2003), the *product development process* (PDP) is a strategic activity related to fulfilling customers' needs (Mundim et al., 2002); (Rabechini Jr.; Carvalho & Laurindo, 2002); (Tonioli, 2003); (Van Kleef, Van Trijp & Luning, 2005); (Browning, Fricke & Negele, 2006); (Van Kleef, 2006); (Ariyachandra & Frolick, 2008) and other stakeholders (Lehmann, 2006): identify their desires and needs, responding with innovative products, well designed and executed (May-Plumlee & Little, 2006); (Koufteros & Marcoulides, 2006), with adequate characteristics of performance, cost, and distribution (Pugh, 1996); (Mundim et al., 2002), require the organizations to use PDPs that integrate and align their resources, in a structured and unique way to the needs of the organization, using different methods and tools (Calantone, Vickery & Droge, 1995); (Sobek II, Liker & Ward, 1998); (Silva, 2001); (Akca & Ilas, 2005); (Scalice & Amaral, 2005); (Rozenfeld et al., 2006); (Jun & Suh, 2008); (Yaday & Goel, 2008).

For Cooper (1994a), Calantone, Vickery and Droge (1995) and Shulman (2003), new products are a key factor for market and financial results of the organizations. Researches from PDMA (*Product Development and Management Association*) indicated that, among the innovative companies with better performance, 49% of sales came from products launched within the last five years (Di Benedetto, 1999), (apud Segismundo & Miguel, 2008). Such findings corroborate with studies from Van Kleef (2006).

At the current competitive environment scenario, organizations must work with a very high degree of efficiency, optimizing the existing resources, so that they can achieve and maintain a strategic position towards the competitors' pressure (Takeuchi & Nonaka, 1986); (Lam & Chin, 2005); (Delamaro & Rocha, 2006). There are many reasons for that: increased competitive pressure, due to technological advances, deregulation and globalization; consumers increasingly demanding and informed, with their needs, expectations and tastes which change rapidly; increasing behaviour polarization of consumer between mass and luxury products; product variety boom; shorter product life cycles, due to consumer requirements, what reduce the pay-back time; increasing R&D costs; shorter time-to-market; increasing demands on performance, with strong pressure for price reductions; companies establishing growth commitments through the development of products; increasing environmental barriers from governments, consumers, and employees; increasing cost of capital; and increasing lack of critical resources for new products (Hatch & Urban, 1974); (IBM, 2005); (Schmenner & Tatikonda, 2005); (Van Kleef, 2006).

Clark and Fujimoto (1991) argue that a company product strategy and how it organizes and manages the development determine how the product will be positioned in the market: the way the development is handled, its speed, efficiency, and quality of work will determine the product competitiveness. The competitive ad-

vantage of a company in the global economy is directly related to its ability to introduce new products on the market and how effectively such products will attract the attention and are purchased by customers, who pay the investments made by the company (Rocha, 2005); (Quintella & Rocha, 2006): organizations develop new products so that they keep favourable revenue and cash flow, after the decline of the products currently marketed. By using different criteria for financial analysis (payback, NPV, etc.), the organization assess the product development viability (Rocha, 2002a; 2002b; 2003a; 2003b); (Norrie, 2006); (Van Kleef, 2006). As per Miller (1993), the project represents only 5% of the total cost of the product development, but sets 70% of operating costs.

However, according to Baxter (1995) out of ten ideas about new products, three will be developed, 1.3 will be launched in the market and only one will be profitable, according to research conducted among 500 companies in the 90s by the England Design Council. The research showed that only 45% of companies managed to keep costs of production within the estimates and that only 49% managed to launch products on schedule: on average, the products cost 13% above the budgeted and have been launched with a six-month delay. As Hollis and Pugh (1990), mortality, since the basic idea becomes a profitable product, is 95%. Moraes (2004) cites a 1996 survey in U.K., with only 1% of software projects completed within the original goals of cost, time and quality, and that about 25% of projects never completed. According to Hatch and Urban (1974), a research in 1968 by Booz, Allen & Hamilton, showed that 33% of new products launched in the market fail and 70% of resources spent on development, testing, and introduction, have been spent with products that had no success in the market whatsoever. The study from Van Kleef (2006) identified that failure rates in developing new products ranged between 25 and 67%, justifying a research to identify the reasons for success and failure.

Based on this scenario, the problem of high rate of failures in projects and product development is identified. This research seeks to help identify the causes of success and failure in PDPs, answering the following question: "What are the critical success factors for project/product development processes?". The answer to this question is pursued through a literature search. The various ideas and findings are then compiled and convergences are identified: a list of critical success factors for PDP is provided, with an expected contribution of highlighting the key areas and activities in projects and product development that enable a sustainable run for competitiveness and success.

2. CRITICAL SUCCESS FACTORS: A BRIEF DESCRIPTION

Rockart (1979) emphasizes that, as important as determining the goals that a manager wants to achieve, it is to determine, conscious and explicitly, the basic structure of variables that could influence the success or failure in achieving

the goals. According to the author, there are many factors influencing the performance of a company. However, only a few account for the success enablement. These few factors are basic and vital to the enterprise and, therefore are called *critical success factors* – CSF.

Critical success factors define the areas of performance that are essential to the organization complete its mission. Satisfactory results in these areas will ensure a successful competitive performance for individuals, departments, and the whole organization, which must respond quickly to events and exceptions that occur (Liu & Lu, 2003). Rockart (1979) argues that most of the managers use the concept of CSF, even implicitly. However, once explained the CSF, management priorities and resources allocation, can be more properly defined.

A process for CSF identification presented by Bullen and Rockart (1981) is based on the manager's current operating viewpoint. By aggregating the CSF from the individual point of view and identifying existing interrelationships, one can discover exactly which areas and activities require managers' attention (and also, if applicable, measurements and reports) due to their criticality.

3. LITERATURE REVIEW

Krishnan and Ulrich (2001), in an extensive research on PDP, listed the following CSF: price and positioning of the product; customer needs identification and fulfilment; organizational alignment; team characteristics; performance optimization and creativity in project management. Meybodi (2003) also listed quality, time, expertise and costs, while Shenhar et al. (2001), Quintella and Osório (2002) identified as dimensions of success of projects, compliance with deadlines and budgets, product quality and revenue generation. Johne and Snelson (1988) cite as critical operational activities for success in product development in-company tests, tests conducted with the consumers, production tests, and market tests.

Cooper and Kleinschmidt (2007) established the following success factors in developing new products: high quality new products definition process: clear definition of activities, scope, points of decision and implementation; new products strategy; sufficient personnel and approved budget; investment in R&D as a percentage of sales; high-quality project teams; involvement and commitment of senior management with the new products development; culture of innovation; multifunctional project; senior management accountability for the results of new products.

Costa Junior and Silva (2003) researched the failure factors in PDP, identifying bad planning, poor management, bad concept, bad execution, misuse of research, and bad technology. Valeriano (1998), Crow (2005), and Cooper (1994b) emphasize that project reviews are essential tools. More recently, Valambrini (2008) emphasized the importance of proper management of the data and information crea-

tion, storage, distribution, use, and disposal, to create organizational knowledge and hence the efficiency of the enterprise decision-making processes.

According to Baxter (1995), studies conducted in the 80s and 90s in England, U.S., and Canada, in around a thousand companies, analyzed the PDP of more than 14 thousand new products to learn how products were developed and whether it would have any relation with its trade performance. The main factors of success were: products viewed by consumers as having more value, features (functions, size, weight, etc.) specified prior to the development; technical team tailored to the development needs; high level of cooperation between technical and marketing staff, high quality in technical activities, technical and economic feasibility studies performed prior to the development; and marketing and sales staff interacting with the development team. These factors corroborate the findings of Van Kleef (2006), which indicated that companies that make massive use of "pre-development activities", such as market definition and identification of customer needs, have a success rate more twice as high than the ones which use few of them. The author says that the success of new product development is closely linked to the customer needs fulfilment, the quantity and quality of ideas about new products, while the main fault occurs by the inappropriate use of the results from customer surveys.

Takeuchi and Nonaka (1986) highlighted the risk of what they called the "next bench syndrome" (the habit of develop products by asking company fellow what type of product he would like), not achieving real market requirements. The authors identified six PDP characteristics of the Japanese leader organizations:

- Built-in instability: projects are requested to the teams with little operational detail, establishing, however, strategic direction, challenging goals and targets, and freedom for action, generating tension among individuals,
- Self-organized project teams: teams create their own dynamic order, taking initiatives and risks and, in some degree, establishing their own concepts and goals,
- Overlapping development phases: activities are overlapped, increasing the process speed and making the information and knowledge dissemination more effective,
- Multiple learning: learning occurs at multiple levels (individual, group, and corporate) and multiple functions, due to the interaction among stakeholders and the proximity to external sources of information,
- Subtle control: even though empowered, teams are managed by the selection of people and their personalities (for example, the balance between more conservative members and the rest of the group), open environment, reward and recognition systems for group performance, mistakes tolerance and anticipation, etc., and
- Learning transfer: strong movement to disseminate the knowledge gained over the various levels, functions, and also to other factors external to the group (e.g., other times).

Griffin and Page (1993) listed indicators used by academics and companies to measure the success in product development: consumer acceptance, consumer sat-

isfaction, sales targets, sales growth; market share goals, payback time, margin achievement, profitability goals achievement, return over investment, development cost, planned launch in time, level of product performance, quality guidelines achieved, time to launch the product, new products % of sales.

Gil (2001), Laseter and Ramdas (2001), Sobrero and Roberts (2001), Von Corswant, Wynstra and Wetzel (2003), King and Burgess (2006), and Keller (2008) reported that the suppliers knowledge is available and can contribute significantly to the development, production, and product qualification processes. Gil (2001) also indicated that customers want freedom to implement changes during the development process, while delivery dates, performance reliability, and budget remain within the established limits.

Moraes (2004) identifies some unanimity about the compliance with deadlines and budgets as criteria of success in projects in IT. While Thomke and Hippel (2002) and Hippel and Katz (2002) argue that the involvement of the customer in the process usually leads to a time reduction, Versprille (2001), Oxberry (2002) and Witzenburg (2003) emphasizes that the use of simulations and separated testing of assemblies and subsystems separately are CSF. According to Baxter (1995) and Gantewerker and Manoski (2003a, 2003b), the key to success in development is to invest more time and talent during the early stages, when expenses are low.

Driva, Pawar, and Menon (2000) pointed out the most used PDP performance measures: total cost of the project, development in time, the actual cost x budgeted cost, real time x planned, time to market, field tests, analysis of expected profitability, supplier development time, reasons for failure in the market, approval of prototypes in safety tests, R&D budget as a percentage of sales, time spent in each development phase, achievement of product quality goals, real x expected profit in products.

Baxter (1995) recommended the establishment of clear, concise, specific and verifiable targets throughout the PDP and also that the process be structured to "funnel" decisions, keeping low initial financial commitment, until development maturity is achieved and heavy investments start (prototypes, production tools, etc.). Rozen, Vitner, and Spraggett (2006) also indicated clear targets, management support, control and communication mechanisms, while Besora (1998) highlights the need to properly coordinate the activities in order to reduce the total time required to have them implemented. Gantewerker and Manoski (2003a; 2003b) explain that the failure in assessing feasibility of projects "creates a weak foundation for the project, usually leading to multiple interactions and significant rework" and suggest the development to be broken down in phases - also recommended by Ulrich and Epping (2000) -, so that each phase is assessed to filter and eliminate projects that will not be successful in the market.

Rozenfeld and Amaral (1999) studied PDP models and identified CSF such as the project degree of innovation, market structure, strategic direction and dimensions of product quality. Gantewerker and Manoski (2003a) define four categories in which members of the development should seek success: strategic positioning, customer interest, economic viability, technical feasibility and safety and legal aspects.

Silva (2001) proposed as indicators of performance of the PDP the: market share; % of the revenue generated by new products, revenue from new products; profit goals; IRR/ROI; growth in revenues from new products, cost of returns of new products; new product orders from new customers; resources flow (investment and time); % of the revenue invested in the development of new products, new product development expenses; prototyping cost; customer satisfaction; competitive advantage; customer acceptance; reliability; number of complaints about the quality; time to develop new products; quantity of new products, quantity of new customers ordering new products; on-time delivery of new products; ratio between new products and total of products; participation of recyclable components; time to develop prototype; quantity of noncompliance in the pilot lots; rate of part count reduction; internal rate of non-compliance in new products; cost of internal non-compliance on new products; product development people qualification; PDP people turnover; performance of suppliers participating in the development of new products; quantity of standard components in new products, project changes needed to meet process capability, skills for managing PDP.

The study from Cusumano and Nokeaba (1990) examined the key variables in the development of automotive products along the years 1985-1990. The shorter time for development of Japanese companies occurs due to the activities overlapping, combined with a good communication process, characterized by a loose control from top management, with simple and challenging targets set by them, and informal activities among various functions.

According to Stanke and Murman (2002), a holistic approach is needed in the PDP, more comprehensive than the individual aspects of analysis and value management, as well as cost over the life cycle and systems engineering.

The study conducted by Baker, Murphy and Fisher (1983) in the USA, based on a survey of 650 projects, identified two key factors to achieve the success in business: (1) appropriate organizational structures, and (2) adequate mechanisms of planning and control. Analyzing stakeholders perception about project success/failure of the project, the authors identified the following factors: team commitment with goals; accurate initial cost estimates; adequate team project competencies; financial resources availability; adequate planning and control techniques; minimum start up difficulties; task focus; lack of bureaucracy; in-site project manager; clearly established success criteria; frequent feedback from corporation and customers; proper use of network techniques; contingency strategies; appropriate project team organizational structure; appropriate control procedures, especially to manage changes; project team participation in the preparation of schedules and budgets; corporation enthusiastic, interested to the internal skills development, flexible, committed to the deadlines, established budgets, and technical goals; project manager with appropriate administrative, human, and technical skills, sufficient power to influence, and authority, committed to the deadlines, established budgets, and technical goals; customer committed to the deadlines, established budgets, and technical goals; enthusiastic public support; lack of legal barriers;

reduced number of public and governmental agents; sufficient position and progress reports; appropriate use of position and progress reports; project manager; customer with sufficient power to influence; coordination with the client; customer support; client interested to budgetary issues; participation of the project team in the process and decision; participation of the project team in solving major problems; project team flexible structure; secure position in the team; team spirit and commitment; dynamic corporation; good coordination with corporation; corporation support; good relationship with corporation; project with same level of complexity than the ones already implemented; resources available at the beginning of the project; ability to early specification stabilization; skill in the closing stages; actual project schedules; appropriate change procedures; good relations with the public authorities; favourable public opinion.

The concept of success developed by Dvir et al. (1998) has two dimensions: benefits perceived by consumers and achievement of design goals. Pinto and Slevin (1988) presented a definition of project performance that considers both internal and external aspects: cost, time, quality (technical specifications fulfilment), use, satisfaction, and efficiency.

Cooke-Davies (2002) in research with more than 70 organizations in Europe, Australia and North America, identified the following CSF for project management: adequacy of the whole company in the concepts of risk management; maturity of the process for responsibilities allocation in regards to risks; adequate risk record management; adequate risk management; adequate project organizational responsibilities documentation; keep project (or phase) duration as far below of three years (one year is the best); allow scope changes only if managed by a mature change control process; keep development measure system integrity; managerial process for project management and operation management cooperation; portfolio and program management practices that allow the company to allocate resources aligned with corporate strategy and business objectives; a set of project, program, and portfolio metrics that lead the organization, providing feedback on performance and anticipate future events; and learning by experience in projects, combining explicit and tacit knowledge.

Tonioli (2003) indicated the use of multifunctional teams of concurrent engineering and a need of product development with SCM people involvement. Also, information systems and the activities of the product engineer, according to the author, have key role in PDP. Gemuenden and Lechler (1997) listed project CSF: senior management (direct support, and interest in the project); formal authority of the project manager; technical training and social profile of the project team; involvement of the project team in decision-making; formal information system and its effectiveness; planning and control effectiveness; intensity and type of conflict; the scope, scale and frequency of changes; rational use of resources; achievement of established goals; and the impact of project to the society.

Baccarini (1999) uses two different concepts of performance: success of the project management and success of product. The success of the process is linked to

the classic aspects of performance (time, cost and technical specification quality), stakeholders' satisfaction with the development and the quality of the management process, with performance criteria, such as: anticipate requirements; meet the project needs; efficient use of resources; communication and early resolution of occurrences; good coordination; stakeholders relationship; team spirit; participatory and consensual decision making; minimal scope changes; lack of disturbances in the organization; full completion of the project; lack of post-closure issues, identification and resolution of problems along the project development. According to the author, the success of the product is evaluated using criteria such as: achieving the organizational strategic objectives of the project buyer/sponsor; meet the users' needs: meet the purposes, be appropriate to use, and meet the needs of other stakeholders.

Meybodi (2003) proposes the use of the just-in-time principles to improving the PDP: generate what is needed, in the amount and timing that is needed, minimal waste, people respect. The study in 51 organizations showed that companies that adopt those principles, develop products with better quality (61%), shorter time (52%), 38% lower development cost, 33% lower manufacturing cost, and introduce new products 71% more frequently than traditional companies. The author also advocates the use of a hierarchical flat organization, with multifunctional elements with decision power to product development. Similar findings and proposals are presented by Ceryno and Possamai (2008) regarding to the use of the principles of lean manufacturing in the PDP.

Van Kleef, Van Trijp, and Luning (2005) mention that incorporating the "voice of the customer" in the early stages of the PDP is a CSF for the development of new products. Wateridge (1998), identified the following criteria to evaluating the performance of IT projects: to meet its purpose; meet customer requirements; team satisfaction; compliance with deadlines and budget; commercial success; and reach quality goals of quality. The study from Zwikael and Globerson (2006) identified CSF for projects: definition of the activities to be implemented in the project; schedule development; organizational planning; personnel recruitment/assignment; of communication planning; and development of the project plan.

MacCormack, Verganti, and Iansiti (2001) challenged the paradigm of effective projects being characterized by a structure that minimizes the changes. According to the authors, the uncertainty and dynamic environment represent key challenges to the accepted models of PDP. They suggest higher investment in the architecture development, with the constant feed-back during the various stages (with possible changes arising thereof): product flexibility results in better projects and products developed.

4. DEVELOPMENT AND CONCLUSIONS

The literature review helped identifying the existence of common CSF, pointed by various authors (cost and budget management, time and deadline management,

product positioning, customer needs fulfilment, organizational alignment, development team characteristics, PDP work process, and organization and work environment management). Justification for those CSF is presented below, based on the CSF and authors indicated:

4.1. Cost and budget management:

- Costs (Pinto & Slevin, 1988); (Baccarini, 1999); (Meybodi, 2003);
- Development costs (Griffin & Page, 1993);
- New product development expenses (Silva, 2001);
- Overall project cost (Driva, Pawar & Menon, 2000);
- Actual cost vs. budgeted cost (Driva, Pawar & Menon, 2000);
- Prototype cost (Silva, 2001);
- Compliance with budgets (Wateridge, 1998); (Shenhar et al., 2001); (Quintella & Osório, 2002);
- Stay within the budgeted limits (Gil, 2001);
- Revenue generation (Shenhar et al., 2001); (Quintella & Osório, 2002);
- Payback time (Griffin & Page, 1993);
- Return over investments (Griffin & Page, 1993);
- Margins achievement (Griffin & Page, 1993);
- Profit target achievement (Griffin & Page, 1993); and
- Actual profit vs. expected profit (Driva, Pawar & Menon, 2000).

4.2. Time and deadline management:

- Time (Meybodi, 2003);
- Deadline compliance (Pinto & Slevin, 1988); (Baccarini, 1999); Wateridge, 1998); (Shenhar et al.; 2001); (Quintella & Osório, 2002);
- Delivery dates (Gil, 2001);
- Launch in time (Griffin & Page, 1993);
- Development time as planned (Driva, Pawar & Menon, 2000);
- Actual time vs. planned time (Driva, Pawar & Menon, 2000);
- Product launch time (Griffin & Page, 1993);
- Time to market (Driva, Pawar & Menon, 2000);
- Prototype development time (Silva, 2001);
- Supplier development time (Driva, Pawar & Menon, 2000);
- Duration of each development phase (Driva, Pawar & Menon, 2000);
- Schedule development (Zwikael & Globerson, 2006); and
- Keep project duration far below three years (Cooke-Davies, 2002).

4.3. Product positioning:

- Product positioning (Krishnan & Ulrich, 2001);
- Market definition (Van Kleef, 2006);
- Price (Krishnan & Ulrich, 2001);
- New product definition high-quality process (Cooper & Kleinschmidt, 2007);
- New products strategy (Cooper & Kleinschmidt, 2007);
- Strategic directions (Rozenfeld & Amaral, 1999);
- Strategic positioning (Gantewerker & Manoski, 2003a);
- Good use of research findings (Costa Junior & Silva, 2003);
- Product characteristics well defined prior to the development (Baxter, 1995);
- Product quality dimensions (Rozenfeld & Amaral, 1999);
- Project degree of innovation (Rozenfeld & Amaral, 1999);
- Project changes to accommodate process capability (Silva, 2001); and
- Portfolio and program management practices that allow the company to allocate resources aligned with corporate strategy and business objectives (Cooke-Davies, 2002).

4.4. Customer needs fulfillment:

- Identify, understand and fulfil customer needs (Wateridge, 1998); (Krishnan & Ulrich, 2001); (Van Kleef, 2006);
- Meet the users' needs: meet the purposes, and be appropriate to use (Baccarini, 1999);
- Adequate use of consumer needs research findings (Van Kleef, 2006);
- Anticipate requirements and fulfil project needs (Baccarini, 1999);
- Stakeholders satisfaction (Baccarini, 1999); (Lehmann, 2006);
- Customer interest (Gantewerker & Manoski, 2003a);
- Avoid "next bench syndrome" to get market requirements (Takeuchi & Nonaka, 1986);
- Customer perception of benefits (Dvir et al., 1998);
- Quality, product quality, achieve quality goals (Wateridge, 1998); (Shenhar et al.; 2001); (Quintella & Osório, 2002); (Meybodi, 2003);
- Technical quality specifications (Baccarini, 1999);
- Performance reliability (Gil, 2001);
- Tests with consumers, to market (Johne & Snelson, 1988);
- Good concept (Costa Junior & Silva, 2003);
- Good technology (Costa Junior & Silva, 2003);
- Products seen by customers as having high value (Baxter, 1995);
- Use, satisfaction and efficiency (Pinto & Slevin, 1988)
- Customer acceptance and satisfaction (Griffin & Page, 1993);
- Users satisfaction (Wateridge, 1998);

- Product performance level (Griffin & Page, 1993);
- Quality guidelines achieved (Griffin & Page, 1993);
- Sales goals and grow (Griffin & Page, 1993);
- Market success (Wateridge, 1998);
- Market share and units sold goals (Griffin & Page, 1993);
- New products % of sales (Griffin & Page, 1993);
- Reasons for market failure (Driva, Pawar & Menon, 2000);
- Achievement of product quality goals (Driva, Pawar & Menon, 2000);
- Technical specifications compliance (Pinto & Slevin, 1988);
- Safety test prototype approval (Driva, Pawar & Menon, 2000);
- Freedom to changes during the development (Gil, 2001); and
- Scope, scale and frequency of changes (Gemuenden & Lechler, 1997).

4.5. Organizational alignment:

- Achieve the organizational strategic objectives of the project buyer/sponsor (BACCARINI, 1999);
- Satisfy stakeholders needs (Baccarini, 1999);
- Organizational alignment (Krishnan & Ulrich, 2001);
- Performance optimization (Krishnan & Ulrich, 2001);
- Rational and efficient resources use (Gemuenden & Lechler, 1997; Baccarini, 1999);
- Clear definition of activities, scope, decision points, and implementation (Rozenes, Vitner & Spraggett, 2006; Cooper & Kleinschmidt, 2007);
- Definition of activities to be performed (Zwikael & Globerson, 2006);
- Clear, concise, specific and verifiable targets (Baxter, 1995);
- Sufficient personnel and approved budget (Cooper & Kleinschmidt, 2007);
- Conflict management (Gemuenden & Lechler, 1997);
- Early resolution of occurrences (Baccarini, 1999);
- Compliance with goals (Gemuenden & Lechler, 1997; Dvir et al., 1998);
- R&D / PDP investment as % of sales (Driva, Pawar & Menon, 2000; SILVA, 2001; Cooper & Kleinschmidt, 2007);
- Resources flow (SILVA, 2001);
- Project teams involved in decision-making processes (Gemuenden & Lechler, 1997);
- Senior management support, interest in the projects, involvement/commitment with new product development, and responsibility about new products results (Gemuenden & Lechler, 1997); (Cooper & Kleinschmidt, 2007);
- Good management and execution (Costa Junior & Silva, 2003);

- High level of cooperation between technical and marketing staff, and marketing and sales staff interacting with the development team (Baxter, 1995);
- Multiple learning (Takeuchi & Nonaka, 1986);
- Communication, communication planning (Cusumano & Nokeaba, 1990); (Baccarini, 1999); (Rozenes, Vitner & Spraggett, 2006); (Zwikael & Globerson, 2006);
- Formal information system and its effectiveness (Gemuenden & Lechler, 1997);
- Internal rate of non-compliance in new products, and cost of internal non-compliance on new products (Silva, 2001);
- Quantity of noncompliance in the pilot lots (Silva, 2001);
- Society impact due to the project (Gemuenden & Lechler, 1997);
- Adequacy of the whole company to the concepts of risk management, maturity of the process for responsibilities allocation in regards to risk, adequate risk record management, and adequate risk management (Cooke-Davies, 2002); and
- Portfolio metrics that lead the organization, providing feedback on performance and anticipate future events (Cooke-Davies, 2002).

4.6. Development team characteristics:

- Team characteristics (Krishnan & Ulrich, 2001);
- Creativity in project management (Krishnan & Ulrich, 2001);
- Qualification, technical and social capacity, high-quality project team (Gemuenden & Lechler, 1997); (Silva, 2001); (Meybodi, 2003); (Cooper & Kleinschmidt, 2007);
- High-quality technical activities (Baxter, 1995);
- Innovation culture (Cooper & Kleinschmidt, 2007);
- Quantity and quality of new product ideas (Van Kleef, 2006);
- Multifunctional project team organization (Cooper & Kleinschmidt, 2007);
- Technical team tailored to the development needs (Baxter, 1995);
- Project team self-organized (Takeuchi & Nonaka, 1986);
- Knowledge transferring (Takeuchi & Nonaka, 1986);
- PDP people turnover (Silva, 2001);
- Suppliers knowledge and performance (Gil, 2001); (Laseter & Ramdas, 2001); (Silva, 2001); (Sobrero & Roberts, 2001); (Von Corswant, Wynstra & Wetzel, 2003); (King & Burgess, 2006); (Keller, 2008);
- Team satisfaction (Wateridge, 1998);
- Organizational planning (Zwikael & Globerson, 2006); and
- Personnel recruitment/assignment (Zwikael & Globerson, 2006).

4.7. Work process (Development process):

- Full completion of the project; lack of post-closure issues, identification and resolution of problems along the project development (Baccarini, 1999);
- Management process quality (Baccarini, 1999);
- Technical and economic feasibility (Baxter, 1995); (Gantewerker & Manoski, 2003a);
- Expected profitability analysis (Driva, Pawar & Menon, 2000);
- Development process broken down in phases (Ulrich & Eppinger, 2000); (Gantewerker & Manoski, 2003a, 2003b);
- Invest in early phases (Baxter, 1995); (Gantewerker & Manoski, 2003a; 2003b); (Van Kleef, 2006);
- Project phases overlapping (Takeuchi & Nonaka, 1986); (Cusumano & Nokeaba, 1990);
- Project reviews/assessments (Cooper, 1994b); (Valeriano, 1998); (Crow, 2005);
- Field tests, in-site tests, production tests (Johne & Snelson, 1988); (Driva, Pawar & Menon, 2000);
- Good planning, develop project plan (Costa Junior & Silva, 2003); (Zwikael & Globerson, 2006);
- Minimal scope changes; no disturbances in the organization; (Baccarini, 1999);
- Customer involvement in the PDP (Thomke & Hippel, 2002); (Hippel & Katz, 2002);
- Simulations (Versprille, 2001); (Oxberry, 2002); (Witzenburg, 2003);
- Safety and legal aspects (Gantewerker & Manoski, 2003a);
- Rate of part count reduction (Silva, 2001);
- Quantity of standard components in new products (Silva, 2001);
- Allow scope changes only if managed by a mature change control process (Cooke-Davies, 2002); and
- Keep development measure system integrity (Cooke-Davies, 2002).

4.8. Organization and work environment management:

- Good coordination; stakeholders relationship; team spirit; participatory and consensual decision making (Cusumano &; Nokeaba, 1990); (Besora, 1998); (Baccarini, 1999);
- Holistic approach (Stanke & Murman, 2002);
- Appropriate organizational structures (Baker, Murphy & Fisher, 1983);
- Project manager formal authority (Gemuenden & Lechler, 1997);
- Proper management of the data and information creation, storage, distribution, use, and disposal (Valambrini, 2008);

- Projects with strategic direction, challenging goals and targets, and freedom for action (empowerment) (Takeuchi & Nonaka, 1986); (Cusumano & Nokeaba, 1990);
- Open environment, reward and recognition systems for group performance, mistakes tolerance and anticipation, etc. (Takeuchi & Nonaka, 1986);
- Managerial support (Rozenes, Vitner & Spraggett, 2006);
- Adequate planning and control mechanisms, efficient planning and control (Baker, Murphy & Fisher, 1983); (Gemuenden & Lechler, 1997); (Rozenes, Vitner & Spraggett, 2006);
- Managerial process for project management and operation management cooperation (Cooke-Davies, 2002); and
- Learning by experience in projects, combining explicit and tacit knowledge (Cooke-Davies, 2002).

5. CLOSING REMARKS

As previously stated, the CSF define the areas of performance that are essential to the organization complete its mission, i.e. the few basic and vital factors to the enterprise. Therefore, identification and validation those factors can help managers to focus their attention to what is really critical for the future of the organization. With this respect, in this paper CSF for Project, Product Development Process, and New Product Development pointed by several authors have been discussed and aggregated.

Findings show eight CSF from such analysis: cost and budget management, time and deadline management, product positioning, customer needs fulfilment, organizational alignment, development team characteristics, PDP work process, and organization and work environment management.

Upon the identification of Project/PDP CSF, excellence on managerial processes is mandatory. For this purpose, managers shall determine routines to guarantee adequate performance on those areas/activities. To do so, we suggest undertaking further research on industrial level.

REFERENCES

Akca, N. & Ilas, A., (2005), "Produktionsstrategien: Überblick und Systematisierung", Arbeitsbericht Nr. 28. Institut für Produktion und Industrielles Informationsmanagement, Universität Duisburg-Essen / Campus Essen, Fachbereich Wirtschaftswissenschaften.

Araujo Junior, C., (2000), "An analysis of the life-cycle of product development tools", [in:] Proceedings of II Congresso Brasileiro de Gestão e Desenvolvimento de Produtos, São Carlos/SP, Brazil.

Ariyachanda, T. R. & Frolick, M. N., (2008), "Critical success factors in business performance management – striving for success", [in:] Information Systems Management, Vol.25, No.2, pp.113-120.

Baccarini, D., (1999), "The logical framework method for defining project success", [in:] Project Management Journal, Vol.30, No.4, pp.25-32.

Baker, B. N., Murphy, D. C. & Fisher, D., (1983), "Factors affecting project success". In: Cleland, D.I. & King, W.R. (Eds.), Project Management Handbook. New York, Van Nostrand Reinhold.

Baxter, M., (1995), Product Design: Practical methods for the systematic development of new products, Chapman and Hall, London.

Besora, F., (1998), "A inovação e o projeto de produtos: Sua importância na pequena e média empresa", Dissertation (Master in Engineering), Programa de Pós-graduação em Engenharia de Produção, Universidade Federal de Santa Catarina, Florianópolis/SC, Brazil.

Browning, T., Fricke, E. & Negele, H., (2006), "Key concepts in modelling product development processes", [in:] Systems Engineering, Vol.9, No.2, pp.104-128.

Bullen, C. & Rockart, J. F., (1981), "A primer on critical success factors", Working Paper, Alfred Sloan School of Management. Center for Information Systems Research, no. 69.

Calantone, R., Vickery, S. & Droge, C., (1995), "Business performance and strategic new product development activities: An empirical investigation", [in:] Journal of Product Innovation Management, Vol.12, pp.214-223.

Ceryno, P. & Possamai, O., (2008), "Como considerar os princípios do lean manufacturing no processo de desenvolvimento de produtos", [in:] Proceedings of ENEGEP, Rio de Janeiro, XXVIII Encontro Nacional de Engenharia de Produção, Rio de Janeiro/RJ, Brazil.

Clark, K. B. & Fujimoto, T., (1991\0, Product development performance: Strategy, organization and management in the world auto industry. Boston, Mass.: Harvard Business School Press.

Cooke-Davies, T., (2002), "The "real" success factors on project", [in:] International Journal of Project Management, Vol.20, pp.185-190.

Cooper, R. G., (1994a), "Debunking the myths of new product development", [in:] Research Technology Management, Vol.37, No.4, pp.40-50.

Cooper, R. G., (1994b), Winning at new products: Accelerating the process from idea to launch. Reading, MA, Perseus Books.

Cooper R. G. & Kleinschmidt E. J., (2007), "Winning business in product development: the critical success factors", [in:] Research Technology Management, Vol.39, No.4, pp.18-29.

Costa Junior. A. & Silva, C., (2003), "Os fatores de fracasso no desenvolvimento de produtos: Um estudo de caso em uma pequena empresa de alta tecnologia", [in:] Proceedings of IV Congresso Brasileiro de Gestão e Desenvolvimento de Produtos, Gramado/RS, Brazil.

Crow, K., (2005), "Control the NPD process with gate reviews and design reviews", [in:] DRM Associates, available at http://www.npd-solutions.com/reviews.html (access Nov, 1st, 2008).

Cusumano, M. & Nokeaba, K., (1990), "Strategy, structure, and performance in product development: Observation for the auto industry", Massachusetts Institute of Technology, Sloan School of Management. Working Paper 3150-90.

Delamaro, M. C. & Rocha, H. M., (2006), "Tomada de decisões no processo de desenvolvimento de produtos: Proposta de modelo baseado na teoria de opções reais", [in:] Proceedings of III Congresso Nacional de Excelência em Gestão, Niterói/RJ, Brazil.

Driva, H., Pawar, K. S. & Menon, U., (2000), "Measuring product development performance in manufacturing organizations", [in:] International Journal of Production Economics, Vol.63, pp.147-149.

Dvir, D., (1998), "In search of project classification: a non-universal approach to project success factors", [in:] Research Policy, Vol.27, pp.915-935.

Gantewerker, S. & Manoski, P., (2003a), "The library – not the lab: Why it's important to do your homework before hands-on product development work begins", [in:] Food Processing, Vol.64, No.9, pp.40-43.

Gantewerker, S. & Manoski, P., (2003b), "Don't get caught in the middle: How to successfully negotiate the intermediate and late stages of new product development", [in:] Food Processing, Vol.64, No.12, pp.32-34.

Gemuenden, H. G. & Lechler, T., (1997), "Success factors of project management: The critical few – an empirical investigation", [in:] Innovation in Technology Management - The Key to Global Leadership. PICMET apos;97: Portland International Conference on Management and Technology, 27-31, 375 - 377.

Gil, N., (2001), "Product-process development simulation to support specialty contractor involvement in early design", Thesis (PhD), Graduate Division, University of California, Berkeley.

Griffin, A. & Page, A. L., (1993), "An interim report on measuring product development success and failure", [in:] Journal of Product Innovation Management, Vol.10, No.2, pp.291-308.

Hatch, T. & Urban, G., (1974), "New products: Minimizing risks and maximizing creativity", Massachusetts Institute of Technology, Alfred P. Sloan School of Management, Working Paper no. 752-74.

Hippel, E. & Katz, R., (2002), "Shifting innovation to users via toolkits", [in:] Management Science, Vol.48, No.7, pp.821-833.

IBM Corporation, (2005), New product development & introduction: Consumer products companies need to move forward boldly. IBM Corporation.

Johne, F. A. & Snelson, P. A., (1998), "Success factors in product development: a selective review of the literature", [in:] Journal of Product Innovation Management, Vol.9, No.2, pp.128-139.

Jun, H. & Suh, H., (2008), "A modeling framework for product development process considering its characteristics", [in:] IEEE Transactions on Engineering Management, Vol.55, No.1, pp.103-119.

Keller, R., (2008), "A better way of developing new products: involve your suppliers and operations people in product development process at very earliest stages", [in:] Industry Week, Vol.257, No.6, pp.12.

King, S. & Burguess, T., (2006), "Beyond critical success factors: A dynamic model of enterprise system innovation", [in:] International Journal of Information Management, Vol.26, pp.59-69.

Koufteros, X. & Marcoulides, G., (2006), "Product development practices and performance: A structural equation modeling-based multi-group analysis", [in:] International Journal of Production Economics, Vol.103, No.1, pp.286-307.

Krishnan, V. & Ulrich, K., (2001), "Product development decisions: A review of literature", [in:] Management Science, Vol.47, No.1, pp.1-21.

Lam, P. & Chin, K., (2005), "Identifying and prioritizing critical success factors for conflict management in collaborative new product development", [in:] Industrial Marketing Management, Vol.34, pp.761-772.

Laseter, T. & Ramdas, K., (2001), "Product types and supplier roles in product development: An exploratory analysis", Working paper n.01-14, Daren Graduate School of Business Administration, University of Virginia.

Lehmann, D. R., (2006), "It's new but is it good? New product development and macromarketing", [in:] Journal of Macromarketing, Vol.26, No.1, pp.8-16.

Liu, R. & Lu, Y., (2003), "Distributed agent for cost-effective monitoring of critical success factors",[in:] Decision Support Systems, Vol.35, pp.353-366.

MacCormack, A., Verganti, R. I. & Iansiti, M., (2001), "Developing products on "Internet time": The anatomy of a flexible development process", [in:] Management Science, Vol.47, No.1, pp.133-152.

May-Plumlee, T. & Little, T., (2006), "Proactive product development integrating consumer requirements", [in:] International Journal of Clothing Science and Technology, Vol.18, No.1, pp.53-66.

Meybodi, M., (2003), "Using principles of just-in-time to improve new product development process", [in:] Advances in Competitiveness Research, Annual 2003, Vol.11, No.1, pp.116-140.

Miller, L., (1993), Concurrent engineering design: Integrating the best practices for process improvement. Michigan: Society of Manufacturing Engineers.

Moraes, R., (2004), "Condicionantes de desempenho dos projetos de software e a influência da maturidade em gestão de projetos. Thesis (Doctor of Business Administration), Faculdade de Economia, Administração e Contabilidade da Universidade de São Paulo, São Paulo/SP, Brazil.

Mundim, A. P. F., Rozenfeld, H., Amaral, D. C., Silva, S. L. & Horta, L. C. (2002), "Aplicando o cenário de desenvolvimento de produtos em um caso prático de capacitação professional", [in:] Gestão & Produção, Vol.9, No.1, pp.1-16.

Norrie, J., (2006), "Improving results of project portfolio management in the public sector using a balanced strategic scoring model", Thesis (Doctor of Project Management – DPM). Royal Melbourne Institute of Technology, School of Property, Construction and Project Management, Design and Social Context, RMIT University.

Oxberry, E., (2002), "Rapid fire: With ever advancing rapid prototyping and production technologies, the development of new materials is as important as that of the management technology itself", [in:] Plastics Engineering, Vol.243, No.12, pp.28.

Pinto J. K. & Slevin, D. P., (1998), "Critical success factors across the project life cycle", [in:] Project Management Journal, Vol.19, No.3, pp.67-75.

Pugh, S., (1996), Creating innovative products using total design. Massachusetts: Addison Wesley Longman.

Quintella, H. L. M. M. & Osorio, R., (2002), "CMM e Qualidade: Caso Dataprev", [in:] Proceedings of ENEGEP. Ouro Preto/MG, Brazil: ABEPRO, Vol.1, pp.21-31.

Quintella, H. L. M. M. & Rocha, H. M., (2006), "Medindo o nível de maturidade dos processos de desenvolvimento de produtos das montadoras de veículos com o CMMI", [in:] Revista Mundo PM, Vol.1, No.6, pp.20-27.

Rocha, H. M., (2002a), "Modos de impacto e efeitos dos produtos nas organizações", [in:] Proceedings of SIMPOI, V Simpósio de Administração de Produção, Logística e Operações Internacionais, São Paulo/SP, Brazil.

Rocha, H. M., (2002b), "Análise de impactos e simulação dos efeitos dos produtos nas organizações e na sociedade", [in:] Proceedings of Congresso Nacional de Excelência em Gestão, Niterói/RJ, Brazil.

Rocha, H. M., (2003a), "Metodologia estruturada de desenvolvimento de produtos: Uma abordagem voltada à excelência nos negócios",[in:] Proceedings of ENEGEP, XXIII Encontro Nacional de Engenharia de Produção. Ouro Preto/MG, Brazil.

Rocha, H. M., (2003b), "Desenvolvimento de produtos: Um instrumento estratégico para sobrevivência das organizações", [in:] Proceedings of Simpósio de Gestão e Estratégia em Negócios, Seropédica/RJ, Brazil.

Rocha, H. M., (2005), "Fatores críticos de sucesso do start up de veículos e a qualidade (CMMI) do desenvolvimento de produtos no Sul Fluminense", Dissertation (Master of Management Systems). Universidade Federal Fluminense, Niterói/RJ, Brazil.

Rockart, J. F., (1978), "A new approach to defining the chief executive's information needs", Working Paper no. 37. Center for Information Systems Research, Sloan School of Management. Massachusetts Institute of Technology.

Rockart, J. F., (1979), "Chief executives define their own data needs", [in:] Harvard Business Review, Vol.57, pp.81-83.

Rozenfeld, H., Forcellini, F. A., Amaral, D. C., Toledo, J. C., Silva, S. L., Alliprandini, D. H. & Scalice, R. K., (2006), Gestão de desenvolvimento de produtos: Uma referência para a melhoria do processo. São Paulo/SP, Brazil: Saraiva.

Rozenfeld, H. & Amaral, D., (1999), "Proposta de uma tipologia de processos de desenvolvimento de produto visando a construção de modelos de referência", [in:] Proceedings of Congresso Brasileiro de Gestão e Desenvolvimento de Produtos. Belo Horizonte/MG, Brazil.

Rozenes, S., Vitner, G. & Spraggett, S., (2006), "Project control: Literature review", [in:] Project Management Journal, Vol.37, No.4, pp.5-14.

Schmenner, R. W. & Tatikonda, M. V., (2005), "Manufacturing process flexibility revisited", [in:] International Journal of Operations & Production Management, Vol.25, No.12, pp.1183-1189.

Segismundo, A. & Miguel, P. A. C., (2008), "Key success factors on new product development: A preliminary investigation on the cooperation model at an automotive company", [in:] Proceedings of ENEGEP, XXVIII Encontro Nacional de Engenharia de Produção, Rio de Janeiro/RJ, Brazil.

Senanayake, M. & Little, T., (2001), "Measures for new product development", [in:] Journal of Textile and Apparel, Technology and Management, Vol.1, No.3, pp.1-14.

Shenhar A. J., Dvir, D., Levy, O. & Maltz, A. C., (2001), "Project success: A multidimensional strategy concept", [in:] Long Range Planning, Vol.34, pp.699-725.

Shulman, R., (2003), "Recovery and the new product paradox", [in:] Brandweek, Vol.44, No.25, pp.20.

Silva, C., (2001), "Método para avaliação do desempenho do processo de desenvolvimento de produtos", Thesis (Doctor of Engineering), Universidade Federal de Santa Catarina, Florianópolis, Brazil.

Sobek II, D. K., Liker, J. K. & Ward, A.C., (1998), "Another look at how Toyota integrates product development", [in:] Harvard Business Review, Vol. 76, No. 4, July-August, pp.36-49.

Sobrero, M. & Roberts, E. B., (2001), "The trade-off between efficiency and learning in interorganizational relationships for product development", [in:] Management Science, Vol.47, No.4, pp.93-511.

Stanke, A. & Murman, E., (2002), "A framework for achieving lifecycle value in aerospace product development", [in:] Proceedings of International Council of Aeronautical Science Congress.

Takeuchi, H. & Nonaka, I., (1986), "The new product development game", [in:] Harvard Business Review, Jan-Feb. 1986, pp. 137-146.

Tesch, D., Kloppenborg, T. & Stemmer, J., (2003), "Project management learning: What the literature has to say", [in:] Project Management Journal, Vol.34, No.4, pp.33-39.

Tonioli, J., (2003), "A integração entre o processo de desenvolvimento de produtos e o gerenciamento da cadeia de suprimentos e sua relação com o papel desempenhado pelo engenheiro de produto", Dissertation (Master of Engineering), Escola Politécnica da Universidade de São Paulo, Universidade de São Paulo, São Paulo/SP, Brazil.

Valambrini, A. C., (2008), "O processo de produção na empresa montadora sob a perspectiva informacional da gestão do ciclo de vida do produto (PLM)", [in:] Proceedings of ENEGEP, XXVIII Encontro nacional de Engenharia de Produção, Rio de Janeiro/RJ, Brazil.

Valeriano, D., (1998), Gerência de projetos: pesquisa, desenvolvimento e engenharia. São Paulo/SP, Brazil: Makron Books.

Van Kleef, E., (2006), "Consumer research in the early stages of the new product development: Issues and applications in the food domain", Thesis (Doctor of Food, Health, and Biotechnology), Wageningen Universiteit, Netherlands.

Van Kleef, E., Van Trijp, H. & Luning, P., (2005), "Consumer research in the early stages of the new product development: A critical review of methods and techniques", [in:] Food Quality and Preferences, Vol.16, pp.181-201.

Versprille, K., (2001), "Elevating CAE into the design process", [in:] Computer-Aided Engineering, Vol.20, No.9, p.52.

Von Corswant, F., Wynstra, F. & Wetzels, M., (2003), "In chains? Automotive suppliers and their product development activities", ERIM Report Series #ERS-(2003-027-LIS. Erasmus Institute of Management, Erasmus University Rotterdam, Roterdam, The Netherlands.

Wateridge, J., (1998), "How can IS/IT projects be measured for success?", [in:] International Journal of Project Management, Vol.16, No.1, pp.59-63.

Witzenburg, G., (2003), "Vehicle development view from the trenches: A look at the tricks and tools automakers use to squeeze time and cost out of new product development", [in:] Automotive Industries, Vol.183, No.3, pp.40-43.

Yadav, O. O. & Goel, P. S., (2008), "Customer satisfaction driven quality improvement target planning for product development in automotive industry", [in:] International Journal of Production Economics, Vol.113, No.1.2, pp.997-1011.

Zwikael, O. & Globerson, S., (2006), "From critical success factors to critical success processes", [in:] International Journal of Production Research, Vol.44, No.17, pp.3433-3449.

BIOGRAPHICAL NOTES

Henrique Martins Rocha is a Professor of Industrial Engineering at Rio de Janeiro State University and at Associação Educacional Dom Bosco (Brazil). He received his Ph.D in 2009 from Sao Paulo State University, M.S. in Management Systems from Fluminense Federal University, MBA in Enterprise Management

from Getulio Vargas Foundation, Specialization in Corporate Finance from the Rural Rio de Janeiro State Federal University, and B.E. in Mechanical Engineering from Rio de Janeiro State University. Dr. Rocha spent 27 years working in industry. At Xerox and Flextronics worked as Program Manager in Brazil, USA, and Canada. He also acts as consultant in process optimization, strategic analysis, productivity best practices, etc.

Maurício César Delamaro earned a degree in Mechanical Engineering from Universidade Estadual Paulista - UNESP, Brazil (1985), a MSc degree in Industrial Engineering from Federal University of Rio de Janeiro, Brazil (1989), and a Ph.D. in Industrial Engineering from Federal University of Rio de Janeiro, Brazil (1997). He is currently Professor at the Department of Industrial Engineering of the Universidade Estadual Paulista - UNESP, Guaratinguetá. He serves at the Undergraduate and Graduate Courses. His research main interest is Engineering and Sustainability, particularly the subarea of Sustainable Development.