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Application of dynamic Balanced Scorecard in the Brazilian Army information technology governance

Aplicação do Balanced Scorecard Dinâmico na governança da informação do Exército Brasileiro

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Abstract: This study aimed the development of an IT Balanced Scorecard based on dynamic systems approach – IT DBSC. The research strategy was a single case study about the process of IT strategic management with the use of the BSC in the Brazilian Army's Telematics System (SisTEx), through qualitative and a quantitative modeling. We performed a BSC document analysis and strategic maps of SisTEx's military units, as the researcher participative observer and confirmatory simulation on proof context. The results sustained the established study propositions, according to causal and effect relationships and delay times considered between strategic objectives, which allowed the simulation of the proposed model.

Keywords: Balanced Scorecard; IT Governance; System dynamics; Dynamics Balanced Scorecard; IT Dynamic Balanced Scorecard.

Resumo: *O objetivo deste estudo é o desenvolvimento de um modelo de Balanced Scorecard de TI sob o enfoque da dinâmica de sistemas – BSCD de TI. Para isso, foi realizada modelagem qualitativa e quantitativa para a construção e simulação do referido modelo, a partir da realização de estudo de caso sobre o processo de gestão estratégica de TI do Sistema de Telemática do Exército Brasileiro – SisTEx. O estudo apoiou-se em análise documental dos BSC e mapas estratégicos das organizações militares que compõem o SisTEx, na condição de observador participante do pesquisador, e no emprego da técnica de simulação confirmatória sobre o modelo desenvolvido, em contexto de prova. Os resultados comprovaram as proposições estabelecidas no estudo, através do estabelecimento de relações de causa e efeito e consideração de tempos de espera entre os objetivos estratégicos, viabilizando a simulação do modelo proposto.*

Palavras-chave: *Balanced Scorecard; Governança de TI; Dinâmica de sistemas; Balanced Scorecard Dinâmico; Balanced Scorecard Dinâmico de TI.*

1 Introduction

One of the reasons why organizations face difficulties in the deployment of their strategies is the use of inadequate gauging tools for a dynamic economy dominated by intangible assets (Costa, 2004). Kaplan & Norton (1997) developed Balanced Scorecard (BSC), a strategic management system that complements the traditional measures with focus on the financial dimension, past performance and tangible assets, with new indicators, based on future performance and distributed in learning and growth perspectives; internal processes; and clients.

The operationalization of BSC occurs through a visual representation of the cause and effect relations between organizational strategic components. This is the strategic map, which is considered to be as important as BSC itself (Kaplan & Norton, 2004), as it communicates how an organization reaches its strategic objectives (Fernandes, 2003). Thus, it supports senior management in the development of cause and effect relations among the strategic objectives of the BSC perspectives, in order to better understand the business and its dynamics (Capelo & Dias, 2009).

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This context is relevant to the Information Technology (IT) area, as it supplies the essential infrastructure and the strategic applications that complement human capital for the promotion of an outstanding performance of the organizational themes (Kaplan & Norton, 2004). It is important to point out that IT-Business strategic alignment is one of the main organizational concerns (Luftman & Ben-Zvi, 2011) and one of the chief areas of IT governance foccus (ISACA, 2012).

IT governance seeks desirable behaviors in the use of IT through specification of decision rights and accountability models (Weill & Ross, 2006). Models of this governance, such as COBIT 5 – a comprehensive model that focuses on auditing and IT process control (ISACA, 2012) – and ITIL V3 (TCO, 2011) – a model with the best practices for IT service management used by providers of these services (TCO, 2011) –, recommend BSC to align IT strategic objectives with those of the business area.

In spite of the success and recognition achieved by BSC even in IT governance, it presents some serious structural problems associated to its development (Barnabè, 2010; Lyell & McDonnell, 2007; Costa, 2004; Fernandes, 2003), three of which are of interest in this study. The first one derives from the unidirectional cause and effect relations between the strategic objectives of the four perspectives, without any feedback. Thus, there is a relative simplification in the strategic map, as all the causality relationships must point in the direction of the financial perspective.

The second structural problem, still related to the strategic maps, occurs due to disregard of the possible delays and the different development velocities between the cause and effect relations (Nielsen & Nielsen, 2013; Fernandes, 2002). After all, time and velocity are disregarded in the development of causality relations between the strategic objectives, giving the impression that all the planning will provide results at the same time. This can lead to mistakes in decision-making, as managers can interpret the results of variables that evolve at different velocities as errors in the planning process.

The third structural problem is the result of the two previous problems. The lack of temporal representation, the unidirectionality and differences between the response velocities of the strategic objectives make the development of simulations difficult, impeding the understanding of future modelling of consequences regarding organizational strategy through the traditional BSC (Fernandes, 2003). After all, this strategy will not be true to the systemic reality of the business environment and, consequently, will prevent the assumption that a strategic decision will provide the impact foreseen on future performance (Fernandes, 2003).

In light of this, when incorporated into the IT governance models such as COBIT 5 and ITIL V3, for example, the traditional BSC may contaminate them with their structural issues, negatively influencing the decision-making process and the IT-Business strategic alignment. In order to avoid this, the suggestion is to incorporate the system dynamics with more accurate results for the organizations (Kozena et al., 2011) through the Dynamic BSC – or DBSC. The DBSC is a strategic management system that uses the essential concepts from the traditional BSC; however, it incorporates modelling tools and simulations of system dynamics (Capelo & Dias, 2010).

In this context, the following research question will be dealt in this study: How can DBSC be applied in IT governance? To answer it, the objective of this study is the development of an IT BSC model through system dynamics perspective – or IT DBSC.

2 System dynamics

System Dynamics (SD) is an area of knowledge recently applied within the managerial context and its concepts are within the scope of System Theory, which tries to improve the understanding of a system over time by modelling its behavior (Nielsen & Nielsen, 2013; Vitor et al., 2007). The delays between actions, their consequences and the feedback mechanisms that influence the system's behavior and define its structure are considered in this modelling (Barnabè, 2010; Lyell & McDonnell, 2007; Costa, 2004; Fernandes, 2003).

Thus, SD seeks to map organizational or social structures, aiming at understanding the intrinsic power relations that operate in these structures and studying them as part of an integrated process (Nielsen & Nielsen, 2013). Furthermore, it uses the simulation technique to understand how these processes evolve over time, as well as how the impacts from the changes in parts of these structures can affect in the overall behavior of the sytsem (Bastos, 2003).

2.1 Feedback, reinforcement and balance loops

A feedback cycle system is influenced by its own previous behavior, based on a closed circuit where the results obtained in the outflows of a process can influence its inflows, thereby creating a causality without a unique direction (Kronmeyer, 2006). The feedback cycle system is the basis of the dynamic strategic map (non-linear) proposed by Fernandes (2003), where the strategic objectives of the BSC perspectives have feedback in their causal relations.

When two or more variables form a closed relation loop (complete cycle), where the first influences the second, the second a third, and so on, until the last variable generates an influence over the first variable

considered, there is a feedback loop (feedback cycle). These loops are responsible for reinforcement (positive) or balance (negative) mechanisms, which influence the system's behavior (Fernandes, 2003). In a closed cycle (loop), this results in enhanced behavior of a certain variable, as from the influence of other variables in the cycle, or even reduction or stagnation of a certain behavior.

The reinforcement loops have a more predictable behavior, as the variables reinforce or accelerate the initial change, and have an exponential behavior, either increasing or decreasing, which can occur in an undefined manner, unless limiting variables are introduced (Costa, 2004). The balance loops occur when there is a relation or when an odd numer of loop relations are negative. Thus, the balance loops limit the initial direction of the change in the variables (Bastos, 2003).

2.2 Qualitative and quantitative modelling

System modelling can be classified as **soft**, which is more subjective and focused on the qualitative aspect and on systemic learning, through the causal-looping diagrams; and **hard**, with a quantitative focus directed at simulation and decision-making (Capelo & Dias, 2010; Costa, 2004; Fernandes, 2003), through stock and flow diagrams. The integration of these two modelling approaches allows for better understanding of the internal dynamics of a certain system and projects the impact of decisions over time, suggesting that the soft modelling precedes the hard one in

providing better understanding of the simulation model (Vitor et al., 2007).

2.2.1 Causal-looping diagrams

Also known as causals (or of influence, feedback or loop), causal-looping diagrams allow for greater understanding through their construction simplicity and representation (Vitor et al., 2007; Costa, 2004). They represent the variables of the model and the cause and effect relations between them, enabling us to identify interactions and their influences in the dynamics of the system's structure. Besides, they have two important purposes, being the first to serve as an outline for causal hypothesis and the second to simplify the model design (Bastos, 2003).

According to Bastos (2003), a *loop* (or feedback structure) occurs in causal-looping diagrams whenever an action provokes a consequence, which will go back to influence that action. It can be quick and direct - or even indirect and long term -, which provokes delays according to that illustrated in Figure 1.

2.2.2 Stock and flow diagrams

The stock and flowdiagramsallow for the development of mathematical approaches focused on computational simulation, as they demand more thoroughness in the system's functional behavior (Vitor et al., 2007; Costa, 2004). Any system – natural or artificial – can be described through a stock and flow diagram, which is composed of four elements, described in Chart 1 and illustrated in the quadrants of Figure 2 (Fernandes, 2003).
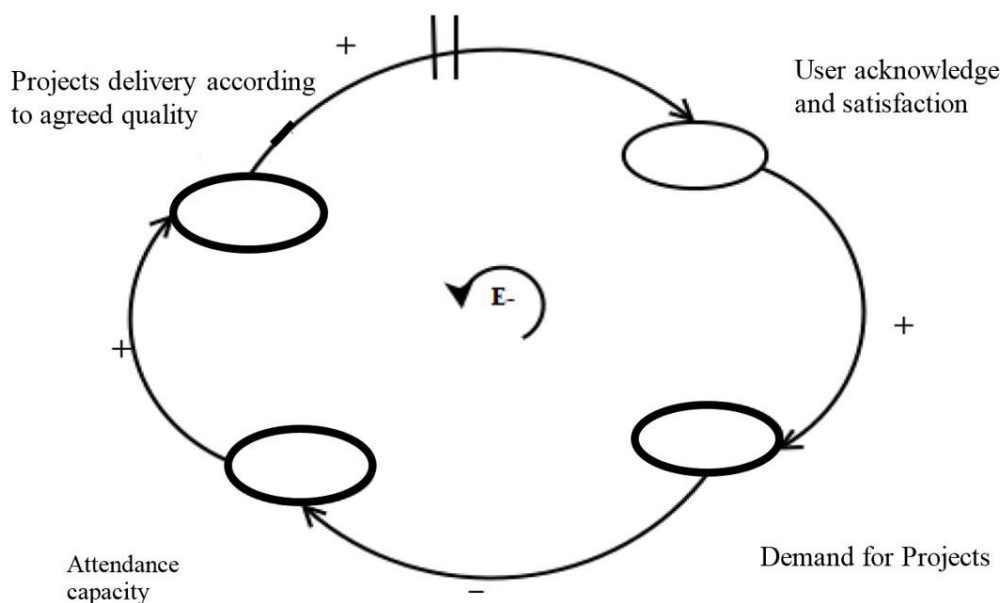

Figure 1. Causal-Looping Diagram. Source: Fernandes (2003), adapted by the Authors.

Chart 1. Elements of the stock and flow diagram.

Elements	Description
Stock (Quadrant 1)	Represents the resources accumulated, for example, the number of projects requested by clients.
Flows (Quadrant 2)	These are the activities that produce an increase or reduction of stocks, through subject or information movement within the system analyzed.
Converter (Quadrant 3)	Component that signals algebraic operations, processes information about stocks or represents information sources that are external to the system considered.
Connector (Quadrant 4)	An information *Link* that describes the relation between the stocks, flows and converters.

Source: Fernandes (2003), adapted by the Authors.
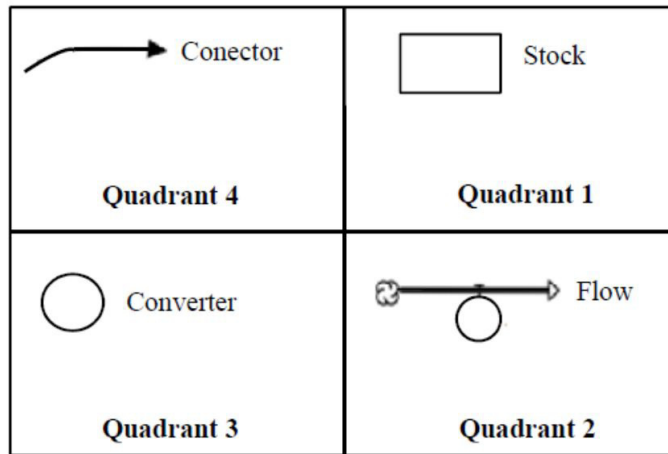
Figure 2. Elements of stock and flow diagrams.

2.3 Dynamic bsc and strategic map

DBSC allows managers to develop a quantifiable model of the strategic management system developed for the organization, which can explore the effect of *feedbacks*, delays and emerging properties, as well as the simulation test for a series of strategies before their execution. Therefore, the DBSC construction process forces managers to detail their mental models and share them, challenging internal consistency and aligning them (Akkermans & Oorschot, 2002). This allows managers to think "outside the box" (Rydzak et al., 2004).

Thus DBSC updates the original strategic map with the effects described in the strategic map with flows that occur in the organization, offering more precise and complex information (Capelo & Dias, 2010; Kozena et al., 2011), by means of a dynamic strategic map. Kozena & Chládek (2010) and Fernandes (2003) proposed this map with the same perspectives of the traditional BSC, however with the feedback cycles and the delays of the cause and effect relations foreseen in the SD.

Therefore, the whole causality chain, previously built in a unidirectional manner, begins to complement the feedback between strategic objectives and perspectives, as well as the delays between the strategic results. This complements the original

(traditional) strategic map and reflects the dynamics of the strategic variables more efficiently, aiming at management sustainability (Kronmeyer, 2006) with more effective decision-making in terms of organizational reality.

2.3.1 Phases, steps, stages and tasks

In the qualitative modelling phase (*soft*), aiming at the development of causal-looping diagrams, Fernandes (2003) adopted the following steps, as from Senge (1996): 1) definition of a situation of interest that must be important and complex for the organization; 2) presentation of the track record of the events, marking those relevant to the situation over the period of time considered; 3) identification of key factors, with the identification of those that must be taken into consideration to understand the situation; 4) behavior observation, observing the behavior standards of the key factors; 5) identification of influences, with the identification of causality relations between the factors; and 6) identification of mental models, aiming at identifying beliefs and prerequisites that can help in the creation of the diagram.

In the quantitative modelling phase (hard), aiming at the transformation of causal-looping diagrams into

stock and flow diagrams, Fernandes (2003) used the following four steps suggested by Wolstenholme (1994), whose logical sequence helps to understand this transformation: 1) identify resources contained in the causal-looping diagram factors, observing that resources flow through the system in the formation of stocks; 2) identify the state of the resources during the transformation inside the system, giving rise to stocks; 3) identify operations that transform resources between states; and 4) model causal-loopings and other factors, which are not considered resources (stocks) or operations (flows), i.e., the converters.

Vitor et al. (2007) suggest a model for the development of DBSC using five stages, where the qualitative and quantitative models stand out, according to Chart 2, establishing tasks.

2.3.2 IT DBSC research model

The structural issues found in the traditional BSC are applicable to the IT context, as it is indicated by models recognized by IT governance, such as COBIT 5 and ITIL V3, which can lead the IT area to make mistakes in its strategic dynamics.The solution proposed in this study is the incorporation of system dynamics to the IT BSC, as the lack of feedback and the delays regarding the cause and effect hypotheses distort the understanding of strategic behavior dynamics. Thus, the IT strategic objectives can only be tested during strategy deployment, as the anticipated understanding of strategy formulation errors and issues will be suspended until they emerge (Fernandes, 2003). As a result, the following proposals arise as a guide to this study:

P1: The use of soft modelling of system dynamics mitigates the issue of linear, unidirectional and static cause and effect relations of the IT BSC;

P2: The use of hard modelling of system dynamics allows for a better understanding of organizational dynamics; and

P3: The simulation of IT DBSC allows for the anticipated knowledge of the negative and positive impacts of IT organizational strategy.

The development of an applicability model of DBSC as an IT governance mechanism must follow the DBSC construction steps, however using the structure of the strategic map with the peculiarities inherent to IT behavior. Therefore, this study is based on the five stages proposed by Vitor et al. (2007), as well as on the steps from Senge (1996) on the construction of causal-looping diagrams (qualitative modelling) and those of Wolstenholme (1994) on the transformation of these diagrams into stock and flow diagrams (quantitative modelling), described before, adding three assumptions described in Chart 3, outlined by Fernandes (2003).

3 Methodology

This applied descriptive-exploratory research is developed under a mixed method with the strategy of a single study case.

3.1 Unit of analysis

The unit of analysis of the case is the strategic IT management process with the use of BSC by the Brazilian Army's Telematics System - SisTEx. Therefore, the location of the research is SisTEx, which is composed of the Army's Integrated Telematics Center (CITEx) and 12 Telematics Area Centers (CTA). Listed on Chart 4 with their respective locations and coverage areas, these centers are active throughout the national territory with a total of 13 Military Organizations (OM) that provide IT services.

SisTEx has the institutional mission of supplying the physical and logical bases for the working of the systems of interest of the Army's Command and Control Strategic System (SC²Ex), its integration in the Land Force Command and Control System (SC²FTer) and in the Military Command and Control System (SISMC²). It also explores, maintains and

Chart 2. Stages in DBSC construction

Stages	Tasks
Start	• Formulation and understanding of the organizational mission and vision.
Construction of the Map	• Establishment of strategic objectives in cause and effect relations; and • Definition of indicators.
Qualitative Modelling	• Identification of critical variables for the organization; and • As from these critical variables and the strategic objectives, construct the dynamic strategic map through the causal-looping diagram.
Quantitative Modelling	• Construction of DBSC through stock and flow diagrams; and • Simulation of the DBSC model.
Analysis of organizational factors	• Analysis of the behavior of critical variables for the organization.

Source: Vitor et al. (2007), adapted by the Authors.

Chart 3. Assumptions for the IT DBSC.

Assumptions	Description
Indicators	• Every measure that composes an indicator must come from the organization processes, either financial, marketing operational or human resources processes.
Critical variables to business dynamics	• For the construction of the causal-looping diagram, variables that can materialize some condition of state (stock) that have a relevant role in the organizational performanece must be outlined; • These variables can be extracted from the indicators or from the strategic objectives of the strategic map; and • This list of variables characterize business dynamics and it is important for them to be able to assume numerical values.
Quantitative Information	• It is necessary to have a quantitative survey of the variables as from the list of variables; and • Obtain information that makes it possible to observe the behavior of variables over time, without any claim to accuracy in the values.

Source: the Authors, as per Fernandes (2003).

Chart 4. Military organizations of SisTEx.

OM	Location	Area of Influence (States)
CITEx	Brasília–DF	All the national territory
1st CTA	Porto Alegre–RS	Rio Grande do Sul
2nd CTA	Rio de Janeiro–RJ	Rio de Janeiro and Espírito Santo.
3rd CTA	São Paulo–SP	São Paulo
4th CTA	Manaus–AM	Amazonas, Acre, Rondônia and Roraima.
5th CTA	Recife–PE	Pernambuco, Paraíba, Rio Grande do Norte and Alagoas.
6th CTA	Campo Grande–MS	Mato Grosso do Sul and Mato Grosso.
7th CTA	Brasília–DF	Distrito Federal, Goiás and Tocantins.
11th CT	Curitiba–PR	Paraná and Santa Catarina.
21st CT	Belo Horizonte–MG	Minas Gerais
41st CT	Belém–PA	Pará and Amapá.
51st CT	Salvador–BA	Bahia and Sergipe.
52nd CT	Fortaleza–CE	Ceará, Maranhão and Piauí.

Source: the Authors, according to data from CITEx.

accomplishes the technical management of the Army's Strategic Communications System (SEC), which provides an adequate level of information security. CITEx is the central coordination and execution unit directly subordinated to the Department of Science and Technology (DCT). SisTEx provided all the data used in this research, through documents, information systems and publications.

3.2 Research stages

The results and analysis of this research were developed in qualitative and quantitative phases, with the use of a protocol that had its identification (project title, person in charge, sponsoring entity, teams, time frame and location), introduction (objetives and justifications), stages of field work, field issues, analysis procedures for data collected and the report structure of the study. It must be highlighted that any pressumption used during the qualitative and quantitative stages was based on documents and/or rules used in SisTEx, which were validated before

used by two strategic level military personnel: the Head of the CITEx Technical Division and the Head of the Planning, Integration and Control Area.

3.2.1 Qualitative

This phase was developed with the analysis of documents and with the researcher's participant observation. The first, which consists in identifying, verifying and appreciating documents with the objective of making them more understandable, so that they can be correlated to the other data from other sources (Souza et al., 2011), was done with the BSC and OM strategic maps. The objective was to select BSC and OM strategic maps that clearly showed how IT would contribute towards business expectations, as well as having a complete definition of the causality chain between the strategic objectives, as this study does not aim at correcting OM strategies.

From the BSC and the strategic map selected from one of the OM of SisTEx, the causal-looping diagram was constructed based on the phases, tasks, steps

and assumptions indicated in this research model (Vitor et al., 2007; Senge, 1996; Fernandes, 2003), with the participation of a representative from Senior Management, a representative from the managerial level and one from the CITEx operational level, as part of the researcher's participant observation.

3.2.2 Quantitative

The proposed IT DBSC model in this stage was simulated and constructed based on a stock and flow diagram arising from the transformation of the causal-looping diagram developed in the qualitative phase, as from stages, tasks and assumptions indicated in this research model (Vitor et al., 2007; Wolstenholme, 1994; Fernandes, 2003). The participants in the stock and flow diagram construction process were one representative from Senior Management, one representative from the managerial level and one from the CITEx operation level. The diagram was validated by the Head of the Planning, Integration and Control Area (SPIC) at SisTEx; by army personnel from SPIC with knowledge of the system; by the Heads of the CITEx Technical Division and the 4th CTA; and by military personnel from several operational areas of SisTEx.

After that, IT DBSC was exposed to a confirmatory simulation within a proof context, as it was based on an empirical model and data (Vicente, 2005) with the purpose of proving the theory about inherent structural defficiencies in BSC and their negative consequences for IT governance. The modelling and simulation were developed with the software IThink (Isee Systems, 2012), aiming at evaluating the dynamic model constructed. The results were assessed by specialists in simulation techniques and tools, as well as by key people in the research organization.

4 Results and analysis

The results and analysis of this research are distributed into the qualitative phase, where the causal-looping diagram is developed, and into the quantitative phase, which from this diagram elaborates and submits the model to simulation, discusses the arising results and proposes a model for migration from BSC to DBSC, in the domain of IT governance.

4.1 Qualitative phase

Following the selection criteria defined according to the document analysis and for the development of the causal-looping diagram, the strategic maps and BSC of the 3rd and 4th CTA were previously chosen. However, the documents of the 4th CTA were adopted due to easy access and the familiarity the researcher had with its processes, besides the fact that this Center sent its management model to the Amazon Quality Program (PQA), which makes its BSC a strategic driver validated annualy by the referred program.

4.1.1 Strategic map, BSC and strategic topics of the 4th CTA

In April 2009, the 4th CTA began the implantation of quality management tools suggested by the National Quality Foundation (FNQ) and of governance and IT management models. This aimed at increasing the quality of IT service delivery and, consequently, improving user satisfaction. Its region of coverage (the Amazon) is characterized by serious logistics and access problems, which create an impact in high cost IT solutions with great difficulties regarding maintenance. In this scenario, the 4th CTA decided to adopt BSC as a way of reducing these difficulties and creating a new culture that values strategic and process management, as well as the planning and development of highly motivated labor guided towards IT services.

The strategic map and the BSC of the 4th CTA are divided into these three strategic topics:

1) Increase the Understanding of the Center's Mission, which has the objective of increasing the strategic presence of the Center and having the best alignment of its services according to its clients' needs;

2) Improve the Quality of Delivery and Support of IT services, according to processes that comply with the best practices in IT service management models, such as ITIL V3; and

3) Achieving Maturity in Project Management, aiming at project management culture, quality of management, adequate organizational atmosphere, and optimization of acquisition processes for goods and services.

The division into strategic topics makes the development of causal-looping diagrams easier, using the steps proposed by Senge (1996) described in the model of this research for IT DBSC.

4.1.2 Description of the situation of interest and track record of the events

In 2011, the 4th CTA performed a comprehensive review of its strategic map to understand a few problems that came up in the first biennium (2009-2010) that escaped BSC logic. The first referred to the motivation rate of the workforce, which did not increase and in some areas even diminished, in spite of heavy investment in training. The second

involved the satisfaction rate of service users that remained stable despite the strategic focus given to addressing their needs.

Considering the logic of the map from Strategic Topic 1 (Increase the Understanding of the Center's Mission), for example, the support and increase in financial revenue indicated it was possible to invest increasingly in human capital, which when trained and valued would reflect directly on the well-being of the workforce, increasing motivation. The result of a highly trained team, following the logic of causality between strategic objectives on the strategic map, would deliver IT services and projects of high quality, significantly increasing user satisfaction. In spite of the enhanced service delivery, as well as speed and quality in the delivery of projects, there was no significant increase in user satisfaction.

4.1.3 Identification of critical variables

In the construction of the causal-looping diagram, we must focus on the critical variables of business dynamics that can materialize some condition of state (stock) with a relevant role in the organizational performance, as well as being able to take on numerical values. They can be extracted from indicators or strategic objectives of the strategic map. In this context, it can be observed an implementation error in all the OM BSCs of SisTEx, as the indicators used mostly do not materialize into some condition of state, nor do they follow the strategic causality defined by the strategic map.

We notice that the more resources are passed on to OM, the more strategic competencies will be developed. Mapping this causality sequence is quite simple and even logical to some extent. However, when concentrating on the next two strategic objectives, we note that the indicators used and the existing strategic objectives will not be able to materialize a condition of state. This is explained in the model of this research for IT DBSC with regard to the indicators where every measure that composes an indicator must come from the organization processes, whether they are financial, marketing, operational or human resources processes, for example.

Due to increased training, which had the objective of contributing towards the motivation of military personnel, the strategy intended to Ensure Alignment of the Main IT Services with User Needs, according to the map of Strategic Topic 3 (Achieving Maturity in Project Management). Satisfaction with the Services Rendered and Satisfaction with the User Service are the two indicators pointed out in the BSC of Strategic Topic 3 as possible measures of this strategy. However, systemic difficulty is determined when making these measurements, taking into consideration the indicator in the previous perspective, i.e., Percentage of Strategic Competencies Developed. After all, considering the previous perspective, there are no organizational processes that can indicate how this percentage can mathematically influence the two indexes. There is clear causality between objectives, but not between indicators.

In the absence of an indicator (or measure) that can be transformed into a condition of state, we will not use the BSC indicator and what it intended to measure, but the indicator of what it should measure, obeying an internal organizational process. After all, for the simulation it is more important to enable the observation of the variable's behavior than outlining its value accurately (Fernandes, 2003). In this sense, considering the action of SisTEx as an IT service provider, the addressing of user needs, via services and projects, is considered a systemic priority.

Table 1 presents the indicators of BSC used as reference (that intended to measure) and the new indicators used in the simulation (that should measure) with DBSC, as the mistakes in the construction of the original BSC, due to the lack of perspective of the DS, made the construction of the simulation unfeasible. The strategic CITEx map highlights this priority in its User perspective, where the strategic objective is to Guarantee the Addressing of User Needs. Thus, they decided to deal with the map of Strategic Topic 3 from the 4th CTA, as it included the variables described in the problems presented in the execution of the strategy.

Therefore, these three variables were considered and validated by military personnel from the strategic level, through non-directive interviews: **User Satisfaction** (measured through the strategic objective Ensure Alignment of the Main IT Services with Client Needs), **Ensure the Addressing of User Needs** (measured through the strategic objective Deliver Projects with the Agreed Quality) and **Motivation of Professionals** (measured through the strategic objective Develop People Based on Strategic Competencies).
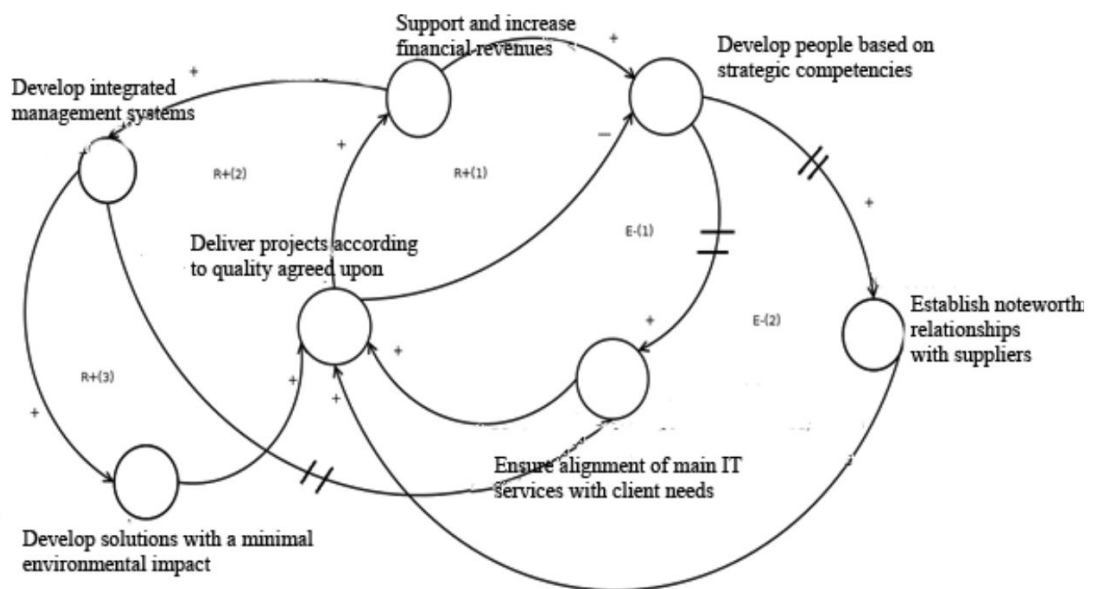
4.1.4 Causal-looping diagram

As from this definition, the causality relationship between strategic objectives and/or business variables was developed, according to the diagram showed in Figure 3, which started from the Clients' perspective and from the strategic objective of Delivering Projects with the Agreed Quality, considering this is the focus of Strategic Topic 3.

As from the causal-looping diagram, we can identify the variables responsible for the main behaviors of the system, including the reinforcement (R+) and balance (E–) mechanisms that are described in Chart 5 and will be used for the construction of the stock and flow diagram, as they provide a simulation of the

Table 1. BSC and DBSC Indicators.

Strategic Objective	Indicator (BSC)	Target (goal)	Problem is highlighted	New Indicator (DBSC)	Target (goal)	Observation
Support and increase financial revenues	% of Internal Work Plan (IWP) addressed	75%	-	That of BSC is maintained.	75%	IWP is the planned budget in the year before strategic execution.
Develop people based on strategic competencies	% of strategic competencies developed	70%	Indicator should be more specific for reality of Strategic Topic.	% of strategic competencies developed in the Project area	70%	In SisTEx, training is one of the tools used to increase professional motivation.
Establish outstanding relationships with suppliers and partners	% of IWP areas addressed by a supplier	100%	The indicator seeks to show capacity for acquisitions, but is not useful to measure process efficiency for this.	% of successful acquisition processes within the Project context	100%	For this goal, CITEx seeks to train and align the acquisition teams with the project teams.
Ensure alignment of main IT services with cliente and user needs	Level of Satisfaction with services rendered	90%	The indicator does not contribute to the causality foreseen in the strategic map, as IT projects are not seen as a service.	Level of Satisfaction with projects delivered	100%	The new indicator captures the essence of user satisfaction with regard to the projects delivered.
Deliver projects with the agreed quality	Satisfaction rate regarding projects	90%	The measure sought to measure the quality of projects with regard to scope, time, and costs.	Rate of Projects delivered with quality	100%	Division of no. of projects with quality (scope, budget and time addressed) by no. of projects.

Figure 3. Causal-looping diagram from Strategic Topic 3.

most impacting results. The problems in the strategy established will be seen through the balance cycles.

4.2 Quantitative stage

The quantitative stage sought to develop a simulation model based on the Stock and Flow Diagram.

4.2.1 Stock and flow diagram

The construction of the stock and flow diagram is based on factors defined in the causal-looping diagram and on the elements (resources, states, converters and connectors) arising from the four steps proposed by Wolstenholme (1994), quoted in the model of this research for the construction of IT DBSC. Figure 4 illustrates the stock and flow diagram, through three representation steps.

The first step (1) is of the balance link E– (1) - professional development - and the factors Develop People Based on Strategic Competencies, Ensure Alignment of the Main IT Services with Client Needs and Deliver Projects with the Agreed Quality. The second (2) is of the balance link E– (1) and Reinforcement link R+ (1) - Increase Financial Revenues, with the addition of the fator Support and Increase Financial

Chart 5. Reinforcement and balance mechanisms.

| Link	Description
R+ (1)	Results from the delivery of IT projects with quality, generating more demand, increasing the service area and, consequently, there is an increase in financial revenues that allow for greater development of the workforce.
R+ (2)	Results from better control generated by the management systems and reduction of rework. Better solutions will be delivered through projects, increasing the demand for the latter.
R+ (3)	Results from revenue increase, as well as use of integrated management systems reduces rework, increasing user satisfaction and demand for projects.
E– (1)	Results from demand increase generated by the constant delivery of high quality projects, which generates a constant allocation of all the technical people in the projects and makes recycling via training difficult.
E– (2)	Results from people's efficiency in training. There is an increase in acquisition processes, generating more quality in the projects and increasing demand. This generates a constant allocation fo all the technical people in the projects, making recycling via training difficult.
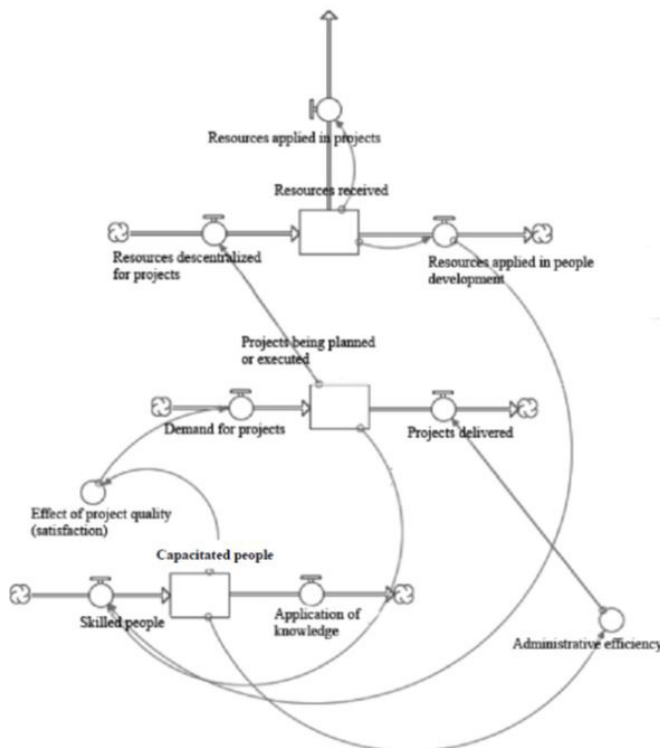
Figure 4. Representation of link E– (1), R+ (1) and E– (2).

Revenues to those mentioned before. The third (3), and last one, of the balance link E– (1), reinforcement link R+ (1) and balance link E– (2) - Efficiency in the Delivery of Projects -, with the added factor Establish Outstanding Relationships with Suppliers.

The strategic objective of Developing People Based on Strategic Competiencies, represented by the flows "Develop people" and "Application of knowledge" and by the stock "Qualified People", is enhanced through the financial resources received, and there is a flow of people training. In SisTEx, training is one of the tools to increase professional motivation. In the case of the 4th CTA, there is a team of 12 military personnel in the project management area. If there are financial resources, there is the formation of a stock of qualified people. The strategy in this Center is to qualify everyone involved in the projects at least once a year. The minimum target accepted is 70%, according to its BSC. The 4th CTA plans the training of all its project team, at least once a year. For simulation purposes, we consider that after a 12-month cycle, all knowledge needs to be renewed, due to innovations and constant changes in the teams.

Competent people, besides being motivated, tend to develop better organizational processes or Ensure the Alignment of the Main IT Services with Client Needs. The clients who had projects delivered relate this factor to the perception of quality. For the simulation, satisfaction equal to 1 was considered, when the target of training 70% of the personnel was achieved; and 0.5, when up to 50% of the team had been trained. If less than 50% of the project team was trained, satisfaction tended towards zero during the simulation. The higher the client satisfaction, the greater the demand for projects, measured through the strategic objective Delivering Projects with the Agreed Quality. The demand generates a project flow, which is stored. The project will only be removed from the stock after it has been concluded. On average, there is one new project request per month in the 4th CTA. The demand can be higher if the user satisfaction increases, or lower if it decreases considerably.

The bigger the number of projects demanded, the more resources are received, according to the strategic objective Support and Increase Financial Revenues. There is a flow of financial resources towards people development (training) in project management. The more financial resources are received, the more resources will be accumulated and can be used to hire training services. According to the CITEx financial track record, the 4th CTA receives on average US$543,000.00 per year for its different activities. On average, 10% of the total value received will be used for training. The rest will be used in the development of projects and daily operational costs. The CITEx makes the resources available in monthly twelfths.

There will be only provision of training resources if there are people who are able to be trained. Furthermore, the projects to be delivered depend a lot on the Center's administrative efficiency, measured through the strategic objective Establish Outstanding Relationships with Suppliers. The more trained people there are, the greater the efficiency of this factor. All the simulation was based on a period of 36 months (3 years), as this was the period defined in the SisTEx BSC for it to reach its view of the future.

4.2.2 Model simulation

If we compare the results that represent dynamic link E– (1) (see Graph 1) with a possible diagram without feedback (traditional) links (see Graph 2) and the complete causal-looping diagram and its results (see Graph 3), we can observe that the traditional system tends to become increasingly efficient over time. In Graph 1 and Graph 3, as well, we can observe that people are not able to be trained, as the projects are demanded and the ability to address them reaches the organizational limit, as they are involved in planning and execution of the projects.

In other words, through the simulation we can observe a constraining behavior that occurs naturally in organizations. It wouldn't be possible to note this type of behaviour beforehand without the loop (feedback structure) modelling in the causal-looping diagram and without the attention given to the time variable, two concepts that are not used in the traditional BSC.
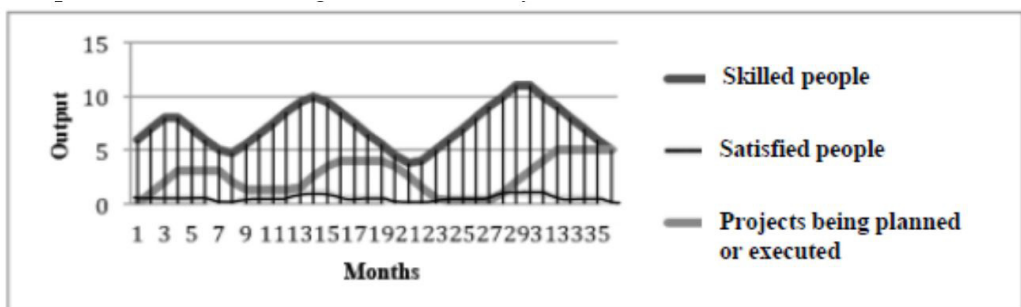
Graph 1. Behavior of target variables in Dynamic BSC.

It is important to highlight that in the real world it is difficult for the behavior of an organizational variable (or of all the variables) to become more efficient in an unlimited manner, according to that shown in Graph 2.

Following up on the evolution of Graph 3, we can see that over time customer satisfaction begins to diminish due to bottlenecks in the delivery, demotivation of the project teams and knowledge obsolescence in the teams. As a result, the number of projects demanded diminishes considerably. It is natural for an organization that intends to deliver high quality IT projects to not be able to support itself for a long time when it admits to this disastrous cycle.

According to Figure 5 and Graph 2, the behavior foreseen in the literature review about the results of structural BSC failures can be confirmed. In other words, the more qualified the people, the better the user satisfaction and the more projects can be demanded, in an infinite cycle that goes against the limiting logic of economy itself that requires the enhancement of resources to deal with its scarcity. It is important to highlight that simulations were only possible as from the traditional BSC, using the information from the DBSC.

4.2.3 Discussion of results

Therefore, the three propositions established in this research could be confirmed, as the use of soft modelling for system dynamics mitigated the problems with regard to cause and effect in
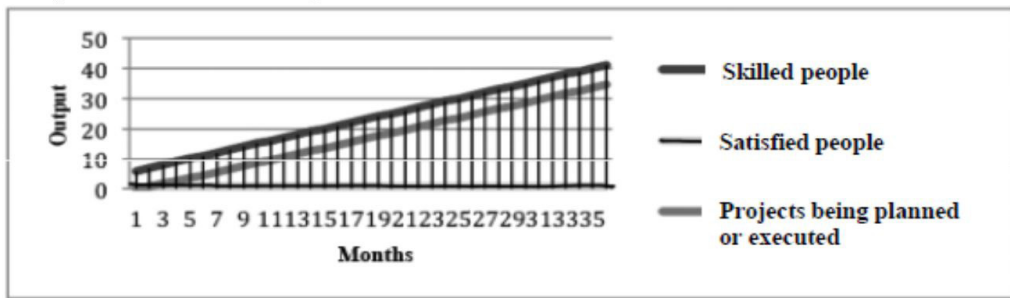
Graph 2. Behavior of target variables in BSC.
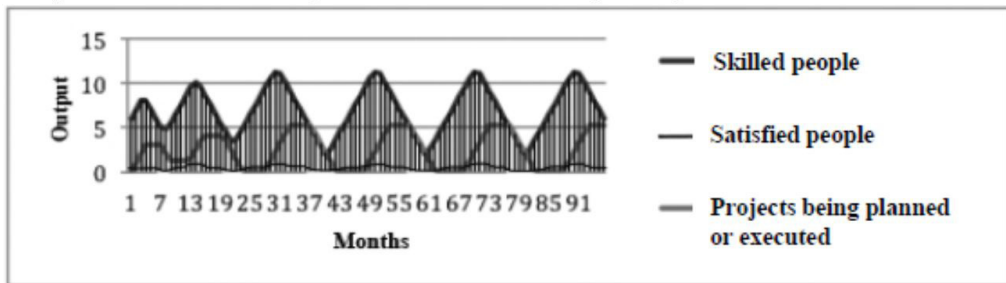
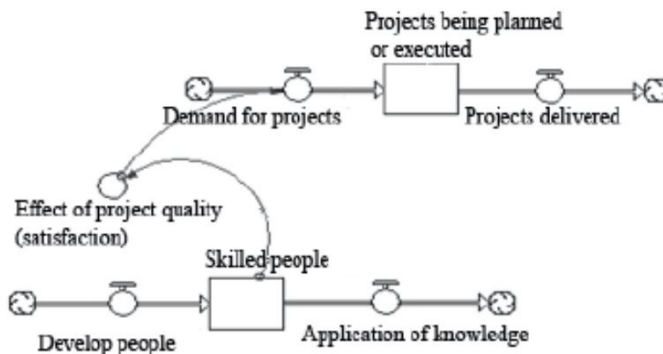**Graph 3.** Behavior of target variables in the complete Dynamic BSC.

Figure 5. Static BSC simulation model.

the traditional strategic map, making them more dynamic and taking into consideration the waiting period between the factors considered. The waiting periods and the existing feedback loops in the DBSC dynamic relations of cause and effect allowed for a simulation of the IT organizational strategy, using hard modelling. It was thus possible to project the impacts of decisions over time, as well as anticipate knowledge about positive and negative impacts in the IT organizational strategy.

A serious problem seen in this research is the lack of a systemic view in the choice of strategic indicators used in BSC. According to Kaplan & Norton (1997), many executives believe they already have a BSC because they complement the financial measures with non-financial measures, such as customer satisfaction and marketshare. However, if these measures do not offer sufficiently specific guidance for the future, with an adequate bases for allocation of resources, formulation of strategic initiatives and binding of the annual budgets, they will only be generic measures, as they do not describe a unique winning strategy.

A deployment error was observed in all the BSCs of SisTEx - most of the indicators used did not materialize into a condition of state, and they did not follow the logic of strategic causality defined by the strategic map. For Kaplan & Norton (2008), the targets of the strategic objectives should not be defined separately, as they must be related to the targets of the other strategic objectives in a chain of causality. This seems to be quite evident for the system dynamics; it doesn't seem to be when the traditional BSC is deployed.

If the choice of the indicators does not represent the real dynamics specific to organization and strategy, following the causality defined in the strategic map and resulting from organization processes, the construction of BSC becomes generic. This makes the follow up of the strategy unfeasible, as there will be a decoupling between the strategy foreseen, the actions developed and the indicators that measure these actions. As a solution, when the indicators are developed, they must incorporate the causality mechanism foreseen in the strategic map and must arise from an organizational process so that it will be possible to measure them.

5 Final considerations

The main objective of this study was to develop a BSC model applied to IT governance, focusing on system dynamics. In this regard, qualitative and quantitative modelling were performed as from BSC and the strategic map of a military organization (4th CTA) in the Brazilian Army's Telematics System - SisTEx. The IT DBSC developed was submitted to a simulation, substantiating the three propositions established in the study. When considering the cause

and effect relations, and the waiting periods between strategic objectives, it was possible to project the negative and positive impacts of the organizational strategy in the referred military institution.

The results of this research can be considered advances in the theoretical and practical aspects linked to BSC. In the theoretical point of view, it was presented the proposal of constructing the IT DBSC, aiming at mitigating structural problems of the BSC in IT governance. In the practical point of view, the results were reflected in the strategic culture of SisTEx itself, as it coincided with the development of new Strategic Planning for this System and provided the use of many of the proposals and advances in the work. This highlighted the migration of its BSC towards a dynamic focus and correction of the strategic indicators. This allows for evolution in the maturity of applying BSC in SisTEx.

Among the constraints of this research, we find those inherent to a case study, such as the impossibility of generalizing the results in the population, in spite of the possibility of theoretical generalization, according to Yin (2001). Besides, the case study was limited to a military context and was based only on a strategic topic for traditional BSC used by one of 13 military organization of SisTEx. More research in other organizational contexts, also in the private sphere, will allow for external generalization.

This research suggests possible future work, such as: validation of the migration model proposed for BSC to DBSC in the IT and the business areas; a survey of the softwares used in the market about BSC and possible improvements in them so as to incorporate the Dynamic BSC; and, also, a proposal of enhancements in the COBIT 5 indicators with the use of Dynamic BSC.

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