FUTURE SRJ
FUTURE STUDIES RESEARCH JOURNAL: TRENDS AND STRATEGIES

Profuturo: **FUTURE STUDIES PROGRAM**
Scientific editor: James Terence Coulter Wright
Evaluation: Double Blind Review pelo SEER/OJS
Revision: Grammatical, normative and layout.

PROSPECTING BRAZIL´S DEFENSE SECTOR: BRAZILIAN ARMY´S CASE STUDY

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ABSTRACT

The present work deals with technological foresight in the defense sector, in Brazil. The theme deals with the case of technological foresight developed by the Brazilian Army (EB), between the years 2009 to 2012. The objective was to identify the systems and materials needed to EB, the technologies required to enable their achievement, and scenarios of national defense industry in 2030. The research method was in two phases, a theoretical framework for the methodology of prospecting, and other empirical, for the fieldwork. The empirical phase was conducted via the Internet, with the consultation of about 2000 respondents, from the most diverse areas of society. The research result was a set of systems, materials and technologies as well as a bunch of tables with probabilities, impact, timing, relevance and risks of the scenarios of national defense industry in 2030. With this information, the EB can develop strategies for transform itself into a new Armed Force, the EB 2030.

Key-words: Future studies. Technological foresight. Defense sector.

RESUMO

O presente trabalho trata sobre prospecção tecnológica no setor de defesa, no Brasil. O tema aborda o caso da prospecção tecnológica desenvolvida pelo Exército Brasileiro (EB), entre os anos de 2008 a 2012. O objetivo foi levantar os sistemas e materiais necessários ao EB, as tecnologias necessárias para viabilizar sua obtenção, e os cenários da indústria nacional de defesa, em 2030. O método de pesquisa se deu em duas grandes fases, uma teórica para a definição da metodologia de prospecção, e outra empírica, para o trabalho de campo. A fase empírica foi realizada via Internet, com a consulta a cerca de 2000 respondentes, das mais diversas áreas da sociedade. O resultado da pesquisa foi um conjunto de sistemas, materiais e tecnologias, bem como um grupo de tabelas com as probabilidades, impactos, prazos, relevância e riscos dos cenários da indústria nacional de defesa em 2030. De posse dessas informações, será possível ao EB elaborar estratégias para transformar-se em uma nova Força Armada, o EB 2030.

Palavras-chave: Estudos do futuro. Prospecção tecnológica. Setor de defesa.

1 INTRODUCTION

The Brazilian Army, locally referred to as *EB*, is conducting a transformation process with views to adapting the institution to new scenarios that have arisen as a result of the indisputable role of leadership Brazil has taken on within the community of nations. This transformation process that the Brazilian Army, hereinafter BA, is experiencing primarily poses to define what the future Army will be like, precisely by the year 2030. Consequently, the Army´s Department of Science and Technology, known as *DCT* in Brazil, initiated a project called *EB* 2030 Technological Foresight - hereinafter referred to as BA 2030 - so as to identify systems, materials, technologies and local defense industry year 2030 scenarios and thus subsidize the preparation of an Armed Force project. To this effect, a group of future study researches from the University of Brasília were called upon to support the *DCT* in completing such a demanding mission. So as to meet the collimated objective, the group conducted a Foresight process by means of extensive field research.

The survey started in 2008 and was concluded in 2012, i.e., it called for 4 years' worth of duration. As specialists, 1.990 respondents from the most varied fields of knowledge took part in the research, thus shaping an unprecedented far-reaching, comprehensive and long lasting study.

In short, the research issue can be defined as follows: Which systems and materials should the BA have by the year 2030? Which technologies should the BA master by 2030 to enable the obtaining of the identified systems and materials? Will the domestic defense industry be able to produce such systems and materials by 2030?

Therefore, the objective of this survey is to use the year 2030 as reference to define the following items:

1) systems and materials of military use required by the BA;
2) technologies to be researched and mastered by the BA;
3) domestic defense industry scenarios.

This research is justified by the need to seek in conjunction with a group of specialists, answers that cannot be obtained in a trivial manner since this is typically a case of future studies involving a public defense organization.

The research´s main limitation involved defining the most appropriate Foresight methodology for use. This issue arose given the fact that available data concerning technological Foresight in the defense segment, particularly amongst foreign armed forces, was scarce. Thus researches had to travel to other countries so as to conduct *in loco* studies and obtain the required information and define the most adequate methodology to prospect Brazil´s defense sector. Both research activities and results are hereinafter presented.

2 THEORETICAL REFERENCE

According to Enric Bas (1999), the prime objective of future studies is to identify possible future developments and evaluate how probable and desirable these alternative developments effectively are.

Manermaa (1995) states that future studies may be categorized into three major types: hermeneutical, technical or emancipatory. Hermeneutical future studies include futurism, utopianism and scientific fiction, are primarily of qualitative nature and are not of relevant use for public or private organizations. Nevertheless, thought leaders and futurologists such as Alvin Toffler (1980), H. G. Wells (1895), George Orwell (1983) and Isaac Asimov (2004) mostly resort to this kind of study.

Technical future studies comprise futurology, econometrics, demography, meteorology and astronomy and are based on the extrapolation of trends using mathematical models to prepare forecasts (Bas, 1999).

Emancipatory future studies pose to determine possible futures and identify the probability of their occurrence (Godet, 1979) and include Foresight, prospective sociology, strategic planning and process re-engineering. Future studies of this kind follow the following basic sequence of activities: 1) determine the different alternative futures; 2) identify the desired and non-desired future alternatives; 3) guide actions to attain or avoid a given future (Bas, 1999).

Foresight, a type of emancipatory future study is defined by Gaston Berger (1967) as being "a means to envision the future, imagining the same as of deductions extracted from today". According to Michel Godet (1991), Foresight is defined as "a panorama of possible futures, i.e., scenarios that are not unlikely, keeping in mind both past determinisms and the confrontation of player or stakeholder projects. Each Foresight scenario (coherent representation of hypothesis) may be subject to a numerical evaluation, i.e., a prediction". Ian Miles (2002) outlined general phases for the prospective analysis process, namely: pre-analysis; recruitment; generation; action and renovation.

Foresight follows a structured vision of the future, i.e., the future would be a result of human actions. Thus Foresight rules out the existence of a single deterministic future and accepts the exploration of alternative futures (Iñiguez, 1994). Foresight accepts quantitative variables but also integrates qualitative parameters and sometimes others that are not quantifiable such as player/stakeholder projects and behavior, thus allowing for a holistic assessment of the future (Godet, 1977). By seeking to perceive and define possible futures, Foresight mitigates deviations due to errors of forecasts given that it factors in uncertainties as to the future (Makridakis, 1993). According to Bas (1999), Foresight provides references concerning alternative futures by means of the construction of possible scenarios and for each scenario, the definition of probabilities and impacts.

The scenario methodology was first employed by the United States Air Force in Foresights the 1950´s (Masini, 1993). By the end of 1960, scenarios were first employed by the private sector at General Electric (Millet & Honton, 1991). At the end of the 70´s, the scenario method as a tool for Foresights was deemed consolidated once adopted by Shell International and included in this company´s strategic management routines (Becker & Van Doorn, 1987).

This research chose the following definition of scenarios as coined by Michel Godet (1994): "the description of a potential future and progression (of events) towards the same". The scenarios method offers a cognitive map of the future, featuring a set of alternative futures, each respectively presenting an associated probability of occurrence (Mendell, 1985). According to Godet (2008), the construction of scenarios comprises three phases, namely:

a) construction of the base: a detailed vision of the system under study´s current state, its boundaries, the definition of key variables and player/stakeholder assessment;

b) definition of possible scenarios and their probabilities, impacts, etc.;

c) description of the evolution of events from the current situation to each scenario´s future state.

There is a variety of Foresight methods which, if conveniently combined, enable the anticipation of future scenarios. Chart 1 introduces a summary of major Foresight methods, categorized into qualitative, quantitative and semi-quantitative, according to the taxonomy proposed by Rafael Popper et al. (2008).

Chart 1: Foresight Methods

Category	Method
Qualitative	**1.1.1.1.1*Back casting*** Brainstorming Citizen Panels Conferences/Seminars Essay/Description of Scenarios Expert Examiner Panels Predictions of Specialists Interviews Revision of Literature Morphological Analysis Relevance Trees/Logical Diagrams Stakeholder/Player Analysis Monitoring Scenarios Scientific Fiction Games and Simulations Field Research SWOT Analysis
Quantitative	Benchmarking Bibliometrics Temporal Series Analysis

	Indicators Modeling Patent Analysis Extrapolation of Trends Impact Analysis
Semi-quantitative	Structural Analysis Cross Impact Analysis Delphi Critical Technologies Multi-criteria Analysis Quantified Scenarios Road-mapping Stakeholder/Player Analysis Grumbach Method

Source: Popper et al. (2008).

For the purpose of this research, the approach elected to define scenarios combines the Quantified Scenarios Method with the Morphological Analysis Method.

The Scenario Method refers to an extensive range of approaches involving the construction and use of scenarios – visions of plausible futures which are deemed consistent to a smaller or greater extent.

Scenarios usually comprise a number of characteristics of the object subject to study, not only a single or a couple of parameters. These may arise from individual work, seminars or using tools such as computer modeling.

Scenario seminars usually involve groups of people who devote themselves to the preparation of alternative future scenarios. Groups of the kind most often focus on a specific issue whereby the resulting scenarios indicate: the perspective of specific field experts; the understanding of groups of people that have been carefully selected to represent a given community, organization or region.

Scenarios can be articulated and prepared in a variety of manners, amongst which: using a 2x2 matrix of key parameters; using archetypical scenarios such as "better than expected", "worse than expected" and "other than expected"; by selecting scenarios that are key-trend and driving force examples that have been identified via STEEPV or similar approaches, to mention but a handful.

However, seminars can also be conducted, especially designed to prepare a desired scenario (Miles, 2005). This kind of scenario requires the identification of specific objectives and actions for the same to be built (Jantsch, 1967; Boucher, 1977; Boucher 1985; Miles, 1981; Schoemaker and Van der Heijden, 1992; Van der Heijden, 1996; Ringland, 1998; Andersen and Jæger, 1999; Roubelat, 2000; Krause, 2002; Berkhout and Hertin, 2002; Green et al., 2005).

Likewise, there are several types of quantified scenarios. One version involves the quantification of parameters that refer to the scenario at hand. For instance, experts may estimate the probability of the occurrence of scenarios, impacts, deadlines and so forth.

Impacts of a given scenario over another may further be estimated, as proposed by Duperrin e Godet (1975) in their SMIC method. Another version involves identifying alternative visions concerning the future (Godet, 2000).

Morphological Analysis is a combined analytical method coined by Fritz Zwick (1969), based on the decomposition of an issue or object of analysis into its attributes. Michel Godet is the leading author who resorts to morphological analysis to conduct prospective analysis (Godet, 2008).

The general idea is to breakdown a system to be studied into its possible attributes which typically are the events that drive the system from the current state to a future one. Subsequently, for each event, the possible states that they may present in the future are identified, i.e., the possible futures.

In as much as the methodology proposed by Godet is concerned, these future states are quantified and a probability of occurrence is defined. It´s worth noting that, according to the theory of probabilities, the sum of probabilities of each possible future of a given same event must be equal to 100% (considering that all possible futures of a given event have been mapped). The combination of each event´s future state generates different paths or scenarios, as pictured in Chart 2, below (Zwicky, 1969; Ritchey, 1998).

Chart 2: Example of a Morphological Matrix used in scenario analysis

	Future 1	**Future 2**	**Future 3**	**...**	**Future N**
Event 1	Event 1 occurs P = 30 %	Event 1 does not occur P = 40 %	Event 1 partially occurs P = 20%	...	Value n1 P = 10%
Event 2	Event 2 partially occurs P = 50%	Event 2 fully occurs P = 25%	Event 2 does not occur P = 25%	...	Valuer n2 P = n2%
Event 3	Event 3 does not occur P = 80 %	Event 3 partially occurs P = 10%	Event 3 fully occurs P = 10%	...	Value n3 P = n3%
...	...	...	...	...	...
Event M	Event m_1 P = m_1%	Event m_2 P = m_2%	Event m_3 P = m_3%	...	Value n_m P = m_n%

Possible future scenario

Source: Prepared by the authors

3 RESEARCH TECHNIQUES AND METHODS

The research method employed primarily consisted of two phases: the theoretical phase comprising the definition of a technological Foresight method for the defense sector and an empirical phase whereby the chosen Foresight method was applied so as to obtain scenarios for Brazil´s defense sector.

The theoretical phase, i.e., definition of a technological Foresight method was conducted as follows: bibliographical revision concerning technological Foresight, including local and international doctorate thesis on the subject matter; study trips to the University of Manchester in the UK with views to understanding how Great Britain conducts technological Foresights and also to study the subject matter with the institution´s professors. This phase finally included the definition of the methodology of choice based on the theoretical studies undertaken by the authors.

Research comprised a 20 year time frame so as to map defense sector scenarios for the year 2030. This empirical phase of the project included field work, consulting specialists primarily by means of surveys conducted over the web (internet). The survey was both qualitative and quantitative. The empirical phase occurred in two stages.

The first was a pilot survey employing a reduced sample of the universe to be researched. However, within the sample efforts sought to comprise all segments of the universe. The objective was to verify if the proposed methodology was consistent and conduct eventual adjustments.

During the second stage, once adjustments had been made, the survey was conducted comprising an ample and comprehensive universe with views to mapping defense sector scenarios for the year 2030. Thus the research methodology evolved according to the general scheme presented in Figure 1 below:

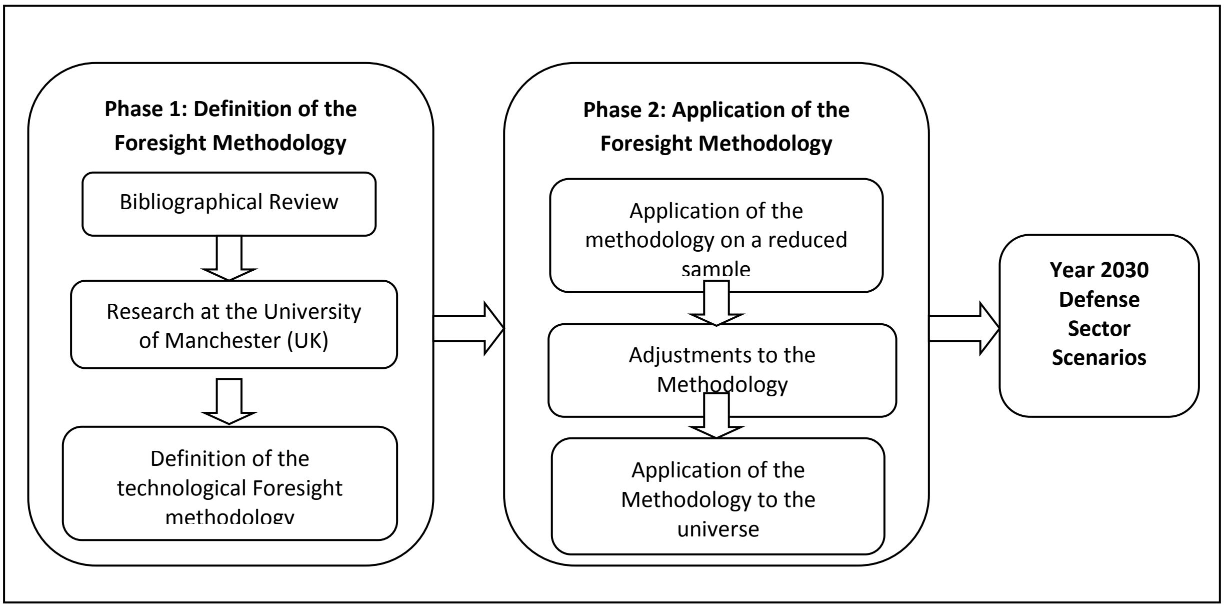
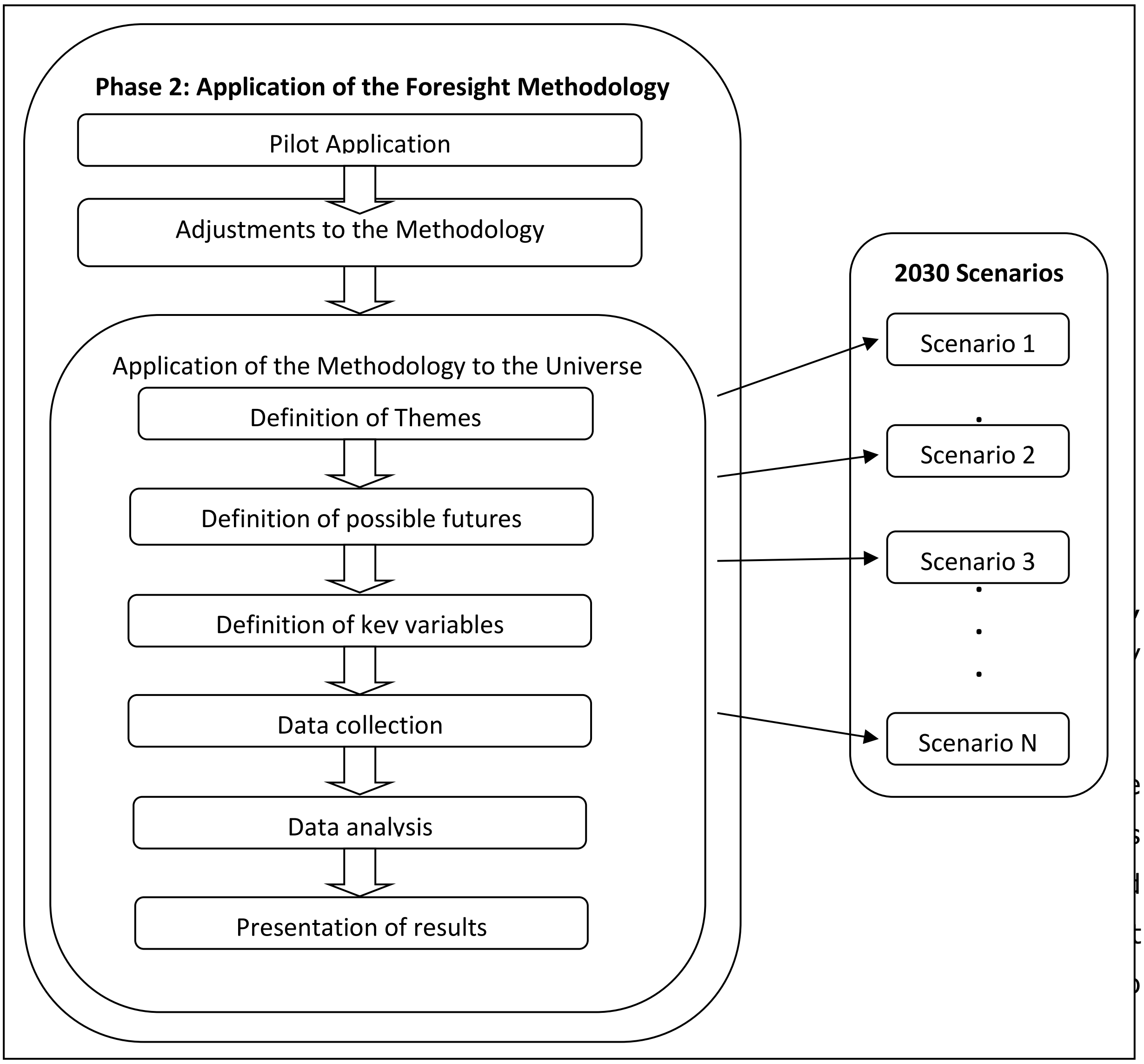


Figure 1: General research method scheme

Source: Prepared by the authors

Nevertheless, it must be emphasized that the application of the Foresight methodology (phase 2) comprises the definition of a number of parameters and variables, such as those exemplified in Figure 2.



Currently the survey is still available on the internet and can be verified at the following electronic addresses:

1) First phase: https://www.surveymonkey.com/s/97SBWVS;
2) Second phase: https://www.surveymonkey.com/s/JYP2YQY;
3) Third phase:
    - first round: https://www.surveymonkey.com/s/ZQ58MFM;

- second round: https://www.surveymonkey.com/s/8P9RHCG.

The overall concept of the Foresight process is to gather the results of the three phases into a single assessment so as to extract a set of conclusions that may subsidize the definition of long term research and development projects. These projects would start immediately so as to ensure the necessary systems and materials are obtained for BA 2030, given that the same would be manufactured by the local defense industry. Figure 3 illustrates the Foresight process concept:

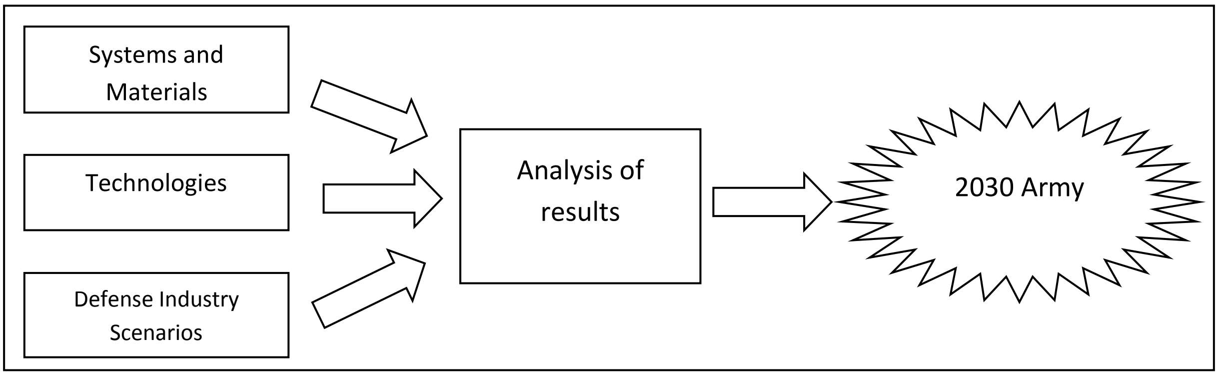


Figure 3: Overall Foresight process concept

Source: Prepared by the authors

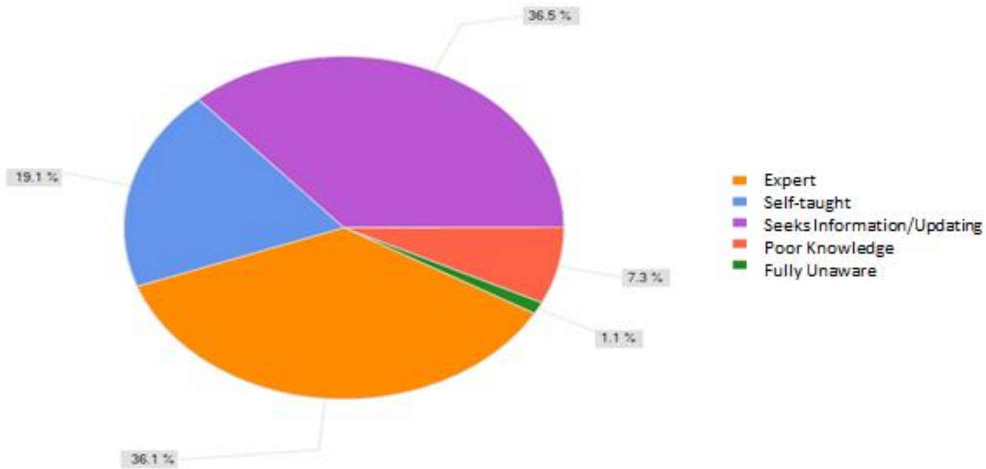
4 DATA PRESENTATION AND ANALYSIS

Field surveys counted on the participation of 1.990 respondents, 1.183 of which (59,4%) finalized all the questions of the questionnaire. Respondents self-assessed themselves as to their knowledge of military matters and self-evaluation criteria included the following:

1) Examiner/expert: in-depth expertise, studies the subject matter in an extensive, comprehensive and in-depth manner and is a member of the specialized community, known as *métier* (36,1%);
2) Self-taught: has a sound understanding of the subject matter, studied with great interest (19,1%);

3) "Seeks information/updating": reasonable extent of subject matter knowledge and whenever possible, reads about the same (36,5%);
4) "Poor understanding": sometimes reads about the subject matter (7,3%);
5) "Absence of knowledge/Unaware": never reads about the subject matter (1,1%);

Self-evaluation results are presented in Graph 1:

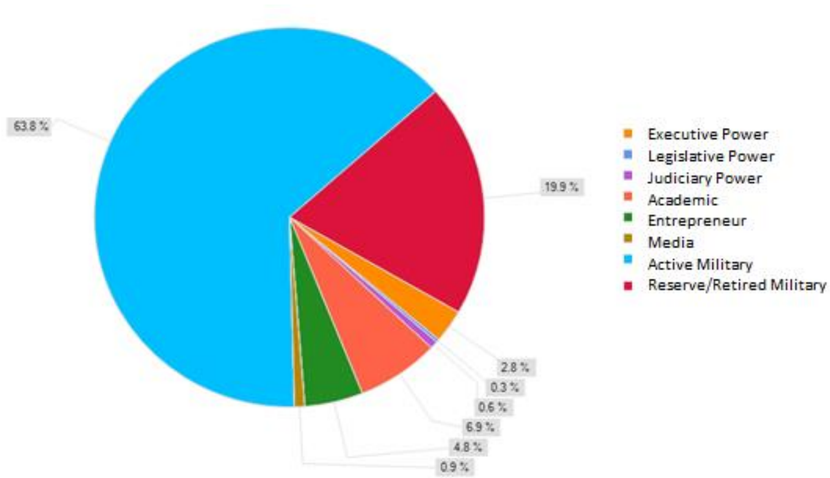


Graph 1: Respondent self-evaluation results
Source: Prepared by the authors

Respondents were also requested to inform the field of professional expertise, previously defined as follows:

1) Executive Power (2,8%);
2) Legislative Power (0,3%);
3) Judiciary Power (0,6%);
4) Academic (6,9%);
5) Entrepreneur (4,8%);
6) Media (0,9%);
7) Active Military (63,8%);
8) Reserve/Retired Military (19,9%).

Distribution per occupational field is pictured in Graph 2.



Graph 2: Respondent distribution per field of occupation

Source: Prepared by the author

4.1 FIRST PHASE: SYSTEMS AND MATERIALS OF MILITARY USE

During the first phase of the field survey, the intent was to anticipate which systems and materials of military use the Army should possess by 2030. The authors deemed adequate to prepare questions concerning Operational Systems (OS) so as to guide the mapping of both systems and materials. Operational Systems are defined in Campaign Handbook C 100-5 "Operations" as follows:

> Combat, combat support and logistics elements interact with each other, integrating operational systems that allow the commander to coordinate the timely and synchronized use of resources within time, site and purpose. Operational systems are: command and control; intelligence; maneuvers; fire support; anti-aircraft defense; mobility, counter mobility and protection; and logistics. (Brasil, 1997)

Thus, handbook C 100-5 defines seven operational systems.

For each of the seven operational systems the following question was made: “Considering operational system [X], indicate a means (material or system) of military use that would promote significant advantage for BA 2030”.

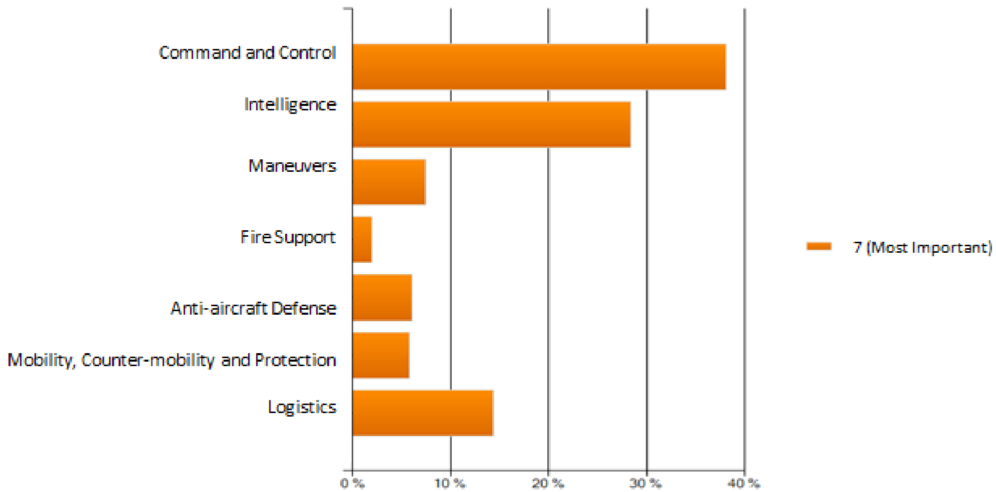
Questions concerning systems and materials of military use for BA 2030 were of the open kind, i.e., the first phase was a qualitative survey. Subsequently results were treated to remove ambiguities and then the frequency of words was analyzed using free, readily available on the internet software known as “Wordle” (http://www.wordle.net/), which graphically represents the most frequently used words highlighting the same in larger font sizes. This method was deemed extremely adequate since it enabled both rapid and easy analysis of the most mentioned systems and materials. For instance, OS Maneuvers presented the results pictured in Figure 6 below:

Figure 4: Necessary systems or materials for Operational System Maneuver in 2030

Source: Prepared by the authors

Respondents were requested to indicate the relevance of each operational system for the Army by 2030. Results indicated that the command

and control system was deemed most important. Graph 3 pictures results collected from this question.



Graph 3: Operational systems relevance for *BA* 2030

Source: Prepared by the authors

As of these first phase results, the Army is already in a position to shape a notion of materials and systems it should possess by 2030.

4.2 SECOND PHASE: TECHNOLOGIES OF INTEREST FOR THE ARMY

The second phase of the field research focused on mapping technologies the Army must master by 2030 so as to enable the development of systems and materials identified in the previous phase. To this effect, a set of 23 technologies of defense interest were employed as ground start which had been previously mapped by research conducted by the Ministry of Defense in conjunction with the Ministry of Science, Technology and Innovation. This study was disseminated by means of a document entitled Strategic Conception- Science, Technology and Innovation of Interest for National Defense Purposes (Brasil, 2003). These are the named technologies:

1) fire gun system environment;

2) signature control;

3) chemical, biological and nuclear defense (CBN);

4) fluids computational dynamics;

5) renewable sources of energy;

6) photonics;

7) data fusion/warehousing;

8) hypervelocity;

9) system integration;

10) machine intelligence and robotics;

11) compound materials;

12) high energetic density materials;

13) materials and processes in biotechnology;

14) micro-electronics;

15) automatic precision navigation;

16) pulsed power;

17) forced-air/drawn propulsion;

18) high sensitivity radars;

19) nuclear reactors;

20) active and passive sensors;

21) information systems;

22) special systems;

23) super-conductivity.

Respondents were asked if there were any technologies deemed of relevance for BA 2030 that had not been included in the initial list. Highlights include nanotechnology, cybernetics, robotics and advanced materials, as pictured in Figure 5.

Figure 5: Other technologies of relevance for *BA* 2030

Source: Prepared by the authors

Next, for each of the 23 technologies of defense interest the following questions were placed:

1) Do you deem that the mastering of technologies [X] for BA 2030, is:

- indispensable;
- very relevant;
- relevant;
- poorly relevant;
- irrelevant.

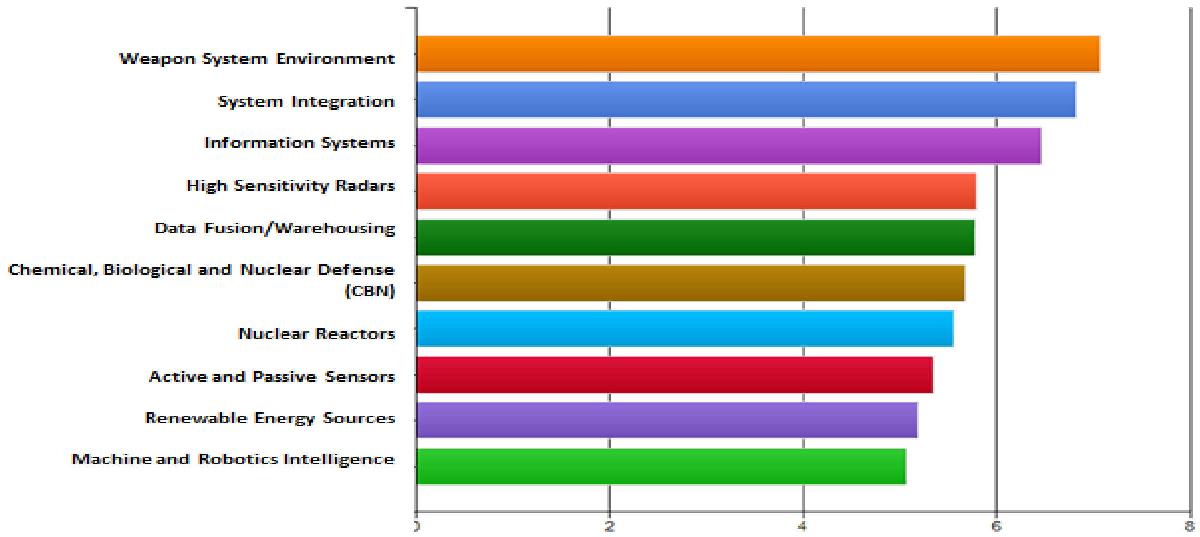
2) Which Operational System you deem would most benefit from the application of technologies [X]?

- Fire Support;
- Command and Control;
- Intelligence;
- Manoeuvers;
- Mobility, Counter-mobility and Protection;

- Anti-aircraft Defense;
- Logistics

3) Do you envision possible applications of technologies [X] at BA 2030? Please mention which you envision.

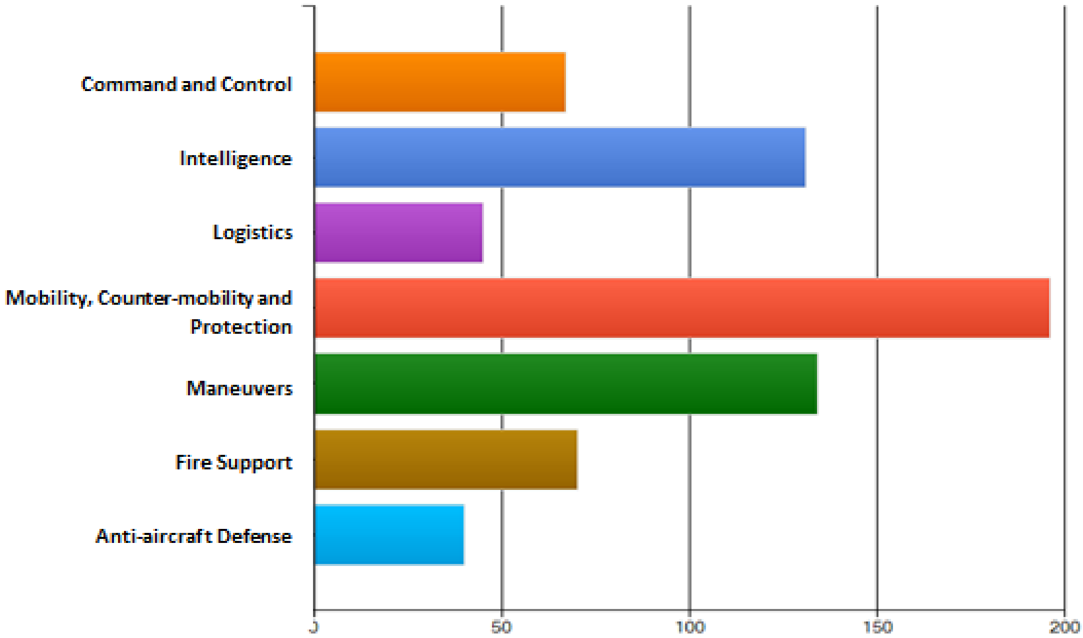
Finally, the following question was placed: "Select the top 10 technologies you deem of highest priority for the Army´s R&D, scoring respective priorities as follows: 1=highest priority, 10=lowest priority)". Results of this last question are pictured in Graph 4.



Graph 4: Ranking of BA 2030 technologies per priority

Source: Prepared by the author

For instance, consider the Intelligence, Machines and Robotics technology mentioned as one of the top tem most important that the Brazilian Army should master by 2030. The question concerning which operational system would most benefit from the application of this technology indicated that Mobility, Counter-Mobility and Protection, Maneuvers and Intelligence ought to be the operational systems that would most benefit from the application of this technology, duly demonstrated in Graph 5.



Graph 5: Operational systems that would most benefit from the machine intelligence and robotics technology

Source: Prepared by the authors

Subsequently the question concerning which application might be obtained by employing this Machine Intelligence and Robotics technology, resulted in responses pictured in Figure 6.

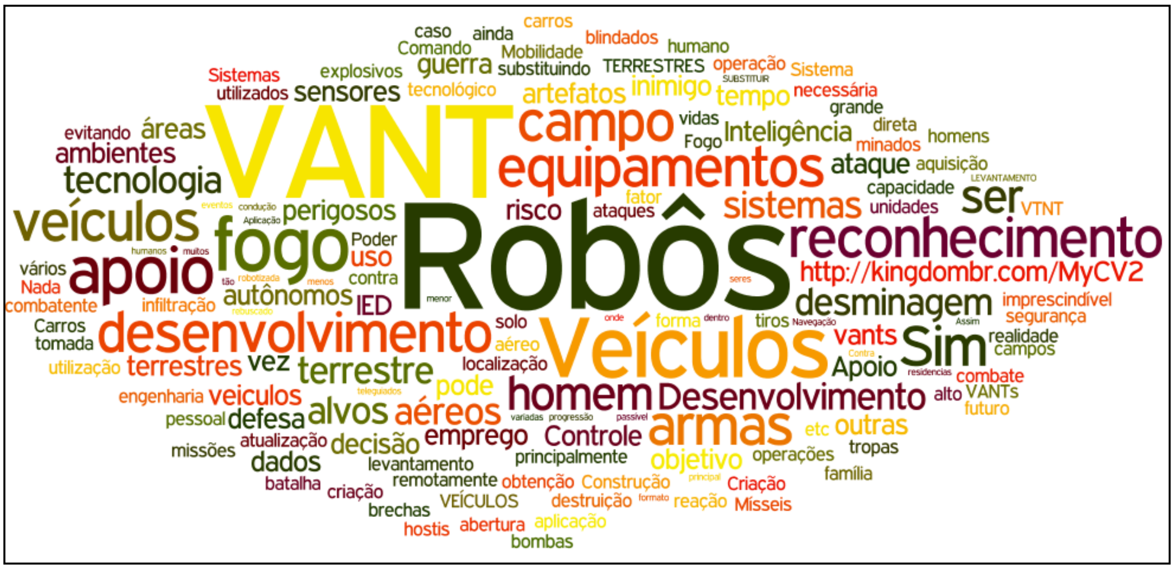


Figure 6: Possible applications of the technology grouped as machine intelligence and robotics

Source: Prepared by the authors

By analyzing and combining the result of the first question with the result of the second question, one may draw some conclusions as to possible applications that ought to be developed to address the needs of the Brazilian Army by 2030. For instance, unmanned aircrafts (Intelligence), mine clearance robots (Mobility, Counter-mobility and Protection), combat robots (Maneuver) and so forth. Figure 7 illustrated some Machine and Robotic technology applications for the mentioned operational systems.

VANT for Intelligence

Combat robot for Maneuvers

Mine clearance robot for Mobility, Counter-mobility and Protection

Figure 7: Operational systems and possible Machine Intelligence and Robotics technology applications

Source: Prepared by the authors

4.3 THIRD PHASE: DEFENSE INDUSTRY PROSPECTIVE SCENARIOS

The third phase of the field survey was primarily quantitative and focused on year 2030 defense industry scenarios. Themes that called for clarification were presented so as to shape a panorama of the Defense Industry in 2030. For each theme, a brief introductory text and three previously defined possible futures, called "scenarios" were presented. Each scenario is named and described in the following manner: Scenario X (name): description.

Consider for instance theme 1: Development of Independent Technological Skills. To the respondent, the following text on the theme is presented: "The Defense Industry will seek the development of independent technological skills. This goal will condition partnerships with foreign countries and companies to the gradual development of research and production in Brazil" (Brasil, 2008).

Subsequently the respondent is informed that, in as much as the theme Development of Independent Technological Skills is concerned, the scenarios hereunder described are envisioned:

- Scenario 1 (full technological independence): In 2030, Brazil advances in a significant manner in R&D of technologies of defense interest and attains full technological independence.

- Scenario 2 (poor technological dependence): In 2030, Brazil advances to a reasonable extent in R&D of Defense interest and attains technological

Independence in most of the areas deemed strategic such as space, cybernetic and nuclear, but remains dependent in other strategic fields of interest.

- Scenario 3 (strong technological dependence): In 2030, Brazil hardly advances in terms of R&D concerning Technologies of Defense interest in some areas, but remains dependent in most strategic areas such as space, cybernetic and nuclear.

To recognize and better appreciate the opinion of respondents who detain more extensive knowledge of the subject matter, weights were assigned to each level of knowledge, as follows:

- expert: weight 16;
- self-taught: weight 8;
- seeks information/updating: weight 4;
- poor knowledge: peso 2;
- complete absence of knowledge/unaware: weight 1.

Thus, for each question, the following calculation formula was applied:

X = (expert*16+self-taught*8+informed*4+poor_knowledge*2+unaware)/31

All in all, 20 themes were explored, whereby 4 pertained to CBC (Cross Border Cooperation), 5 to the field of economics, 3 referred to military matters, 4 to the field of politics and 4 to the social field as demonstrated in Chart 2.

Chart 2: Scenario analysis fields and themes

Field	Theme
CBC (Cross border Cooperation)	Development of Independent Technological Skills
Economics	Integration of Research with Production
Economics	Establishment of a Special Ruling and Tributary Régime
Military	Armed Conflict Outbreak in South America
CBC (Cross border Cooperation)	Defense Products and Services Technological Content Expansion

Social	Human Resource Skill Level Elevation
Military	Brazilian Participation in Peace Operations
Military	Expansion of Brazil´s Military Cooperation with Other Countries
Economics	Participation of Foreign Companies in Brazil
Politics	Development of Nuclear Weapons
CBC (Cross border Cooperation)	Improvement of the R&D Infrastructure
Economics	Formation of a Favorable to Innovation Environment
Economics	Implementation of Financing Mechanisms
Social	Society´s Interest in Defense Matters
Politics	Integration of CB&IC (Cross Border & International Cooperation) of Defense Interest
Social	Establishment of Policies Recognizing/Appreciating Human Resources
Politics	Implementation of Strategic Planning Systematics
Politics	Defense Budget
Social	Participation of Armed Forces in Police Operations
CBC (Cross border Cooperation)	Formation of a Defense Technological Center/Area

For each theme and respective possible scenarios, five questions were asked. The first question referred to the probability of a given scenario occurring by 2030. Each scenario could present one of the following probabilities (P) of occurrence:

- occurrence is highly probable (P=83%);
- occurrence is probable (P=66%);
- the chance of occurrence is the same as that of non-occurrence (P=50%);
- non-occurrence is probable (P=33%);
- non-occurrence is highly probable (P=16%).

Each scenario´s probabilities are presented in Table 1.

Table 1: Individual theme scenario probabilities

	Scenario 1	Scenario 2	Scenario 3
Theme 1	36	55	51
Theme 2	54	55	39
Theme 3	47	55	50
Theme 4	38	49	52
Theme 5	50	53	50
Theme 6	51	52	56
Theme 7	64	59	38
Theme 8	50	60	47
Theme 9	47	62	53
Theme 10	36	65	40
Theme 11	46	54	32
Theme 12	50	58	45
Theme 13	47	57	49
Theme 14	41	52	52
Theme 15	50	58	49
Theme 16	46	57	55
Theme 17	53	60	43
Theme 18	44	59	46
Theme 19	60	57	41
Theme 20	50	56	46

Source: Prepared by the author

The second question referred to the impact that a given scenario would have on the Brazilian Defense Industry should it come about. Each scenario, in the event of occurrence, could promote one of the following impacts (I):

- very positive (I=+2);
- positive (I=+1);
- neutral (I=0);
- negative (I=-1);
- very negative (I=-2).

Each scenario´s impacts are presented in Table 2.

Table 2: Individual theme scenario impacts

	Scenario 1	Scenario 2	Scenario 3
Theme 1	1,7	0,5	-1,4
Theme 2	1,8	0,0	-1,6
Theme 3	1,8	0,8	-1,5
Theme 4	0,9	0,3	-0,1
Theme 5	1,8	0,4	-0,5
Theme 6	1,9	0,0	-0,6

Theme 7	1,3	0,4	-1,0
Theme 8	1,6	0,7	-1,0
Theme 9	1,7	0,2	-1,0
Theme 10	1,0	0,9	-1,2
Theme 11	1,8	0,7	-1,4
Theme 12	1,8	0,7	-1,4
Theme 13	1,9	0,7	-1,3
Theme 14	1,6	0,6	-1,3
Theme 15	1,8	0,7	-1,1
Theme 16	1,7	0,6	-1,4
Theme 17	1,6	0,5	-1,4
Theme 18	1,8	0,0	-1,7
Theme 19	0,4	0,1	-0,3
Theme 20	1,8	0,2	-1,4

Source: Prepared by the authors

The third question focused on probable time-frames for the scenarios presented to come about. Each scenario could occur within one of the following time spans:

- short term (valor = 2015);
- mid term (valor = 2022);
- long term (valor = 2030); e
- beyond 2030 (valor = 2055).

Each scenario´s term for occurrence is presented in Table 3.

Table 3: Estimated term for scenario occurrence

	Scenario 1	Scenario 2	Scenario 3
Theme 1	2050	2028	2020
Theme 2	2041	2024	2019
Theme 3	2042	2026	2017
Theme 4	2042	2028	2023
Theme 5	2039	2023	2021
Theme 6	2039	2024	2024
Theme 7	2027	2020	2033
Theme 8	2036	2023	2024
Theme 9	2042	2024	2021
Theme 10	2046	2025	2021
Theme11	2043	2025	2017
Theme12	2040	2023	2020
Theme13	2037	2023	2020
Theme14	2042	2025	2020
Theme15	2038	2024	2019
Theme16	2039	2025	2020

Theme17	2036	2024	2020
Theme18	2034	2021	2028
Theme19	2026	2021	2034
Theme20	2040	2024	2021

Source: Prepared by the authors

The fourth question was about the relevance of the theme presented in as much as defining scenarios for the Defense Industry by 2030 is concerned. Thus, as to relevance, themes could be:

- extremely relevant (valor = 5);
- very relevant (valor = 4);
- relevant (valor = 3);
- poorly relevant (valor = 2);
- irrelevant (valor = 1).

Accordingly, the scale of theme relevance ranges from 1 to 5 and results are presented in Table 4.

Table 4: Theme relevance

	Theme Relevance
Theme 1	4,6
Theme 2	4,6
Theme 3	4,3
Theme 4	4,0
Theme 5	4,2
Theme 6	4,6
Theme 7	3,7
Theme 8	4,1
Theme 9	4,1
Theme 10	3,9
Theme 11	4,5
Theme 12	4,3
Theme 13	4,4
Theme 14	4,0
Theme 15	4,2
Theme 16	4,3
Theme 17	4,1
Theme 18	3,2
Theme 19	4,6
Theme 20	4,1

Source: Prepared by the authors

Finally, each scenario´s risks were quantified using as risk definition the product of the probability given impact (R=PXI), in compliance with the ISO/IEC Norm Guide 73 (ISO, 2002) and the United Kingdom´s Risk Management Norm (FERMA, 2012).

To this effect, Table 1 values were multiplied by Table 2 values. The result was normalized according to a 0 to10 scale so as to facilitate comprehension, using the following standardization formula:

R={[(P*I)*(-1)]+200}/40

Thus, risk varies from 0 (minimum risk, when L = 100 and I = +2) to 10 (maximum risk, when L = 100 and I = -2), as presented in Table 5.

Table 5: Individual theme scenario risk

	Scenario 1	Scenario 2	Scenario 3
Theme 1	3,4	4,3	3,2
Theme 2	2,5	5,0	6,6
Theme 3	2,9	4,0	6,9
Theme 4	4,2	4,6	5,2
Theme 5	2,7	4,5	5,7
Theme 6	2,6	5,0	5,8
Theme 7	2,9	4,5	5,9
Theme 8	3,0	4,0	6,2
Theme 9	3,0	4,7	6,3
Theme 10	4,1	3,6	6,2
Theme 11	3,0	4,1	6,1
Theme 12	2,7	4,0	6,5
Theme 13	2,8	3,9	6,6
Theme 14	3,3	4,2	6,6
Theme 15	2,7	4,0	6,4
Theme 16	3,0	4,2	6,9
Theme 17	2,8	4,2	6,5
Theme 18	3,0	5,0	6,9
Theme 19	4,5	4,8	5,3
Theme 20	2,8	4,7	6,6

Source: Prepared by the author

These tables enable a variety of analysis. Analysts may be interested in the most probable scenarios, in scenarios of greatest negative impact, in those of greatest risk, shortest term and may even discard less relevant themes to simply the analytical process, amongst other options. For instance, if one analyses

Theme 4´s three scenarios, it becomes evident that Scenario 3 simultaneously presents the highest values for both variables probability and risk. The same occurs with Theme 6´s Scenario 3. Consequently, the analyst may suggest a given action or specific strategy to deal with these possible futures.

In the case of Theme 6´s Scenario 3, this might be: "the Armed Forces prioritize human resource skill development in areas that are in alignment with National Defense programs and projects. However, scientific-technological interchange of military institution R&D´s with those of Brazil and abroad does not occur, thus hindering the country´s access to technologies of National Defense interest". Given the above, a possible strategy that might be suggested would include: "foster technological-scientific interchange of R&D military institutions with institutions of the kind in Brazil and overseas", which would lead to the following possible strategic actions:

- establish joint R&D agreements between military educational and research institutes and universities in Brazil and abroad; and
- set-up national military R&D institution offices at universities and research centers, in Brazil and abroad, and vice-versa.

5 FINAL CONSIDERATIONS

This was the first time this kind of research work was conducted at the Brazilian Army. The task required stamina and was deemed far-reaching, lasting approximately 4 years, from 2008 to 2012, collecting the opinion of nearly 2.000 (two thousand) respondents from diverse areas of Brazil´s society.

The survey enabled the mapping of systems and materials of military use that the Brazilian Army will require by 2030. Technologies that ought to be researched so as to support the development of such systems and materials were also identified. Finally, scenarios for the year 2030´s national defense industry were prepared since it will be up to this industry to manufacture the required systems and materials. With these scenarios in hands, strategies and courses of action can be designed to foster Brazil´s Defense Industry Base.

This research will significantly contribute with the Brazilian Army in as much as preparing a Force project that will transform today´s Army into an Army of the future, by 2030.

However, most importantly, this study enabled the experimenting of Foresight techniques and methods, promoting the acquisition of precious knowledge amongst both researchers and professionals involved, which will certainly be improved as time goes by. The capability acquired in the field of future studies is invaluable for the Army, for Defense and for Brazil.

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