
In search of the elements of an Intra-organizational Innovation System for Brazilian automotive subsidiaries

Raoni Barros Bagno^{a,1}, Lin Chih Cheng^a

^aDEP/NTQI - Federal University of Minas Gerais, Brazil.

Abstract: The present study focuses on providing a theoretical basis for product technological competence development in global automotive organizations in Brazilian subsidiaries. It is argued that the necessary knowledge is fragmented in literature among studies on new product development, knowledge management and organizational learning, organizational competences and technological innovation.

It presents the concept of Intermediate Technological Leadership (ITL) as the enterprise purpose to be reached and the concept of Intra-organizational Innovation System (IIS) is presented as a model to be constructed and applied in such local subsidiaries, in order to enable the achievement of all necessary technological competences. The integration of theoretical sources reveals six IIS basic elements: Strategical adequacy, Interpretation of external environment, Conception of organizational internal structure, Integration of external structure, Systematization of organizational basic processes and Consideration of human factors and relationships. This study aims to be a reference for other ones on technological competence development in automotive subsidiaries of emergent countries, or in organizations of other areas.

Key Words: Technological innovation systems, organizational competences, new product and technology development, automotive industry.

1. Introduction

Product development in Brazilian automotive industry has been aggregating new methods and technologies due to the legislative requirements, market needs and new organizational strategies. Since the great market opening occurred in the nineties, this industrial sector has been experiencing a fast transformation of its subsidiary structures. Such transformation aims at a continuous preparation of these local organizations for a more competitive market.

¹ NTQI, UFMG (Production Engineering Department), Av. Presidente Antônio Carlos, 6627 Belo Horizonte - MG, Brazil; Tel: +55 (31) 3499 4889; Email: rbagno@uai.com.br; <http://www.dep.ufmg.br/labs/ntqi/index.html>

There are many purposes that motivate different countries involvement in companies' Product Development Programs. Among them, the use of subsidiaries' competences and reduction in development cost can be emphasized. In the Brazilian case, local market demands and particularities have been the basis for investments in R&D [12]. Within this context, the paper will begin by presenting an analysis of the main theoretical studies that form the basis of this article's central argument. Following this, it will discuss the role played by the Brazilian subsidiaries of worldwide organizations. It will, then, present the concept of Intermediate Technological Leadership, and will propose a theoretical model that shows the identified IIS element. It will be argued that this model should be the main theoretical foundation for a practical IIS implementation. The final section will discuss the applicability and the relevance of this study.

2. Theoretical basis

2.1. Knowledge management and organizational learning

Nonaka and Takeuchi are seen as essential references on knowledge creation for technological innovation [17]. Representing the Japanese approach, these authors affirm that the success of Japanese companies mainly happened due to their abilities in organizational knowledge creation, which they define as being the capacity a company has to create knowledge, to spread it in the organization and to incorporate it in products, services and systems.

The acquired learning or created knowledge takes the form of new concepts of products, archetypes, procedures or services. In the western approach, Senge, Dibella and Nevis and Argyris and Shön, present strategies of organizational learning emphasizing more explicit knowledge than the Japanese does [24], [6][1]. Nonaka and Takeuchi center their organizational knowledge creation theory in four mechanisms for knowledge conversion: Tacit-Tacit (socialization), Tacit-Explicit (externalization), Explicit-Explicit (combination) and Explicit-Tacit (internalization) [17]. Such mechanisms have been identified throughout studies and reviews of innovative processes in Japanese organizations. Both approaches recognize organizational characteristics such as managers' roles, people's autonomy, objectives, *etc.*, and discuss the ideal conditions for learning process improvement.

2.2. Organizational competences

In any organization beginning to develop new products and technologies, there are activities, work processes, physical structures, organizational and professional profile definitions that were not there before. Organizational Competences refer to the systematization of all these necessary elements which will sustain new abilities now present within the organization.

Prahalad and Hamel studied the concept of competences focused on product's base technologies. According to them, core competences are related to the

product's base technological domain, and this would be the major argument to explain the difference between technology-based corporations [20]. Prahalad and Hamel present an important relation between competence formation and innovative dynamics as they recognize that companies, which are not focused on technological abilities, are increasingly more limited in identifying innovative ways in their current product line or simple expansions [20].

For organizational competence formation, a careful consideration of local context is strongly necessary, as the differences between local and foreign environments are very relevant. It is also important to consider strategic alliances which are normally focused on the complementarity of strength and weakness. Such strategies are commented by Fleury and Fleury, Prahalad and Hamel and Medcof [11], [20], [14].

2.3. New product development process

Before launching a new product in a local market, there must be a stage-structured process that managerially leads it to market – a process called PDP (Product Development Process). PDP is applied from needs identification (customers' needs, technological tendency, legislative criteria, *etc.*) and choice of product concept to its commercial launch. PDP divides the pioneering product into a list of stages, each one constituted by a list of prescribed, multifunctional and parallel tasks [4].

According to Cheng, different approaches and background of each author have produced different perspectives of PDP [2]. For instances, Clark and Wheelwright and Pugh are authors who bring us a product engineering perspective [3], [21]. Whereas, Dolan and Cooper take a perspective under marketing concepts [7], [4]. Meyer's concept of platform identifies the relationship between structural and technological approach and product development strategies [15]. Griffin and Page search for common points among companies and propose a list of best practices in New Product Development (NPD) environment [13].

2.4. Technological innovation taken from the economic perspective

In economics approach, technological innovation acquires prominence from the moment when it appears as a competitive advantage. The works from the economics perspective have origin in the neoclassic economic theories, in which Schumpeter constitute a very important reference [23]]. It can be stated that this approach takes an external view of the organizational structures, but it does not make indepth discussions about Intra-organizational processes. Pavitt, Nelson and Winter, amongst others, are also considered reference authors [19], [16]. The most important elements of this analysis are frequently competitiveness, investment politics, innovative pay-back, rate of economic growth within organizations and countries, creation and conduction of strategies within subsidiaries, and the innovation as a dynamic market key element.

In Brazil, this approach becomes more relevant, mainly among those who see a sustainable way for economic and social development through technological

innovation. It can be noted that they are mainly from research institutes such as IPEA and from the main local universities [22].

2.5. Innovation in emergent countries companies

The theoretical bases examined in the previous sections consider complementary aspects of product and technological innovation within industrial organizations. However, very little integration of different theories could be found. This context reinforces the need to construct a model for technological innovation that is appropriate to emergent countries.

Few authors have tried to integrate knowledge from this theory in search of applicable models to the specific context of companies located in Brazil. Amongst those, Fleury and Fleury study Brazilian innovative context more actively, assessing Intra-organizational aspects [10]. More specifically, Figueiredo presents an integrated and contextual model for emergent countries companies, examining the trajectories of accumulative technological competence, their relation to underlying learning processes and their impact on the operational performance within companies [8].

Figueiredo explains "learning" as a two-dimensional term: the trajectory of accumulative technological competence within an organization, and the processes by which individual knowledge is transformed into physical systems, production processes, procedures, routines, products and services. External and internal knowledge acquisition processes are crucial for companies in emergent countries, yet they do not have any previous knowledge background. Such study concludes with a close relation with the basic characteristics of knowledge acquisition process, the rhythm, the consistency and the composition of trajectories of accumulative technological competence [8].

3. R&D centralization and decentralization: the roles of Brazilian subsidiaries in worldwide organizations

R&D competence development will occur in a subsidiary according to its autonomous level within a worldwide organization. When local R&D occurs, it tends to be more directed to local market characteristics. Moreover, it is considered successfully accomplished when a subsidiary develops local competitive strategies, establishes complex organizational structures, develops products for local market, and also elaborates proper management systems. It is also observed that local governments are concerned with attracting foreign investments through local infrastructure creation that could potentialize the subsidiary competitiveness within global competition [9].

Fleury has identified three different subsidiary categories in Brazil. In the first category is a subsidiary that acts as the headquarters operational arm. In the third one is a subsidiary that works as a competence center, guaranteeing the autonomy in local market according to its own technological competence. In the second one, a subsidiary remains in an intermediate phase as a relatively independent unit [9].

Moreover, other classifications in specialized literature concerning the subsidiary roles can be found [5][12].

There are several evidences of increasing product and technological development activities in Brazil. The contact with new knowledge, new technologies, flexibility and agility for product adaptations, lower development costs, incentive taxes, and requirements for local performance are some of the main aspects involved in the process [12]. It is important to define an appropriate level of autonomy and also a suitable resource allocation for R&D within the subsidiary. It aims at best exploration of local opportunities.

The Brazilian automotive sector is dominated by foreign companies, which means that Brazilian insertion in technological development will also depend on strategies of those organizations. Dias affirms that Brazil can be consolidated as an important product development basis for worldwide market, by developing specific products for some market niches or by specializing in specific subsystem development. Thus, after developing satisfactory competences to local market, a subsidiary becomes a strong developed site for countries and markets with similar characteristics of its own [5].

Brazilian automotive engineering began to adapt some foreign vehicles transmissions in the sixties. Today, in some subsidiaries, there is competence to develop a complete vehicle. As examples of local competence development, General Motors do Brasil can be cited as one of the five development centers of GM group in the world. A few years ago Fiat presented its Brazilian product development center as the first one outside Italy. Ford and Volkswagen have gradually more Brazilian engineers involved in international product developments. The interesting point in these involvements is that the direction of knowledge flow has being inverted in many recent cases. Currently, Brazil is the 11th automobile world-wide producer and the first in South America [18].

4. Intermediate Technological Leadership

ITL or Intermediate Technological Leadership is a concept applied here to explain some purposes which have been recently observed in Brazilian automotive industry context. To be in search of Intermediate Technological Leadership consists on implementing a strategy to extend the local competence in product and technological development.

One of the main assumptions of ITL is the product development site integration and also physical location within a local market limits. It would be the best alternative to a fast understanding of the specific market rules and to select and develop specific products and technologies to that market. So, it can be defined as "ITL stimulated by local market", considered here as an ITL sub-category that occurs when local market is the main reason of technological competence formation. ITL second sub-category is identified when technological competence development is justified by exclusiveness, business share, or even seeks to become a technical reference in development of new product or subsystem among other sites of the same industrial group. In such way, an internal competition is supposed

to happen within the subsidiaries. This sub-category is called "Intermediate Technological Leadership stimulated by internal competition".

5. The road-map to ITL: identifying the necessary elements of an Intra-organizational Innovative System

In this article's context, a particular system that provides for any organization ITL accomplishment is called Intra-organizational Innovative System (IIS). This section summarizes the integration of different theories in order to identify IIS foundations.

Figure 1 tries to integrate the main points of view of each theory cited in section 2 and the industrial context identified in section 3. The theory contributions explored have been sorted out in six distinct elements. Each one represents a necessary field to be approached by a complete IIS. An attempt to identify the contributions for this reference model is sketched below:

- **Strategical adequacy.** It considers the subsidiary local autonomy, its defined role in the global organization, the headquarters dependence in adopting or not of an ITL position and the local capacity that influence it. The main sources to explore this element are presented in organizational competence and technological innovation specialized literatures mainly when this last one talks about organizational arrangements.
- **Interpretation of external environment.** It aims to consider legislation, tax incentives, local market needs and many other constraints that influence directly on the product portfolio strategy. The PDP literature approaches these points focused on design inputs whereas technological innovation literature approaches them as strategical decision parameters.
- **Organizational internal structure conception.** It aims to establish the physical environment characteristics and the work division. PDP and Knowledge Management literatures complement the topics related to the organization's structure for product development.
- **External structure integration.** It considers the contact to knowledge and competences which can be found outside organization limits (universities, research centers, *etc.*). Strategic alliances are well boarded in Organizational Competence literature. However, the other topics are more detailed by technological innovation literature.
- **Organizational basic processes systematization.** It considers the New Product Development Process and those ones related to the continuous organizational leaning. They are largely discussed on product development literature with great contributions from knowledge management studies.
- **Consideration of the human factors and relationships.** Because such topics are more related to human behaviors, this element was not deeply emphasized here. Specific studies, focused on organizational culture, industrial psychology and human resources are potential sources of knowledge for these topics.

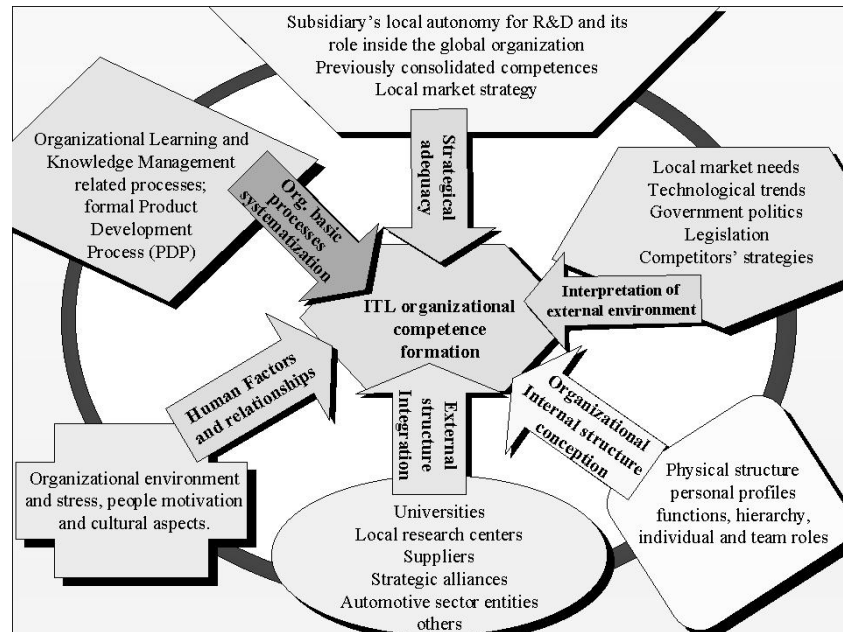


Figure 1. Necessary elements of an Intra-organizational Innovative System

6. Conclusion

Technological competence formation within ITL context presents great social and economic relevance for country development. This article aimed to provide an important way for changing the roles currently played by Brazilian subsidiaries within their organizations. This change includes new investment attractions and high valued jobs to Brazil, also motivating other organization development which composes the structure for innovative support. Such reality, however, should be based on complete IIS's, conceived from a rigorous theoretical search in this presented theory that has to be carefully integrated to practical environment, which will demand an specific and adequate system to each singular organizational context.

These reflections were made under the automotive industry context. This is because of its complex and mature supply chain, great impact on country's economy and recent relevant changes emphasized by local media. Therefore the concept extension for other industrial areas as food, chemicals, electronics, *etc.* characterizes an important gap for next studies.

7. References

- [1] Argyris C, Schön D. Organizational learning II: Theory, method and practice. Reading, Mass: Addison Wesley, 1996.

- [2] Cheng LC. Caracterização da Gestão de Desenvolvimento de Produto: delineando o seu contorno e tópicos básicos. In: Anais do 2o. Congresso Brasileiro de Gestão de Desenvolvimento do Produto. São Carlos: UFSCar, 2000; 1: 1-10.
- [3] Clark KB, Wheelwright SC. Managing New Product and Process Development. New York: The Free Press, 1993. 896pp.
- [4] Cooper RG. Winning at New Products: accelerating the process from idea to launch. 2. edn. Reading: Addison-Wesley Publishing, 1993; 358pp.
- [5] Dias AVC. Produto Mundial, Engenharia Brasileira: integração de subsidiárias no desenvolvimento de produtos globais na indústria automobilística. Ph.D. thesis, Escola Politécnica, USP, 2003.
- [6] Dibella A, Nevis, EC. Como as organizações aprendem. São Paulo: Educator, 1999.
- [7] Dolan RJ. Managing the New Product Development Process. Reading: Addison Wesley, 1993; 392pp.
- [8] Figueiredo PN. Aprendizagem Tecnológica e Performance Competitiva. Rio de Janeiro: Ed. FGV, 2003; 292pp.
- [9] Fleury A. Gerenciamento do Desenvolvimento de Produtos na Economia Globalizada. In: Anais do 1o. Congresso Brasileiro de Gestão de Desenvolvimento do Produto. Belo Horizonte: Universidade Federal de Minas Gerais, 1999; 1-10.
- [10] Fleury A, Fleury MTL. Aprendizagem e inovação organizacional: as experiências de Japão, Coréia e Brasil. 2. edn. São Paulo: Atlas, 1997; 237pp.
- [11] Fleury A, Fleury MTL. Estratégias empresariais e formação de competências: um quebra-cabeça caleidoscópico da indústria brasileira. São Paulo: Atlas, 2000; 160pp.
- [12] Galina SVR. Desenvolvimento global de produtos: o papel das subsidiárias brasileiras de fornecedores de equipamentos do setor de telecomunicações. Ph.D. thesis, Escola Politécnica, USP, 2003.
- [13] Griffin A, Page A. PDMA Success measurement project: recommended measures for product development success and failure. Journal of Product Innovation Management, 1996; vol. 13, 6: 478-496.
- [14] Medcof JW. Why too many alliances end in divorce. Long Range Planning, 1997; vol.30, 5: 718-732.
- [15] Meyer MH. Revitalize your product lines through continuous platform renewal. Research Technology Management, 1997; vol. 40, 2: 17-28.
- [16] Nelson RR, Winter SG. In search of a useful theory of innovation. Research Policy, 1977; vol.6, 1:36-77. In: Revista Brasileira de Inovação, 2004; vol.3, 2: 243-282.
- [17] Nonaka I, Takeuchi H. Criação de conhecimento na empresa. São Paulo: Campus, 1997.
- [18] OICA. OICA Statistics 2005. Available at http://www.oica.net/htdocs/statistics/tableaux2005/Statistics_2005.htm Accessed on Dec. 31st 2006.
- [19] Pavitt K. Key characteristics of the large innovating firm. British Journal of Management, 1991; 2: 41-50.
- [20] Prahalad CK, Hamel G. The core competence of the corporation. Harvard Business Review, 1990; 79-91.
- [21] Pugh S. Total design: integrated methods for successful product engineering. Addison Wesley, 1991.
- [22] Salerno MS, DE NIGRI JA. (Orgs.) Inovação, padrões tecnológicos e desempenho das firmas industriais brasileiras. Brasília: IPEA, 2005.
- [23] Schumpeter J. (1911) A Teoria do Desenvolvimento Econômico. São Paulo: Nova Cultural, 1985.
- [24] Senge P. A Quinta Disciplina. 2 edn. São Paulo: Best Seller, 1990.