Competitive intelligence – Quality function deployment integrated approach to identify innovation opportunities

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Abstract: Technological innovation has been the subject of discussion countrywide for playing a leading role in economy. An important factor in innovation is the identification of technological opportunities. However, companies differ on the capacity on noticing and exploring these opportunities. Moreover, it is important to consider the customers' needs at this stage because it ensures a safer way to successful identification and introduction of new products/processes. In this context, the objective of this research is to present the development of a Competitive Intelligence (CI), an analytical model integrated to the QFD (Quality Function Deployment) technique to identify technological innovation opportunities focused on customers' needs. In this analytical model, QFD was applied as one of the analytical tools of the CI. The primary purpose was to integrate the development of strategic vision originated from the CI with the identification of customers' needs resulted from the QFD. The developed methodology was applied in a small company in the Limeira Industrial Pole - Brazil, known as Latin America's biggest producer and exporter of plated jewelry. The results demonstrated the efficiency of the methodology proposed in identified potential technological innovations besides providing useful information to the decision-making process in technological development and management.

Keywords: technological innovation, competitive intelligence, QFD.

1. Introduction

Nowadays, the technological innovation plays a leading role in an economy based on knowledge. There is a substantial set of evidences that innovation, in special the technological innovation in products and processes, constitute a crucial factor for national economic growth (MANUAL DE OSLO, 2008; LACERDA et al., 2001). However, the process of technological innovation is quite complex and expensive. It involves several factors, among which the opportunities identification plays a significant role (MANUAL DE OSLO, 2008; DRUCKER, 2000).

One of the techniques that can be applied in opportunities identification for technological innovation is the competitive intelligence (CI), which is increasingly disseminated, all over the world (GARBER, 2001; PRESCOTT; MILLER, 2002; FULD, 1994). According to Fuld (1994), competitive intelligence can be understood as "analyzed information for decision-making". To produce competitive intelligence it is used a methodology known as the "CI cycle", which involves the steps of planning and direction, information collection, analysis and dissemination (HERRING, 1999). The analysis step is the most important one and must be planned at the beginning (planning step) to serve as the framework for the whole work in the forward steps (KAHANER, 1996). Theanalytical framework usually combines different tools that are chosen to help analyze and integrate specific information pieces in a structured and efficient process. The selection of the analytical tools depends on countless factors that can be taken into account (FLEISHER; BENSOUSSAN, 2003; CALOF, 1999).

In order to assertively identify the opportunities for new products and processes, it is important to combine technological and market knowledge (DRUMOND, 2005). It is also worthy to emphasize the importance of understanding the customers' needs for the innovation as a safe way to successfully introduce new products in market (DRUMOND, 2005), and an important source of information to characterize technological opportunities (PORTER, 1991). As for this purpose, QFD is one of the most important techniques developed in the field of quality management, and is generally applied in the product development process (AKAO, 1990; CHENG et al., 1995). Besides that, the QFD favors the translation of these requirements into technical

product and process parameters, ensuring the innovation focus on customers' needs (AKAO, 1990). Therefore, both competitive intelligence and QFD technique can be used to collect and analyze strategic information for product and process innovation. Although the combination of these techniques is very promising, this scientific approach has not been deeply researched yet.

The product investigated in this study to validate the proposed analytical model was the plated jewelry. It is a very important product for the regional development of the city of Limeira, the main Brazilian plated jewelry industrial cluster. The present study is a deployment of a previous research ran by the Materials Technology Information Center (NIT/MATERIAIS) of Federal University of São Carlos (UFScar) that identified the importance of technological innovation in the field of surface treatment for plated jewelry (NIT/MATERIAIS, 2002). Incipient technological innovation was highlighted in that industrial cluster, apart from the increasingly change in customers' preferences and emergent competitors' threats with attractive low-cost and high quality products, especially from China (NIT/MATERIAIS, 2002).

The objective of this study is thus to develop an analytical model integrating competitive intelligence and QFD techniques, to identify technological opportunities for innovation focused on customers' needs and evaluate its application in a specific case. The methodology was applied to identify surface treatment technologies opportunities for plated jewelry products.

2. Competitive intelligence and technological innovation

Competitive intelligence is very important to produce technological knowledge and intelligence for the analysis of the state of art, technological trends and challenges, with a strategic vision on competitiveness and customers (ASHTON; KLAVANS, 1997; FLEISHER; BENSOUSSAN, 2003). The competitive intelligence can be considered a tool for the innovation process, to observe the market, analyze the strategies and behaviors of competitors, the behavior of customers, their values, expectations and needs (KRÜCKEN-PEREIRA et al., 2001).

According to Fuld (1994), the proposal of competitive intelligence is to launch the conceptual and methodological bases which allow the collection and analysis of data, with the intention of accomplishing the synthesis of high added-value information appropriated to the decision-making process. It concerns competitive processes, since the organizations are immersed in an extremely dynamic and competitive environment and need to obtain useful information from the same environment to take the opportunities and to neutralize threats.

The competitive intelligence takes place with the application of a methodology comprising several steps in a cycle, the competitive intelligence cycle (HERRING, 1999; FULD, 1994; KAHANER, 1996; DUGAL, 1998). A 6 steps adaptation of the classical four-step cycle (HERRING, 1999) was developed by the Materials Technology Information Center (NIT/MATERIAIS), Federal University of São Carlos, as shown in Figure 1 (NIT/MATERIAIS, 2004). The adaptation was to facilitate the training of practitioners and the project management.

The 6 steps of the cycle are: identification of needs, planning, collection, analysis, dissemination and evaluation. The analysis step is considered one of the most important inside the cycle (CALOF, 1999). In this step the collected information will be turned into actionable intelligence in order to help the managers in the decision-making process. The use of a structured analytical framework, normally containing analytical tools (pre-selected in the planning step) is recommended in the step of analysis (CALOF, 1999). There are more then a hundred analytical tools that can be used, for instance: scenario analysis, reverse engineering, analysis of market, SWOT techniques (strengths, weaknesses, opportunities and threats), Analysis of the Industry (Porter's 5 forces), benchmarking, patents analysis, among others (HERRING, 1999; FULD, 1994). The choice of the appropriate tools constitutes an important factor for getting good results (CALOF, 1999).

3. Quality function deployment (QFD)

The QFD, conceived in Japan in the second half of the 60's decade, is a mechanism that translates the voice of customer into product and process appropriate requirements, in each stage of the product development process (EUREKA; RYAN, 2003). The objective of QFD is to correctly identify the quality as defined by the consumer, then translated into

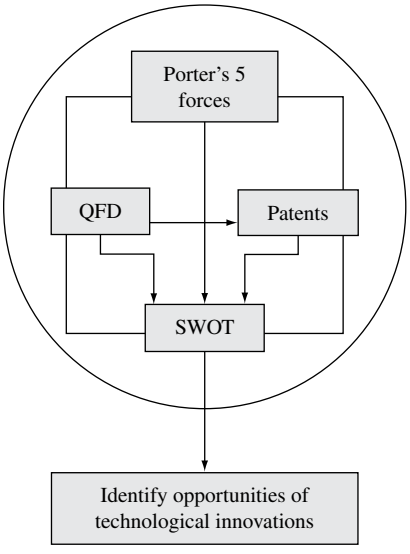

Figure 1. The competitive intelligence cycle adapted (NIT/MATERIAIS, 2004).

product specifications. The translating process begins with the identification of the consumer's requirements. Next, the existing relationships between these requirements and the technical language specification, which is, the technical characteristics that will meet the consumers' requirements (SHARMA et al., 2006; HEIZE, 2001)

The typical approach of QFD is centered on a four-stage process, consisted of a group of matrices that relates the input and the output data. In the first stage, the product planning matrix, of QFD, frequently referred to as the house of quality (KILLEN et al., 2005; CRISTIANO et al., 2000; EUREKA; RYAN, 2003), qualitative customers' requirements are translated into independent and measurable characteristics of product quality. The second stage examines the relationship between those characteristics of quality and the various project's components or parts. The few important components or parts, according to a prioritization conducted on phase 2, are the deployed in the third matrix, which explores the relationship between the parts and the manufacturing processes to produce them. In the fourth and last stage, the key manufacturing processes and its parameters are then translated into work instructions, control plans and training needed to secure that the critical components and processes quality are maintained (CARNEVALLI et al., 2004).

As for the purpose of this research the house of quality solely will be applied, once the main objective so far is to apply the QFD technique to identify opportunities of improvement in the product and not to actually produce it.

4. An CI-QFD analytical framework approach for innovation support

Having in mind the identification of opportunities for technological innovations focusing on customers' needs, an analytical framework was composed by the combination of several competitive intelligence (CI) analytical tools and the product development QFD technique. To support and guide the development of such analytical framework, three macro-objectives were then considered from literature review as the theoretical foundation to the selection of each of the analytical tools. The first one was entitled as 'general diagnosis' and is subdivided into two micro-objectives: analyze the organization and its competitive environment, and identify customers' needs. The second macro-objective was named as 'technological knowledge' and the third, 'strategic correlations between innovation needs and available technologies' (MANUAL DE OSLO, 2008; DRUMOND, 2005), as discussed in greater details below:

4.1. Macro-objective 1: general diagnosis

The general diagnosis macro-objective aims to map the enterprise's technological current state from both internal and external point of view. This makes it possible to identify technological innovation needs connected to the customer needs and overcome competition, besides creating strategies that maximize company strengths to take opportunities and minimize or eliminate internal weaknesses and possible threats from external environment.

4.1.1. Analyze the organization and its competitive environment

The analysis of the organization's internal environment mainly involves an analysis of the company's technological development and management practices. This step is considered to be extremely important as it shows up enterprise's strengths and weaknesses, and its technological capabilities and vulnerabilities (DRUMOND, 2005).

The external competitive environment analysis, in turn, mainly involves the competitors, suppliers, customers and possible substitute technologies. From the analysis of this environment it is possible to map the pressure that each of these players exert over the organization, and also to identify the internal strengths and weaknesses, and external technological opportunities and threats (MANUAL DE OSLO, 2008; DRUMOND, 2005).

The SWOT and Industry (Porter's 5 forces) analysis are both tools widely applied in CI that meet the needs above discussed. As from the literature, these tools are told to be complementary, hence, for the intent of the analytical model here proposed, they present this same connotation (FLEISHER; BENSOUSSAN, 2003). SWOT technique helps out, by definition, the decision-making managers to check and to provide plans and actions to deal with the main strong and weak internal aspects of the organization and the external opportunities and threats to the company's business (FLEISHER; BENSOUSSAN, 2003) and the Porter's 5 forces analysis provides information about the company's competitive environment, analyzing its potential of profitability through the power of bargain of clients and suppliers, rivalry between the competitors and threat of new incoming and substitute technologies and products (PORTER, 1991; FLEISHER; BENSOUSSAN, 2003).

4.1.2. Identify customers' needs

This is considered to be one of the primary points for the identification of innovation opportunities once customers constitute a key reason for any company's existence. Their needs must be taken into account in the new technologies identification process in order that the company may meet them and make the innovation process less risky as a new product launches (MANUAL DE OSLO, 2008; DRUMOND, 2005).

Among the existing analytical tools with the purpose of capturing the customers' needs, the market research (CALOF,

1999), widely applied by the marketing function, and the QFD (CHENG et al., 1995), primarily implemented by the product development area, stand out. Although the market research can also be helpful for this intent, QFD was chosen to compose the analytical model here presented because it can bring valuable information about relationships between customers' needs and corresponding technical requirement for the innovation of product and process for much known product kinds such as the plated jewelry, focused in the present study. The technical requirements may also be considered as source of very important information as for the purpose of the analytical model. Besides that, QFD culminates in the prioritization of clients' needs, which can result in time saving and increased probability of success (CHENG et al., 1995).

4.2. Macro-objective 2 - technological knowledge

Regarding the incorporation of new technologies it is necessary to know every existing technological tendencies and technologies worldwide. It is also extremely important to any organization to detain the technical knowledge of its own technologies, which can be constantly improved. Therefore, it is necessary a constant technological monitoring to identify opportunities and/or threats from the outside environment (MANUAL DE OSLO, 2008; DRUMOND, 2005).

For the purpose of gathering technological information the patent analysis is one of the most important and complete sources and, for that reason, it was selected for this analytical model (ASHTON; KLAVANS, 1997). Estimative shows that 70% of the information reported in patents are not encountered in any other source of information (ASHTON; KLAVANS, 1997). Apart from that, the patents contain information about products and processes not yet produced or implanted, what permits that technological trends are traced. Hence, the patent analysis provides semi-quantitative indicators and qualitative insights on technological development history, current status and future trends and challenges, which can be helpful when identifying possible opportunities of innovations and new product and process technologies (ASHTON; KLAVANS, 1997; TRZESNIAK, 1998).

4.3. Macro-objective 3 - strategic correlations between innovation needs and available technologies

This macro-objective has the purpose of correlating the customer's technological needs to the existing technologies and technological development capabilities of the enterprise itself (DRUMOND, 2005). It sets up the ending of the process of identification of innovation opportunities turned into the customers' needs and it is especially important to support the decisions on which incremental or completely new innovations might be fully implemented. The Figure 2 shows a schematic representation of the analytical model proposed. The correlations between analytical tools constitute the great differential of the model, once, solely, those tools do already exist and are frequently applied.

Another differential introduced is the application of QFD as a key strategic analytical tool of CI. It is important to mention that besides the fact that all the analytical tools solely contribute with relevant information, they also provide information from the interactions between them, which enriches the decision making process. The main planned correlations with the purpose of identifying opportunities of technological innovation present in this model are as follows:

- **QFD & Patents:** The QFD technique can be very useful when applied together with the patent analysis, because the customers' needs identified and turned into technical requirements can provide strategic direction for the refined searching of patents and related technical solutions that fit the primary needs evaluated.
- **Porter's 5 forces, patents, QFD, QFD-patents & SWOT:** To complete and provide a synthesis of the main findings the analytical process, the SWOT technique was inserted in the model as a meeting point of all other analyses. The primary objective of this synthesis is to have the main findings deployed in four distinct dimensions: strengths, weaknesses, opportunities and threats. By doing so, the processes of communicating those finding and the developing recommendations to the decision makers gets even more structured, logic and of easy understanding.

5. Practical application of the CI-QFD analytical model

The competitive intelligence cycle was applied in a Brazilian company named Electrochemical S/A aiming to

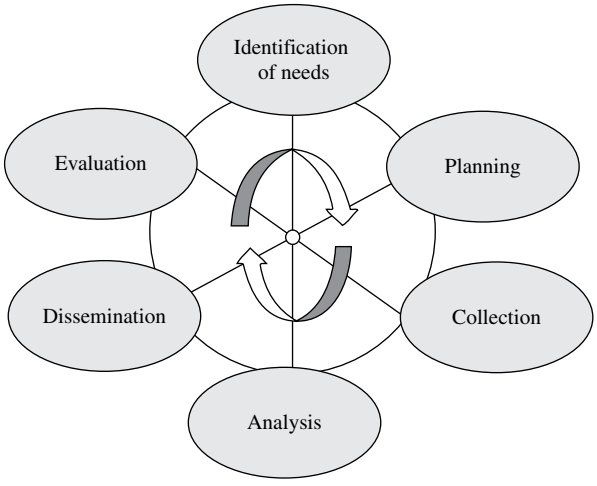

Figure 2. A CI-QFD analytical framework to support innovation.

validate the analytical model proposed for the analysis stage of the CI cycle. This company plays an important role as the main surface treatment raw materials supplier in the Brazilian Limeira's industrial cluster of plated jewelry. This cluster has an estimated production of 60% of the plated jewelry Brazilian production which goes around R$ 900 million per year. About 1/3 of the population of the city (50 thousand people) is employed in a sort of activity related to this sector and there are approximately 1000 companies, mainly small and informal businesses (IBGM, 2005). The main economic activity segment of the focused company is the supply of raw materials and related services for surface treatment, especially chemical substances for galvanization baths, the chemical solutions that contain the metal to cover the plated jewelry by electro-deposition (SAMPAIO, 2002).

The application of the CI cycle has followed all the six steps already described in Figure 1 and section 2. In this particular case, in the first stage, Identification of needs, the need focused during the application of the cycle was the identification of technological innovation opportunities turned to the customers' requirements. In the second phase of the cycle, planning, the sources of information to be consulted to the research were mapped and a three-month schedule for the entire project execution was developed. The means selected to capture the primary information, directly from the source, were interpersonal and by phone interviews, and for capturing the secondary information, the advanced search in articles (Metadex for instance) and patents (i.e. derwent innovation index) data bases. At the collection stage, all data were collected and organized as demanded by each of the analytical tools selected.

During the Analysis step, all the analytical tools were first analyzed solely and only then the study on their interactions was conducted. It is important to register that the application of QFD was adapted from the literature to meet the objectives of this research. Only the so called house of quality matrix was used. Three of them were developed with three distinct focuses: one for the bath product, one for the plated jewelry product and the latter for the galvanoplasty technical service. As for the deployment of customers' needs into technical requirements, several meetings with specialists with multidisciplinary knowledge were conducted. All the results generated during the research were disseminated by means of a written report and an oral presentation to the organization's CEO. The entire CI cycle application was finally evaluated as satisfactory and the use of QFD technique integrated to the analytical model as one of its tools was considered an important key factor to the successful results presented by the research.

5.1. General results

There is a great potential for innovations in surface treatment of plated jewelry by the optimization and changes in the baths presently used for electro-deposition. In summary, the main findings concerning the technological aspect were as follows:

- Shining aspect of the plated jewelry with good quality requirements was the primary characteristic identified as important to customers. The study showed that a match with a new alloy of gold, copper and gallium can bring great results as for that desired characteristic.
- A promising market niche is the use of cleaner technologies. For example, there are multilayer chemical compositions that could substitute the presently used intermediary monolayer of nickel. It is possible to deposit on a layer of copper an additional layer of gold-palladium, gold-cobalt, gold-palladium-copper or cobalt-molybdenum-phosphorus. Another example is the use of polymer additive and noble metal for the substitution of bath's solutions that contain cyanide.
- There are new technologies of surface treatment that have a potentially great technological impact as substitute candidates for the present galvanization technologies. For example, the PVD (physical vapor deposition) and some specific nanotechnologies. These technologies have been developed for high added value products in sectors like dentistry, aerospace and automotive industry, and at present are economically impracticable for the plated jewelry sector, due to the high cost. Nevertheless, a systematic monitoring of these technologies dynamism is a strategic preventive measure. The possibility of cost reduction on the use of these technologies, because of new technical improvements can make them an important source of opportunities or threats, depending on the decisions and timing of actions taken by the company involved.

It was observed that the focused company did not know the wide range of emergent technologies that have potential use in its activity segment. The information and knowledge extracted from the application of the analytical model and the way of the presentation chosen allowed the company's manager to develop a structured view and reflection of its competitive environment, important strength, weaknesses, opportunities and threats not undertaken before. The recommendations of directions of actions and strategies that resulted from the analytical process brought up an important support for strategic decisions to the company.

6. Decisions in management

The fulfilled study reinforced the perception of the need of a new strategy to strengthen the position of the company in its competitive environment. The company's strong business strategy includes technological differentiation

and it was evidenced the importance of the adoption of competitive intelligence methodologies for the monitoring of the technological and business environment dynamism. The study showed to the company's managers the importance of searching for potential technologies, and the results were used for planning an internal technological monitoring infrastructure to support decision-making.

It was also observed that the services offered play a central role in the business process as a whole, constituting an important competitive advantage. The reliability relationships developed between the company itself and the customers strengthens the collaborative technical improvements in the production chain. Nevertheless, it is necessary to meet the main quality and general needs demanded by the customers. The results allowed recommending the improvement of the recruiting process for the service sector of the company, as well as the need to increase the agility in the service delivery, culminating in an additional improvement in the supplier-customer relationship (partnership). The study was also important to emphasize the promotion of employees' awareness of the strategic values of the services as a differential for the competitive positioning of the company. It was also evidenced the importance of improvement in the communication process of the company with the main stakeholders of the production chain. The result was the planning of an interactive site for interconnection of the company with its customers, and the systematization of a service to schedule visits of the customers to the laboratories, enriching the set of decisions stimulated by the present study.

7. Final remarks

The application of the CI-QFD analytical framework and the combination of the related methodologies were important to highlight strategic insights and develop recommendations for the decisions on technological and business innovation of the focused company in the present study.

The application of the QFD technique combined with the other analytical techniques was important to identify priorities to attend the needs and desires of the customers as a support for the innovation decisions in products, processes and organizational structures. The use of the competitive intelligence tools (industry, patents and SWOT analysis) in an inter-connected way with the QFD product development tool allowed analyzing technological, customer and business information in an interactive and integrated way. A set of potential innovative technologies was highlighted, a structure for monitoring the technological progress could be planned and additional service improvements were recommended for the competitive strengthening of the company.

The business competitiveness approach and the ability to anticipate risks and opportunities were strengthened with the integrative application of the competitive intelligence tools combined with the technical and production approach normally obtained with the use of QFD alone for the product development and innovation.

The methodological approach may be also applicable in other situations, technological areas and economic activities. The CI-QFD analytical framework is flexible enough to incorporate other analytical tools used in product development, quality and marketing fields, combined with other competitive intelligence tools, according to the focus and intelligence needs. Further empirical studies can be of academic interest in defining the limits and advantages of using different tools in the analytical framework and combining different methodologies. The monitoring and possible adoption of new technologies by any given production chain is also an important academic study that can strengthen the development of methodologies and analytical tools for the innovation in products, processes and organizational structures.

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