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Innovation in the Defense Sector in Brazil: the case of Command and Control Project

Luiz Guilherme de Oliveira*

Adjunct Professor, Dr. Scientific and Technological Policy, State University of Campinas (UNICAMP), Brazil

Abstract

The present work aims to understand the process of innovation in the defense sector, performing a case study of the Command and Control Project of the Brazilian Army, given its strategic value attached to the National Defense and the industrial development of Brazil. For purposes of mapping innovation, the Department of Defense was divided into two parts, one on the production of goods and services called Strand Hard-and another on the application of the products in the sphere of Military Doctrine and Strategy and Tactics of war–Strand called Soft. The innovation in each component is checked into vectors, and the strand hard links in the value chain of the Complex Product Systems (CoPS) and strand Soft Operating System to Combat Military Doctrine of the Earth Brazil. This methodology allows you to explore all stages of innovation in the production process and marketing of goods and services for defense, showing where the core of competitive advantage and bottlenecks in the process and at the same time, exploring aspects of the generation of strategic advantages and defense tactics, which reflect the main aspect of innovation in the defense sector. It should be noted, also, presented the concept of strategic knowledge, divided into central, critical and sensitive. The case study allows us to test this methodology and at the same time, identify strengths and weaknesses of the innovative process design study and conclude that for CoPS development projects generates defense on the one hand, strategic and tactical advantages to the National Defense and on the other hand, provides competitive advantages to organizations and businesses, contributing to economic diversification and competitiveness of the productive country.

Introduction

Knowledge and innovation increasingly become the key factors of the competitive strategies of nations and companies for the development and the acquisition of competitive advantages. In this light, the military innovations, in particular, have special importance due to its strategic role on the modern National Defense, and because of its role in the development of national industry, through the dual use of technologies developed. Thus, the national development of military innovation has become a necessity, since knowledge and technologies of this nature are not easily transferred.

In the case of this study, innovation is understood as a process of solving organizational problems by increasing production efficiency and supply of goods and services in order to obtain a competitive advantage over competitors. These ideas are based on Schumpeter (1978, 1984) [1,2] and evolutionary approach developed from his works.

In the case of the defense sector, innovation follows two paths. The first is seen in innovations that have occurred in economic output for the market. The second, starting from the design of National Defense as a public defense of state sovereignty and protection of the nation, innovation refers to the application of defense products to deter potential threats and overcome the existing [3].

Methodologically, the Department of Defense was divided, for purposes of verification of the innovative process in two parts, one characterized by the production of goods and services and another for implementing these. The first component, to be marked by the production of goods, has a more tangible and, therefore, will be designated Hard Strand of the Department of Defense. In it are allocated to organizations manufacturing technological devices and also the organizations of research and development, marketing and product marketing. Apparently, the idea of "hard" seems to better connect to manufactured goods, however, should also be allocated on the Strand Hard, despite its intangible nature, operational services based on goods or technology or expertise useful to the defense. Strand Hard, technological innovations occur systematically in the form of engines of war, but also non-technological innovations in the form of services or improvements of organizational processes.

The second strand has more intangible characteristics and thus will be called the Strand Soft Defense Sector, which are employed in the mills technological and defense services produced and sold in the Strand Hard. Soft Strand, occur mainly non-technological innovations in the field of Doctrine, Strategy and Tactics Military. Technological innovations that occurred directly in the Strand Soft, without the prior development of a product in the Strand Hard, are rarer to occur and difficult to observe. However, we can mention the combat systems of the future [4], as examples of technological innovations that occurred directly in the Strand Soft. The future combat systems simulate combat conditions with the use of engines of war has not produced, which influences the determination of requirements for technology development Strand Hard.

As to flow between the parts, it appears that the strand extends Hard skills strand Soft products by means of which provides, but

***Corresponding author:** Luiz Guilherme de Oliveira Ph.D, Adjunct Professor, Dr. Scientific and Technological Policy, State University of Campinas (UNICAMP), Brazil, E-mail: lgoliveira@unb.br

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also imposes demands and provides feedback to the strand Soft, for example, technical requirements and capabilities innovative respectively. The Strand Hard Soft demand and supply new products, doctrinal, translatable into technical requirements, and also provides feedback for use of the products used. Therefore, the flow occurring between the Hard and Soft Strands of the Department of Defense also occur in both directions and are marked by the supply of skills, demands and feedback.

Whereas every innovation creates and amplifies asymmetries, therefore, innovation in the defense sector represents the path of modernization of the sector. Thus, the justification for this work is its relevance in theoretical and empirical, to represent, respectively, the possibility of advancement of knowledge and the expansion of scientific literature on the phenomenon of innovation in the defense sector. Moreover, the case selected for study-the Command and Control Project of the Brazilian Army-win special relevance because of their resulting products position themselves at the forefront of international technological frontier. For all these aspects, the study in question is justified by the need for scientific exploration project in order to advance knowledge management innovation defense.

The main question that guides the paths of this research is how the process of innovation occurs in the defense sector.

Under the guidance of the research question can be considered as general objective of the study to understand the innovation process of the Department of Defense, through the exploration of the case study in the light of the evolutionary approach.

As for the intermediate goals, we have:

(I) Verify that the project deliverables are innovations in the defense sector;

(II) Verify that the project deliverables are Complex Product Systems (CoPS) defense, and

(III) Mapping the process of innovation in both strands of the Department of Defense.

To explore the innovation of the defense sector, this paper employs qualitative methodology based on case study of Project Combat Command and Control (C^2 Cmb) Brazilian Army. Initially, we reviewed the literature by means of literature, which provide the pillars for interpretive analysis of data collected. The documentary research project provided the initial data for the interviews undertaken with key project managers and the general subordinate projects, a total of four (04) respondents. The data collected through interviews, after the speech analysis performed according to established taxonomies, allowed the preparation of structured questionnaires and applied to managers, developers and customers and users of products, totaling fifteen (15) respondents. The data collected with questionnaires completed the project information, after processing, analysis and interpretation in order to identify the relevance in the design of their products as CoPS defense and mapping aspects of innovation in the sector.

Innovation Management in Defense

The innovations in the defense sector are primarily focused innovations to war and occur mainly through the introduction or improvement of any kind of technology, especially technologies for military use, introduced in the form of weapons, equipment and vehicles war. For this reason, the management innovation of Defense is of peculiarities.

For example, in the case of demand, the market has characteristics of monopsony in order to be few buyers in military compounds, which require technical requirements based on doctrinal grounds, previously conditioned paradigms of technological innovation. In addition, the Armed Forces have organizational and cultural peculiarities, which reflect the negotiations for the acquisition of products [4].

In aspects of the proposal and implementation of innovation, lobbying and political influence have played a part. In the case of private investment, there is hesitation that occurs due to limited demand in the sector and the uncertainties of the political budget process. Seeking to overcome such restrictions, the exploitation of the civilian market through the sale of dual-use technologies, has become a fundamental need for the development of innovations in the sector [5].

The engines of war, obtained through technological innovations are usually classified as Complex Product Systems (CoPS) defense. The CoPS defense devices are composed of technologies developed in different fields of science, integrated in order to enable the performance of their duties of war as a whole, specific and customized. Examples of CoPS various defense equipment and advanced weaponry, for example, unmanned aerial vehicles, systems of anti-aircraft weapons, sophisticated communications equipment and data transmission - plus many other dual-use such as nuclear energy systems, modern aircraft and command and control systems computer [6,7].

The defense CoPS differ from mass-produced goods because of their characteristics in terms of paradigm and technological trajectory, competitive strategies, market characteristics and peculiarities of management. Typically, the tasks of design and integration of multiple technology components, for example, represent the key skills of the production process and management, as it presents the most important stage of the development process of innovation and value chain of production. At this stage are developed activities that created the design and integration of system components, generating a final product with high added value and customized according to customers' needs [8].

Another important feature of CoPS defense is that its implementation usually runs from temporary inter-organizational alliances, leading to the structuring of a network of actors, within which each have specific tasks [9].

For its technological complexity, the CoPS defense products are positioned at the forefront of the technological frontier, differentiated and high value added and, in commercial terms, have a high earning potential, which compensates for the high investment needed for development.

There is a trend of decentralization and regional physical production of CoPS defense [10]. For this reason, it has been common in CoPS projects, outsourcing practices of productive work and presence of secondary integration activities with the main actors of the project [8].

The innovations are promoted by organizations based on a combination of assets, however, are precisely the organizational expertise of the greatest importance for the innovation process [11]. Therefore, knowledge is highly strategic for the organization in

order that these areas are responsible for acquiring and maintaining competitive advantages. The strategic knowledge, according to their characteristics, can be classified into three types according to Martins-Mota and Oliveira (2009) [3]:

(I) core knowledge, when referring to the most important aspect of the development process of innovation. This knowledge should be dominated by the main actor and are the targets of greatest interest of imitators and competitors, requiring special protection.

(II) critical knowledge are those who, despite being of great importance to the innovation process, not concentrated central aspects of innovation and characterized by being of a specialized nature and segment about a particular activity or technology. These are skills that can be delegated to the secondary actors, despite their relevance.

(III) Sensitive knowledge, when they are not of fundamental importance to the innovation process, and therefore can be delegated to secondary actors. However, these insights have special features sensitive, scarred by the vulnerabilities that are or that require special care, such as difficulty of acquisition and mastery, ease of imitation, rarity, and others.

In the innovation management of the Department of Defense, however, must be careful not to trivialize the concept of innovation. Not every type of improvement or technical change occurred in the sector should receive the status of innovation. In particular, non-technological innovations have considerable difficulty to identify. Thus, minimum criteria should be established for that particular technical change of the Department of Defense is considered innovation. The following criteria will be:

(I) creation of something new;

(II) Generation of competitive advantages, strategic or tactical;

(III) Presentation of a solution to a problem, and

(IV) To be replicated, by diffusion, so as not to be configured in a single case.

The following Table 1 shows the vectors of innovation and the taxonomies used in each part of the sector, according to the approaches used by each author.

Case Study Project C² Brazilian Army

Project C² was chosen for case study because it has features technology intensive and knowledge, developed exclusively nationwide. The data and information presented in this section are based on Kohl (2008) [12] and in interviews and questionnaires used. Based on these sources, it was found that the Project C² is an exclusive project of the Brazilian Army Application of Information Technology (IT) in support of ground operations. Its flagship product, the Program Command and Combat Control (C² Cmb Program) is an information system that enables the integration of command and control facilities to support all operating systems for combat.

The project aimed to improve the quality and speed the flow of information and orders transmitted by means of real-time monitoring of ongoing operations and optimization of data transmission. Its two main parts are the data integration software and telecommunications infrastructure. The integration software (C² Cmb Program) was developed with the imposition of their distribution was free of any

Strands of Defense					
Hard			*Soft*		
Vectors of innovation	**Taxonomies**	**Approach**	**Vectors of innovation**	**Taxonomies**	**Approach**
- inputs; - Assets; - Technologies; - Logistics; - Skills; - Product; - Design and Integration; - Operational Services and complementary; - Distribution and Delivery; - Strategic Relations; - Marketing, and - Demand and Market .	- Search and selection; - Definition of product; - Tacit and explicit knowledge; - Life cycle of the product; - CoPS; - Customization; - Design and Integration; - Expertise; - Skills; - Integrating Social; - Technical Integrator; - Join ventures; - Learning-by-doing; - Learning-by-use; - Learning-by-leaning; - Administered markets; - Product innovation, process, organizational and marketing; - Incremental and radical innovation; - Offset; -Technological paradigm; - Network of Actors; - Partnership;- Services; - Integrated solutions; - Use dual.	- Andersen (2003); - Barras (1986 e 1990); - Davies (2003); - Dombrowski e Gholz (2006); - Dosi (2006); - Kulve e Smit, (2003); - Malerba (2006); - Nelson e Winter (2005); - OCDE (2006); - Prencipe, Davies e Hobday (2003); - Rosenberg (2006); - Schumpeter (1978); - Teece (2005).	- Military Doctrine; - Command and Control; - Intelligence; - Maneuver; - Support of fire; - Air Defense; - Mobility, and- Logistics	- Purpose; - Offensive; - Simplicity; - Unity of Command; - Mass; - Economy Forces; - Maneuver; - Surprise; - Security; - Doctrinal Innovation; - Strategic Innovation; - Tactical Innovation.	- Military Doctrine of the Brazilian Army Ground.

Fonte: Martins-Mota e Oliveira (2009)

Table 1: Matrix Mapping Vectors Innovation in Hard and Soft Strands of the Department of Defense.

licensing costs and utilization, which pre-set technical standards used, reducing the options for selection of technological paradigms. Based on this order, the Program and also Cmb² C software Geographic Information System is open source and fully integrated user interfaces, executable on Windows and Linux platforms.

As the telecommunications infrastructure has been developed called Telematics Module (TM) to troubleshoot connectivity issues in order to allow separate networks and working alone, such as networks, HF radio, VHF or UHF and wired communication networks, exchange information seamlessly integrated. The MT, when connected, form a physical and logical network capable of transmitting data, voice and images from (or to) any users, as well as (or) external networks, such as the World Wide Web and any network public switched telephone or a cellular network, allowing multiple routes to be automatically selected for data transmission, expanding, therefore, safety and reliability.

Another important aspect of the project is its potential for dual use, developed mainly with the integrated C² for the Civil Defense of the State of Rio de Janeiro, whose goal is to provide better planning and more effective and timely response to disasters and situations that demanding action from the Civil Defense. The dual use is also present in stimulating domestic industry by means of subcontracts established for the development of component parts.

Considering the criterion of the four requirements necessary to support innovation of the Department of Defense relating to Project C² has found that:

(I) Requirement 1-creating something new Project C², in fact, was characterized by developing and producing goods and services for use in the industry, which generated improvements in existing services of the Department of Defense, particularly command and control.

(II) Requirement 2-generation of competitive advantages, strategic or tactical. The products developed developers to generate competitive advantages and strategic and tactical advantages to the troops that use them, thereby allowing the increased defense capabilities as a whole.

(III) Requirement 3 - Presentation of solution to an existing problem. The project deliverables are solutions to the problem of speed and accuracy of information presented in modern warfare.

(IV) Requirement 4-be replicated so as to not set up in a case or a single exception. All products created with the project are replicable, allowing its diffusion through imitation and knowledge transfer.

As for its features, it appears that the products developed in Project C² have many interfaces with each other and with other existing systems, which derives its architecture consists of components modularized and reusable, connectable via plug-ins, which provides many features and the fulfillment of various demands of users.

Considering the characteristics of production and coordination of the innovative process, we found that the C² was implemented through a temporary project for the purpose of integration of technologies and systems developed separate and distinct players, forming an elaborate network and complex.

In the aspect of competitive strategy, Project C² integration activity deposited on the central aspect of the whole innovation process. Other activities and stages of product development were delegated to secondary actors, with no damage to the field of technology or compromise of competitive advantages.

Thus, for all these features presented, it appears that the products developed in Project C² can be considered innovations in the defense sector and also Complex Product Systems (CoPS) Defense. As for the mapping of the C² project in the areas of the sector, will be checked the processes of development, production and delivery of products according to innovation vectors of each strand.

In the case of inputs used in the production of tangible parts, such as hardware, shelters and containers Module Telematics, the project led to the establishment of strategic relationships with major suppliers of domestic and foreign inputs.

As for assets, may be cited the knowledge accumulated and concentrated in organizations and individuals, due to know-how and expertise developed in previous projects. This knowledge enabled the establishment of innovative organizational routines useful to the project.

For technologies promoted the project, almost all are for civilian use, adaptable for military use by means of strengthening and backup subsystems and thus have dual-use qualities, necessary for the promotion of national industry.

In the aspect of knowledge, can be considered as the central knowledge engineering activities related to software, teleprocessing, logical networks, systems design and architectural design. As for the critical knowledge, we mention the knowledge about sensors, eg on radar to detect aerial threats and knowledge of reusable solutions, such as communications protocols, reusable in other applications that preconized diffusion information network. As for the sensitive knowledge, may be cited knowledge about high performance computing, in order to find optimal solutions to third-party components.

Project C² also counted with accumulated knowledge resulting from experience brought from outside the institution by some engineers. There were also several examples of knowledge acquisition, by the method of learning-by-doing as a result of learning provided by the empirical development of the project itself, and were also acquired knowledge through learning-by-learning, due to the implementation of various external courses performed and acquired knowledge through the study of foreign books.

Project C² has promoted the development of new products, in particular Module Telematics, absent in other defense markets. Moreover, there is the further development of Telematics Module Jungle (MTS) and Mobile Telematics Module (MTM) for armored vehicles. All these products have characteristics of customization according to user profile national presenting also multiple interfaces and transparent to the user.

As for operational services, the concept of Service Oriented Architecture (SOA), used by the C2 system, enables the functionality implemented by an application are made available as independent services. That is, the information obtained by any of the users will be provided by the system to any other user.

Mapping Project C^2 Soft Strand refers to the effects of innovation in the field of application of the products developed under the principles of the Brazilian Terrestrial Military Doctrine.

In the aspect of the Military Doctrine, it was found that the project is generating C2 doctrinal necessary updates of employment due to the fact that optimize the program, through technology, the existing system of command and control. Doctrinal changes have also occurred in the life cycle of products for software programs and applications. Therefore, doctrinal changes in the life cycle of products possibly occur with other products that have complex technological content and are highly dependent on information technology, as occurs with most CoPS defense.

The project products C2 enabled significant improvements in the operating system command and control, since this innovation maximizes each of the principles of war the following:

(I) the principle of goal - to generate greater awareness of the battlefield and the areas of strategic interest, allowing goals to be better defined from more complete and accurate;

(II) At the beginning of the offensive - facilitates the achievement of the initiative of the shares, considering the gains in communications and control of commanders;

(III) The principle of simplicity - the digitization of data facilitates the preparation of plans, as well as its transmission, making the orders more clear and concise;

(IV) The principle of unity of command - the products facilitate the maintenance of unity of command and unity of effort, due to the optimization of communications and information;

(V) The principle of mass - the digitization of the troops facilitates the concentration of troops at the decisive time and places;

(VI) the principle of economy of forces - the digitization of troops and resources facilitates the employment of all combat power available, the most effective way possible, leaving the minimum required for secondary actions;

(VII) The principle of maneuver - the geographical information and digitization of troops provided by the products of the project easier to impose a disadvantage to the enemy;

(VIII) The principle of surprise - the higher science of the battlefield, communications better and the most accurate and current even easier to reach the enemy unprepared, and

(IX) The principle of security - information and communications products Project C2 reduce the possibility of the enemy get some unexpected advantage.

The C2 Program provides a more accurate view of the battlefield and generates more accurate and recent information, increasing the security chain of command.

Project C^2 products facilitate the accuracy and confidentiality of intelligence information, due to encryption of data and communications. Project C^2 also facilitates the synchronization of fires with the troops scattered on the ground and increases accuracy on targets. Synchronization occurs mainly due to the accuracy of information and improving the quality of communications, reducing crashes and casualties caused by friendly fire.

The improvements made by the Project C^2 products maneuvers occur indirectly, via other operating systems for combat. The program incorporates C^2 also features that facilitate various logistics functions. For example, geographic information allow better exploit the characteristics of the terrain and find the troops, making the distance calculations, check the trafficability of the roads, the navigability of rivers and implementation, identification of logistical points of interest, which can be directly extracted from program information screens or calculated with the use of software tools available on the computers in combat.

Finally, the development of project products allowed the C^2 gain a competitive advantage to domestic industry, mainly because of the dual-use technological innovations that were implemented. In the field of application of the products, optimization of operational combat systems, which are the vectors of innovation in Soft Strand, through the use of the products developed, allowed to gain strategic and tactical advantages to the Brazilian Defense Industry.

Conclusions

It appears that innovation in the defense sector gained increasing importance because of its strategic value related to national defense and development of technologies with possible dual use, usually as classified Complex Product Systems (CoPS), and thus positioned at the frontier of knowledge, which enables dynamic and competitive gains externality effects to all sectors of national economy.

The case study of Project C^2 allows us to test the methodology of dividing the industry into two parts, for verification of the innovative process. Thus, the use of links in the value chain adapted to CoPS as the basis for the vectors of innovation in the Strand Hard exhibited all stages of the innovation process, showing the core of competitive advantage and bottlenecks in the process. In the case of Soft Strand mapping, according to the operating systems of combat and the principles of war, it was possible to examine the practical effects of innovation in terms of strategic and tactical advantage of the Department of Defense. Finally, the definition of strategic knowledge facilitated the identification of the most important assets to the management of innovation in the industry.

As the final conclusions, the case study of Project C^2 infer that options for designs complex Systems Products (CoPS) defense proves to be a very productive alternative for the Brazilian Department of Defense, due to the appearance of dual use technologies developed. On the one hand the strategy of development of CoPS in the defense sector generates strategic and tactical advantages to the National Defense, on the other hand, provides competitive advantages to the productive sector of the country.

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