



PROPOSITION OF A STRATEGIC DELIVERY MANAGEMENT SYSTEM FOR THE OIL AND GAS INDUSTRY: BSC AND AHP INTEGRATED APPROACH

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Highlights

- A new strategic delivery management system (SDMS) of flexible pipes was proposed.
- Performance criteria aligned with the organizational strategy were selected considering the four perspectives of BSC.
- AHP method was applied for prioritization of contractual deliveries.
- Integrated use of BSC and AHP methodology allows the selection and management of supplies critical to meeting short-term strategic goals with a focus on results.

Abstract

Goal

Call the attention to the challenge of managing a contract portfolio of delivery of flexible tubes, considering the complexity of supply and the need for speed in decision-making in a competitive and constantly changing market, in which managers have to deal with a huge amount of information. The management of the supply of flexible pipes is a multifaceted issue, whose components may present different and even mutually inconsistent management priorities.

Method

The article presents a *Balanced Scorecard* (BSC) bibliographic review for deployment of the corporate strategy, the application of the *Analytic Hierarchy Process* (AHP) for multi-criteria analysis, and the combined use of both methods – BSC and AHP – to support the decision-making process, as well as a case study of the development of a strategic delivery management system (SDMS) for oil and gas industry in Brazil.

Results

The flexible pipe SDMS provides a system for a structured, objective, balanced and flexible management to meet internal and external business needs with the required agility. It can be adopted by any organization to support decision-making in complex problems.

Study limitations and implications

The management system met the need of the organization for which it was developed. However, for it to be enhanced and used as a management good practice for contractual delivery of flexible pipes it should be deployed in other organizations that provide this type of product in the Brazilian and international markets.

Practical implications

This article proposes a management system that can be deployed in any organization that supplies flexible tubes to a market, in order to support the decision-making process with a focus on organizational strategy.



Originality

We propose a new management system that uses a combined approach of BSC and AHP methodologies for performance analysis and decision-making support aligned with corporate strategy, developed to meet a real business demand.

Keywords: *Balanced Scorecard. Analytic Hierarchy Process.* Multicriteria Decision Making. Prioritization and Selection. Management system.

1. INTRODUCTION

Over the years, the economy has grown in an unstructured way, leading organizations to overcome themselves, making continuous efforts to be successful in an increasingly competitive and constantly changing environment. In a context in which the efficiency in operations and profitability are the keys to achieving competitive advantage, managers have less time to answer the market issues. Organizations configure their resources to meet market needs and meet the expectations of stakeholders through long-term strategy. While competing for resources and customers, organizations must evaluate the effectiveness of the results of their decisions and actions. Managers, however, may discord in opinion as to the relevance of the aspects that define and evaluate organizational performance, disagreeing on which criteria should be adopted, the level of importance of each and the interpretation of their results (Bentes *et al.*, 2012).

During the past decade, academics and researchers have devoted increasing attention to the measurement of organizational performance and the influence of the *Balanced Scorecard* (BSC) on it and on strategic planning. Since it was designed by Kaplan *et Norton* (1992), the BSC has been widely adopted by different organizations in the world, and has evolved from a performance measurement instrument to a tool for the successful implementation of a strategy (Punniyamoorthy *et Murali*, 2008; Huang, 2009; Grigoroudis *et al.*, 2012). The BSC correlates performance to strategy through a balanced multidimensional set of financial and non-financial measures to evaluate the result of complex and intricate activities associated with the implementation of the strategy and monitoring the achievement of its objectives. It allows managers to understand many relationships and causal effects through a holistic view of the business and transcend traditional notions about functional barriers, improving the decision making and problem solving processes (Kaplan *et Norton*, 1992; Sandström *et Toivanen*, 2002; Huang, 2009).

In a performance evaluation process focused on the fulfillment of strategic goals, the decisions cannot be made

based on the maximization of a single criterion but in the balance of a set of criteria (Bentes *et al.*, 2012). The use of multi-criteria models has been considered as adequate to the solution of these questions and it properly meets the complexity of the performance evaluation and decision making processes (Cooper *et al.*, 2001; Punniyamoorthy *et Murali*, 2008; Huang, 2009; Bentes *et al.* 2012). The *Analytic Hierarchy Process* (AHP) developed by Saaty (1991), is one of the most used multicriteria methods for decision making, since it is effective in solving problems involving various criteria, such as the performance evaluation of flexible pipe supply analyzed in this study.

In this context, the issue addressed in this study is the need for managers to have a management system that will help them to make quick, well-based and successful decisions regarding the supply of flexible pipes with a focus on corporate strategy in a competitive and constantly changing market, considering the complex, multidimensional and inherently paradoxical nature of organizational performance.

Thus, the main goal of this study is to propose the Strategic Delivery Management System (SDMS) of flexible pipes for the oil and gas industry based on an integrated approach that combines the BSC and AHP methodologies for the decision-making process aligned with the organizational strategy. A secondary goal is to extend the application of *Balanced Scorecard* and *Analytic Hierarchy Process* combined methodologies for the entire oil and gas industry and for the Brazilian market. The relevance of this work is based on the development of a SDMS which brings together well-established mechanisms for performance analysis and decision-making. Although other studies explore a joint application of BSC and AHP through illustrative hypothetical examples or theoretical discussion, this article presents a system developed to meet the real and specific needs of engineering and manufacturing companies that provide flexible pipes for the oil and gas market. The analysis of results obtained in the steps of the SDMS developed in the case study is not part of the scope of this study.



2. THEORETICAL FRAMEWORK

2.1 BSC concept and elements for deployment and implementation of corporate strategy

The organizations must evaluate the effectiveness of the results of their decisions and actions when competing for resources and clients. Strategic planning differs from the operational due to its conceptual, visionary and directional mode. Managers understand that a rapid response to change is difficult and, for this reason, strategic planning is critical to the implementation of a strategy (Huang, 2009). A mere understanding about the performance standards that the organization has to achieve is not enough. These standards need to be properly communicated and understood by all levels of the organization and top management must be able to regularly monitor the progress of meeting the strategic objectives in order to ensure the successful achievement of corporate strategy. Obtaining the objective measures of efficiency analysis taking into account all of the organization's operational dimensions is required for a meaningful evaluation (Kaplan *et Norton*, 1992; Punniyamoorthy *et Murali*, 2008). The implementation of a strategy is the transformation of strategic objectives into action through a wide range of efforts (Punniyamoorthy *et Murali*, 2008). The difference arises when the organization chooses to perform certain activities and decide how to execute them (Porter, 1996).

The *Balanced Scorecard* was developed because of the need to consider other perspectives than the financial, to assess the compliance with the long-term strategic objectives, enriching the process with the inclusion of indicators such as the level of customer service, the level of employee satisfaction, *marketing share* by segment, among other important factors for organizational success (Punniyamoorthy *et Murali*, 2008).

The BSC is a system derived from long-term strategy. With a comprehensive set of performance indicators, it supports strategic planning and its implementation through the integration of short-term activities around a common understanding: the organizational objectives. In its approach, it provides a clear view as what the organizations should measure in order to enable a balanced management of all functional areas. In addition, the BSC provides *feedback* on internal processes and external results for continuous improvement. When fully deployed, it transforms strategic planning into the nerve center of the organization (Punniyamoorthy *et Murali*, 2008; Huang, 2009; Grigoroudis *et al*, 2012.).

The BSC model comprises four perspectives related to business activities, which can be critical to most organizations and applicable to all levels:

- Financial perspective:

The level of customer satisfaction, internal business performance and the level of innovation and internal improvements reflect a particular vision of the organization regarding its results on the market and the factors considered critical to the success of its business. The financial criteria indicate whether the organizational strategy, its implementation and enforcement, as evidenced in these perspectives, are actually contributing to improved financial results. The seeking for improved financial performance may require a review of the corporate strategy or its implementation. It is worthy to note that an excellent set of balanced indicators does not ensure a winning strategy.

- Internal processes perspective:

In this perspective, the company adopts criteria that represent what the organization must do internally to meet customer expectations. According to the causal model of the BSC, the ability of employees leads to the improvement of internal processes.

- Client perspective:

It presents results associated with delivering differentiated value propositions, which may include participation of the market in specific segments, partnerships with the target customers, acquisition and retention of customers in targeted segments and customer profitability. Fundamentally, it reflects the factors that really matters to the customers, which are generally associated with time, quality, performance and costs.

- Learning and growth perspective:

The activities that comprise this perspective were the basis for the development of BSC. It captures the ability of employees, information systems and organizational alignment to the business management and adaptation to change. A process depends on qualified and motivated employees with access to accurate and timely information to be successful. It highlights the organization's ability to innovate, improve, learn and therefore grow, generating greater returns for stakeholders.

From these perspectives the company defines the goals, indicators and initiatives related to the business areas identified as critical, which enable the top management to evaluate the strategic success based on measurable criteria and carry an updated management, whose review of indi-



icators and performance evaluation criteria is done every six months. The indicators are designed to allow appropriate performance measurement and establishment of corporate, department and individual goals. The parameters for evaluation of the results are carefully selected (Punniyamoorthy et Murali, 2008).

In addition, the BSC has four management processes that contribute separately and combined to align the long-term strategy with short-term actions (Kaplan et Norton, 1996). The first aims to clarify and translate the corporate vision and strategy into a set of integrated indicators and goals approved by top management in order to establish long-term guidelines that guide the short-term initiatives. The second deals with the communication and the establishing of linkages, leading managers to communicate the strategic objectives for all organizational levels by linking individual, sectoral and corporate objectives. The third process, which is to plan and set goals, aims to integrate the business and financial plans establishing objectives in accordance with the BSC perspectives for resource allocation and prioritization. This process enables managers to undertake and prioritize initiatives that meet the strategic long-term objectives during the management. The fourth and final process, *feedback* and strategic learning, facilitates learning with a focus on strategy. In this, the organizations monitor whether they are achieving the expected results in the short run throughout their whole structure from the point of view of the four perspectives presented, not just the financial.

However, the diverse perspectives and measures of BSC create difficulties such as the need to balance the priorities of different performance criteria from different levels, the need to manage mutually inconsistent results and forecast a final result that synthesizes the results (Bentes et al., 2012).

2.2 Application of AHP method to support multi-criteria decision making

The AHP was developed in the early seventies for military planning and resource allocation. According to Saaty (1977; 1991), the method allows choosing of the best decision alternative considering multiple criteria, expressed through qualitative or quantitative values. By using the AHP, the decision makers structure the problem in smaller pieces making the final goal a set of goals, sub-goals and, finally, action alternatives, reducing difficult decisions to a number of pairwise comparisons and prioritizing alternatives to synthesize results (Huang, 2009; Bentes et al, 2012; Grigoroudis et al, 2012.). It provides a clear reason of why a certain decision is the best. AHP is a powerful and flexible process, which contributes to managers in dealing with the intuitive, rational and irrational risk and uncertainty in complex environments.

It can be applied to solve various problems, such as predicting results, projected or desired future planning, group decision-making, control over changes in decision-making, resource allocation, selection of alternatives, analysis costs versus benefits, among others. The AHP model recognizes and utilizes the knowledge and experience of decision makers in setting priorities and where subjective judgments are needed due to lack or absence of information that can be measured objectively (Huang, 2009).

The three principles of application of AHP are decomposition, priority and synthesis (Huang, 2009; Bentes et al, 2012.). In decomposition, the problem analysis is broken down into simpler elements, namely the overall goal, the alternatives to be chosen and the criteria (and their sub-criteria) that contribute to achieving the overall goal. Priority is established by comparing side-by-side the criteria on the same level. By setting the priority, it establishes the importance of a criterion in relation to another of the same level. The problem is finally synthesized with priority ranking by the principle of hierarchical composition for global assessment of the mapped alternatives, where all pairwise comparisons among the alternatives, equalized by the importance of the criteria, reflect how much each decision alternative contributes to the fulfillment of the overall objective (Huang, 2009; Bentes et al, 2012.). According to Huang (2009), there is still a fourth principle: the sensitivity analysis. In it, decision makers test the best choice comparing the stability of the results changing the priority of the criteria.

2.3 Application of BSC and AHP to the decision-making process

Numerous studies have used the combination of the BSC with multiple criteria analysis techniques given the multidimensional nature of that system. Mostly adopt AHP due to the ability of this model to assist decision makers in choosing between alternative strategies and allocation of resources for implementation of the selected strategy and achievement of strategic objectives (Huang, 2009; Bentes et al, 2012; Grigoroudis et al., 2012).

The BSC system does not formally explain how to consider the importance of its prospects in a *framework*. Many studies deal with the BSC own framework, but few explore the proper way to implement it in an organization. Decision makers may be led to believe that the criteria have the same degree of importance, since they are related and have the same overall goal. In practice, however, its criteria seldom have the same weight. The AHP aids the BSC as a useful tool for prioritization and consolidation of measures for evaluating organizational performance based on multiple criteria (Bentes et al., 2012).



3. RESEARCH METHOD

This study addresses the management of contractual deliveries of multinational companies operating in Brazil that provide flexible pipes for the upstream phase of exploration and production of oil and gas. It features a proposition of a management system for decision-making based on BSC and AHP multicriteria analysis methodologies focused on corporate strategy. The study was conducted for over two years by research professionals with experience in project management, management systems, operations research and portfolio strategy areas. For the development of the system proposed in this study, we conducted interviews with managers who are challenged daily to make decisions concerning the provision of flexible pipes and underwent an extensive literature research to identify benchmarking patterns that contribute to make them call the right decisions in the right way.

Operations performance is a concept with different points of view, and there is no consensus on which evaluation criteria should be adopted or how these criteria work over time. However, it is of common knowledge that a single indicator does not present a clear goal of performance or achievement to the goals of business critical areas, so the development of a set of indicators with a balanced view, ie, combining the financial and operational results is required. Since the operating conditions of flexible tubes manufactured by leading-edge companies that seek technological leadership are specific to each project, well and function (production, water injection, gas injection, service type, gas export and others), the supply of most of these products includes engineering, design, quality control and manufacturing innovative activities. Thus, the criteria set in this work focused on the success critical factors associated with the successful completion of these activities, based on the four perspectives of the BSC. As Sadström *et Toivanen* (2002) affirmed, the development of new products is a demanding activity with regard to the management focused on achieving satisfactory results. Since the 1980s, the speed and flexibility variables, which are complementary to those traditional and oriented to budgeting and monitoring of the project, began to receive greater priority in the processes of research and development of new products and in management control. According to Punniyamoorthy *et Murali* (2008), it is expected that the *scorecards* of corporate strategies have around 20 to 25 performance indicators, with the following distribution in the BSC perspectives: Five indicators (22%) in each of financial, customer and learning and growth perspectives, and around eight to ten indicators (34%) in the internal processes perspective. However, despite this distribution had been used as reference to set prioritization criteria, this was not achieved in the proposed system due to the greater emphasis on financial perspective and less focus on learning and growth.

As Punniyamoorthy *et Murali* (2008) mentioned, there are four barriers that compromise the implementation of the stra-

tegy in the organization, as follows: the vision of employees, who may not understand the organizational strategy; the people, because in most cases they do not have performance goals directly related to the defined strategy; the time, energy and capital resources, which are not allocated to key activities for achieving the strategic goals; and the management, since it devotes much time to the short-term tactical decisions and little time to organizational strategy. Decisions taken during the supply process can directly affect the time, cost, manufacturing and quality of flexible pipes, as well as customer satisfaction and relations with suppliers and subcontractors. For this reason, decision makers need to know the organization's strategic goals, as well as the relations of cause and effect behind the costs and revenues. They also need to receive appropriate *feedback* of their decisions. The development of the management system proposed in this study focused on enabling decision makers to overcome the described barriers and be able to analyze the problems, take an appropriate course of action that connects the supply of the product, including all of its activities, to the long-term strategic goals and promote a continuous improvement.

We conducted a literature review with a search for the keywords in the Scopus database. The case study was completed through the application of the best market practices studied in the literature review as described in SDMS steps presented in Section 4.

Case study: development of a Strategic Delivery Management System to support decision making process

This section presents the SDMS of flexible pipes for the oil and gas industry, developed based on the integrated approach to BSC and AHP methods to support the decision-making process aligned with organizational strategy (Figure 1).

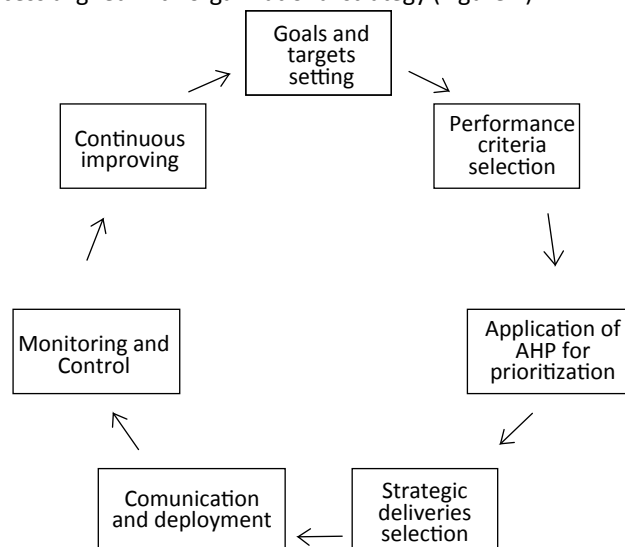


Figure 1 - Strategic Delivery Management System (SDMS).

Source: Author's Study, 2016.



The ultimate goal of this system is to support in a structured, flexible, fast and objective way, the decision-making process for managing the supply of flexible pipes, considering the complexity of the following requirements: (i) to perform the best possible prioritization of different delivery services with unique supply conditions regarding the financial, internal process, customer and learning and organizational growth perspectives; (ii) to select those most relevant to meet the short, medium and long term strategic goals; (iii) to deploy the decision adopted at all organizational levels; (iv) to monitor and control the obtained results; (v) continuously improve the strategy and its implementation in order to make the organization more competitive in a constantly-changing environment.

The SDMS proposed is a continuous system, a cycle, and its main steps are detailed below.

4.1 Goals and targets setting

This comprises the unfolding of the strategy into strategic goals and performance targets to be achieved by the organization within the prescribed period. The SDMS was developed for an organizational strategy with the following strategic goals and targets for the period of one year:

- Reduce costs by 15%;
- Increase cash by 5% in the current year;
- Reduce exposure to risks by 5%;
- Increase by 30% the number of deliveries made in contract deadline;
- Increase manufacturing occupation by 10%;
- Increase by 20% the product local content rate;
- Increase customer satisfaction by 5%;
- Increase investment in innovation and technology by 15%;
- Increase the rate of compliance with corporate governance by 30%.

The objectives and goals listed in this work are fictitious. They were created for model building and can be replaced by others, according to the adopted organizational strategy.

4.2 Performance criteria selection

After defining the strategic goals and targets, we must select criteria that enable an objective, rapid, holistic and assertive assessment of the results achieved through short-term actions and decisions.

Figure 2 presents the definition of the criteria and proportionalities adopted in this research after interviews with experts, analysis of the flexible pipe supply business and extensive literature review. Both the criteria and proportionality were selected taking into account the strategic goals presented in the goals and targets setting step. It is expected that other strategies or contexts require different criteria and/or application of the proportionality rules adopted, without damage to the model.

As observed, this model has the following distribution criteria in BSC perspectives: six criteria (30%) in the financial perspective, eight (40%) as internal processes aspects, four (20%) in the customer's perspective and two (10%) on learning and growth perspective. This distribution is the result of a management that sees great relevance in the monitoring and control of financial results and less importance in learning and organizational growth.

4.2 Application of AHP method for prioritization

For the SDMS development, we chose to use the AHP method for weighting of performance criteria and prioritization of flexible pipe deliveries.

The criteria selected in the previous step were split in two levels (Figure 3):

- Strategic level: BSC perspectives;
- Tactical level: criteria that aim to translate strategy into lower level (in this case, for each delivery) aspects through medium-term measurable performance results.

After choosing the criteria, we conducted a pairwise comparison between level 1 (Table 1) and the level 2 (Tables 2, 3, 4 and 5) items, according to their relevance.



BSC perspective	Criterion	Calculation	Proportionality
Financial	Revenue (MBRL)	Estimated value in millions of reais, considering adjustments and exchange rate	Direct
	Cost (MBRL)	Estimated value in millions of reais, considering adjustments and exchange rate	Indirect
	Gross margin (%)	Expected percentage [(revenue - cost) / income]	Direct
	Contribution margin (MBRL)	Amount estimated in millions of reais of the unit contribution margin	Direct
	Year cash box (MBRL)	Amount estimated in millions of reais to receive this year, considering adjustments and exchange rate	Direct
	Hedging rate	Percentage of the value of the expected risk covered by the expected value of technical contingency (technical contingency expected / predicted risk)	Direct
Internal processes	Performed physical progress (%)	Percentage of actual physical progress	Direct
	Expected delay (days)	Maximum day delay provided	Direct
	Machine-time (h)	Total machine-hours provided	Direct
	HH (h)	Total man-hours planned	Direct
	Size (km)	Total length in kilometers	Direct
	Complexity (h/m)	Expected average time for manufacture of a meter of the product (total production machine estimated time / full compliance in meters)	Direct
	Nonconformity (Qty)	Nonconformity amount found during the execution of the project	Direct
	Manufacturing in Brazil (Y/N)	"Yes" to manufacture in Brazil, or "no" to other cases	Direct
Client	Priority to the client (Y/N)	"Yes," whenever the delivery to the first oil production unit or impact the rump-up of it, or "no" to other cases (Yes = 9 and not = 1)	Direct
	Deadline date to the contractual (days)	Remaining contractual amount of days to delivery to the customer (contractual delivery date - current date)	Indirect
	Customer satisfaction (0-10)	Satisfaction survey of the note with the customer (zero to ten scale)	Indirect
	Competition existence (Y/N)	"Yes," whenever there are qualified bidder for the supply of the product, or "no" to other cases (yes = 4 and not = 6)	Direct
Learning and growth	Innovation need (Y/N)	"Yes," whenever there is need for product qualification, or "no" to other cases (yes = 9 and not = 1)	Direct
	Service to strategic objectives (0%-100%)	Percentage of compliance with the strategic objectives achieved in performance assessment (yes = 9, no = 1)	Direct

Figure 2 - Performance criteria.

Source: Author's Study, 2016

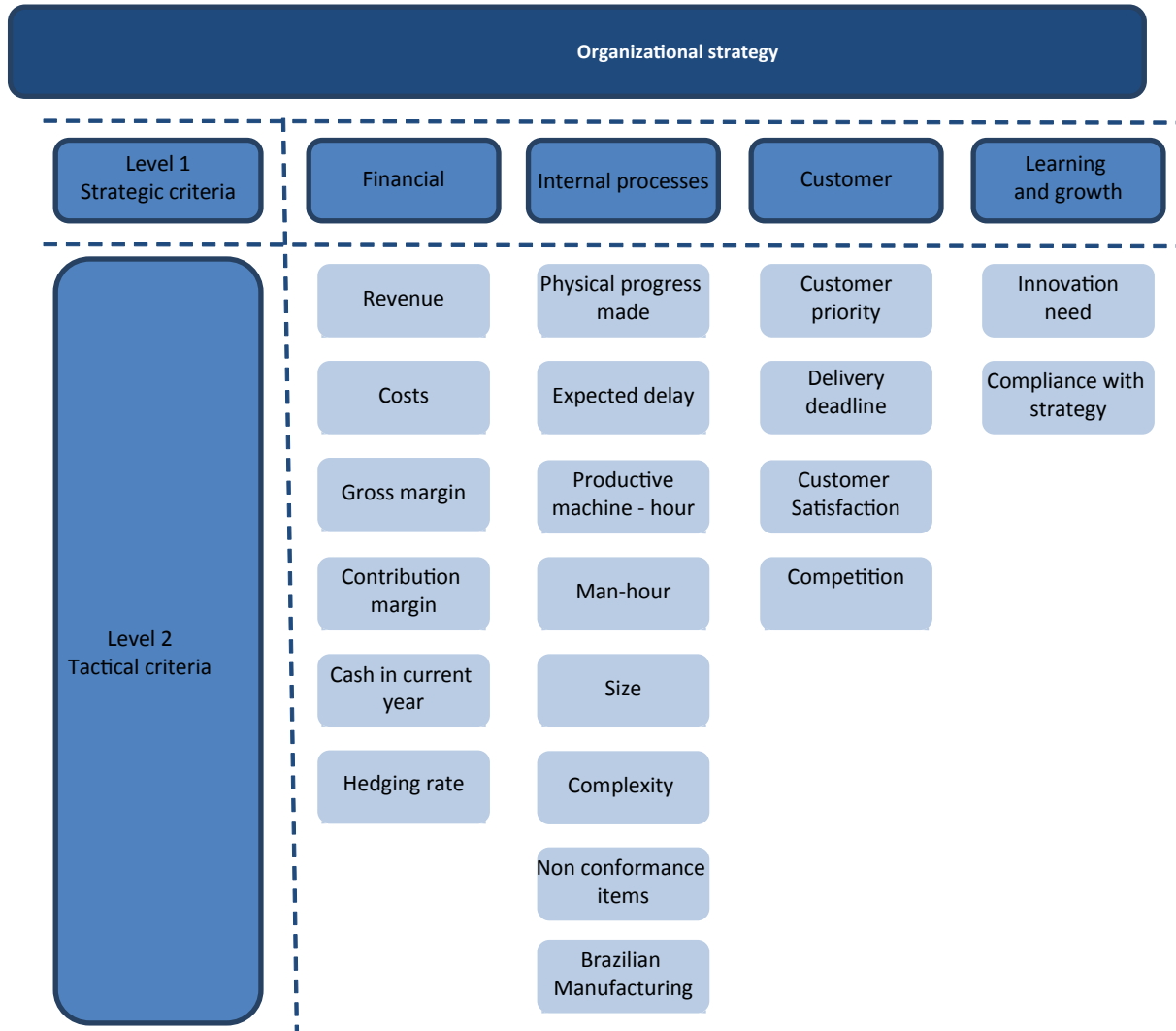


Figure 3 - Levels of performance criteria for prioritization.

Source: Author's Study, 2016



Table 1 - Comparison of Level 1 criteria.

BSC Perspectives	Financial	Internal processes	Customer	Learning and growth
		More important	Equal	Equal
			Equal	Less important
				More important

Source: Author's study, 2016.

Table 2 - Comparison of level 2 criteria of the financial perspective.

Financial perspective	Revenue	Costs	Gross margin	Contribution margin	Current year cash	Hedging rate
Revenue		Equal	Less important	Equal	Less important	More important
Costs			Less important	Equal	Less important	More important
Gross margin				Equal	More important	Much more important
Contribution margin					More important	Much more important
Current year cash						Much more important
Hedging rate						

Source: Author's study, 2016.

Table 3 - Comparison of level 2 criteria of the internal processes perspective.

Internal processes perspective	Physical progress made	Delay	Machine-hour	Man-hour	Size	Complexity	Non conformance items	Brazilian Manufacturing
Physical progress made		Less important	Equal	Equal	More important	More important	Much less important	Less important
Delay			More important	More important	Much more important	Equal	Much less important	Less important
Machine-hour				Much more important	Much more important	Much less important	Less important	Less important
Man-hour					More important	Less important	Much less important	Less important
Size						Much less important	Much less important	Much less important
Complexity							Equal	Much more important
Non conformance items								Much more important
Brazilian Manufacturing								

Source: Author's study, 2016.



Table 4 - Comparison of level 2 criteria of the customer perspective.

Customer perspective	Customer priority	Contract deadline	Customer satisfaction	Market competition
Customer priority		Much more important	Equal	Much more important
Contract deadline			Equal	Less important
Customer satisfaction				More important
Market competition				

Source: Author's study, 2016.

Table 5 - Comparison of level 2 criteria of the learning and growth perspective.

Learning and growth perspective	Innovation need	Compliance to strategic goals
Innovation need		Less important
Compliance to strategic goals		

Source: Author's study, 2016.

After the pairwise comparison, in order to continue AHP modeling and criteria weighting, the importance of scale was established with the weights in Table 6 as follows.

Table 6 - Levels of importance and values for prioritization.

Importance	Value
Much more important	9
More important	5
Equal importance	1
Less important	1/5
Much less important	1/9

Source: Author's study, 2016.

This way we obtained the results shown in Tables 7, 8, 9, 10 and 11 for calculating the balancing of the level 1 and 2 criteria, as seen below:

Table 7 - Relative importance of the BSC perspectives.

BSC Perspectives	Weight
Financial	0,35
Internal processes	0,12
Customer	0,35
Learning and growth	0,18

Source: Author's study, 2016.

Table 8. Relative importance of the financial perspective criteria.

Financial perspective	Weight
Revenue	0,12
Costs	0,12
Gross margin	0,33
Contribution margin	0,19
Current year cash	0,21
Hedging rate	0,02

Source: Author's study, 2016.

Table 9 - Relative importance of the internal processes perspective criteria.

Internal processes perspective	Weight
Physical progress made	0,10
Delay	0,11
Machine-hour	0,07
Man-hour	0,03
Size	0,01
Complexity	0,22
Non conformance items	0,32
Brazilian manufacturing	0,14

Source: Author's study, 2016.

Table 10 - Relative importance of the customer perspective criteria.

Customer perspective	Weight
Customer priority	0,49
Contract deadline	0,07
Customer satisfaction	0,25
Market competition	0,19

Source: Author's study, 2016.

Table 11 - Relative importance of the learning and growth perspective criteria.

Learning and Growth perspective	Weight
Innovation need	0,17
Compliance with strategic goals	0,83

Source: Author's study, 2016.

We used actual data delivery for prioritization, ranked as follows:

For directly proportional criteria, all the delivery data regarding a specific criterion were divided by the highest value obtained for that, and multiplied by 10. Thus, the delivery with best performance in criteria evaluation ranked 10, while the others got lower values with appropriate proportion to the original data.

For inversely proportional criteria, the lowest value found for a given criterion was divided by the actual data and multiplied by 10. So the criterion with better performance (ab-



solute lowest score in the criteria) also ranked 10, while the others kept proportionality.

Tables 12, 13, 14 and 15 present the parameterized data used (ranging from 0 to 10) for each of the BSC perspectives.

Table 12 - Parameterized data of financial perspective.

Delivery	Financial Perspective					
	Revenue (MBRL)	Costs (MBRL)	Gross Margin (%)	Contribution Margin (MBRL)	Current year cash (MBRL)	Hedging rate
	DP	IP	DP	DP	DP	DP
Delivery 1	7	0	9	9	1	8
Delivery 2	4	1	8	7	5	4
Delivery 3	5	1	8	9	8	4
Delivery 4	2	1	7	6	3	10
Delivery 5	10	0	10	9	10	4
Delivery 6	6	0	9	10	9	6
Delivery 7	6	0	7	7	3	9
Delivery 8	1	2	8	8	1	3
Delivery 9	1	3	7	6	0	3
Delivery 10	1	3	5	3	0	5
Delivery 11	0	4	4	2	0	6
Delivery 12	6	0	9	10	2	5
Delivery 13	4	1	7	6	2	6
Delivery 14	0	10	0	0	0	6
Delivery 15	5	1	10	10	2	5
Delivery 16	7	0	7	6	3	4
Delivery 17	2	1	3	3	1	6
Delivery 18	5	0	7	6	3	5
Delivery 19	2	1	5	4	1	10
Delivery 20	5	0	8	9	2	10
Delivery 21	2	1	7	7	1	3
Delivery 22	5	0	8	9	4	7
Delivery 23	2	1	7	6	1	9
Delivery 24	4	0	7	7	2	8
Delivery 25	2	1	5	3	1	3
Delivery 26	5	0	8	8	5	3
Delivery 27	2	1	7	7	2	8
Delivery 28	6	0	6	5	3	8
Delivery 29	2	1	3	2	1	3
Delivery 30	6	0	7	7	3	9
Delivery 31	2	1	6	4	1	6
Delivery 32	6	0	7	6	3	9
Delivery 33	2	1	5	4	1	9
Delivery 34	7	0	8	7	2	5
Delivery 35	7	0	9	9	9	7
Delivery 36	10	0	9	9	1	9
Delivery 37	1	2	6	5	0	8
Delivery 38	6	0	9	9	2	5
Delivery 39	1	1	7	5	2	6
Delivery 40	8	0	8	9	1	10



Source: Author's study, 2016.

Table 13 - Parameterized data of internal processes perspective.

Delivery	Internal processes							
	Physical progress made (%)	Expected delay (days)	Machine-hour (h)	Man-hour (h)	Size (km)	Complexity (h/m)	Non conformance items (Qty.)	Brazilian Manufacturing (Y/N)
	DP	DP	DP	DP	DP	DP	DP	DP
Delivery 1	4	5	8	3	4	4	6	10
Delivery 2	5	8	7	1	4	4	5	10
Delivery 3	10	0	5	1	8	1	4	10
Delivery 4	10	0	3	1	7	1	4	10
Delivery 5	6	6	10	10	2	10	10	10
Delivery 6	8	3	6	3	5	2	7	10
Delivery 7	4	10	6	1	5	2	8	10
Delivery 8	3	6	2	3	5	1	4	10
Delivery 9	4	2	2	1	5	1	0	10
Delivery 10	2	4	2	1	4	1	2	10
Delivery 11	2	5	1	1	5	0	0	10
Delivery 12	5	8	7	3	5	2	5	10
Delivery 13	2	3	6	1	4	3	6	10
Delivery 14	3	9	1	1	5	0	2	10
Delivery 15	1	2	6	1	4	3	8	10
Delivery 16	1	8	10	1	7	2	10	10
Delivery 17	1	6	6	1	9	1	4	10
Delivery 18	1	5	7	1	9	2	1	10
Delivery 19	1	4	4	1	8	1	2	10
Delivery 20	4	0	5	1	8	1	3	10
Delivery 21	6	4	3	1	7	1	2	10
Delivery 22	2	1	6	1	8	1	0	10
Delivery 23	3	4	3	1	7	1	2	10
Delivery 24	1	9	5	1	8	1	3	10
Delivery 25	1	10	3	1	8	1	4	10
Delivery 26	3	10	7	1	8	2	1	10
Delivery 27	4	2	4	1	9	1	0	10
Delivery 28	7	8	9	1	9	2	4	10
Delivery 29	9	10	5	1	7	1	0	10
Delivery 30	1	2	8	1	9	2	2	10
Delivery 31	5	4	4	1	10	1	2	10
Delivery 32	2	4	7	1	8	2	4	10
Delivery 33	2	10	5	1	9	1	4	10
Delivery 34	1	10	9	1	4	4	9	10
Delivery 35	4	4	8	1	4	4	6	10
Delivery 36	3	8	10	6	2	10	9	10
Delivery 37	2	3	2	1	5	1	2	10
Delivery 38	3	1	6	1	4	3	7	10
Delivery 39	2	5	2	1	4	1	1	10
Delivery 40	2	10	10	1	4	4	9	10

Source: Author's study, 2016.



Table 14 - Parameterized data of customer perspective.

Delivery	Customer			
	Customer priority (Y/N)	Contract deadline (days)	Customer satisfaction (0-10)	Market competition (Y/N)
	DP	IP	IP	DP
Delivery 1	1	1	5	5
Delivery 2	1	1	5	5
Delivery 3	1	9	6	5
Delivery 4	1	10	8	5
Delivery 5	1	0	8	5
Delivery 6	1	2	6	5
Delivery 7	1	1	6	5
Delivery 8	1	2	6	5
Delivery 9	1	3	7	5
Delivery 10	1	2	5	5
Delivery 11	1	4	5	5
Delivery 12	1	1	10	5
Delivery 13	1	1	6	5
Delivery 14	1	9	5	5
Delivery 15	1	1	10	5
Delivery 16	1	1	6	5
Delivery 17	1	1	5	5
Delivery 18	1	1	10	5
Delivery 19	1	2	8	5
Delivery 20	1	2	8	5
Delivery 21	1	3	10	5
Delivery 22	1	1	5	5
Delivery 23	1	2	7	5
Delivery 24	1	1	6	5
Delivery 25	1	2	5	5
Delivery 26	1	1	10	5
Delivery 27	1	3	6	5
Delivery 28	1	2	5	5
Delivery 29	1	4	8	5
Delivery 30	1	1	6	5
Delivery 31	1	3	5	5
Delivery 32	1	1	6	5
Delivery 33	1	2	6	5
Delivery 34	1	0	10	5
Delivery 35	1	1	5	5
Delivery 36	1	0	8	5
Delivery 37	1	2	6	5
Delivery 38	1	1	10	5
Delivery 39	1	2	7	5
Delivery 40	1	0	6	5

Source: Author's study, 2016.



Table 15 - Parameterized data of learning and growth perspective.

Delivery	Learning and growth	
	Innovation need (Y/N)	Compliance with strategic goals (0%-100%)
	DP	DP
Delivery 1	1	10
Delivery 2	10	10
Delivery 3	1	5
Delivery 4	1	7
Delivery 5	1	10
Delivery 6	10	8
Delivery 7	10	10
Delivery 8	10	6
Delivery 9	1	7
Delivery 10	10	7
Delivery 11	10	5
Delivery 12	1	9
Delivery 13	10	5
Delivery 14	1	7
Delivery 15	10	8
Delivery 16	1	6
Delivery 17	10	5
Delivery 18	1	8
Delivery 19	1	10
Delivery 20	1	6
Delivery 21	10	7
Delivery 22	1	7
Delivery 23	1	9
Delivery 24	1	7
Delivery 25	1	9
Delivery 26	1	5
Delivery 27	10	8
Delivery 28	1	8
Delivery 29	1	8
Delivery 30	1	8
Delivery 31	10	9
Delivery 32	1	10
Delivery 33	1	7
Delivery 34	10	6
Delivery 35	10	6
Delivery 36	1	6
Delivery 37	1	10
Delivery 38	1	7
Delivery 39	1	5
Delivery 40	1	8

Source: Author's study, 2016.

The data used must be collected, processed and organized in a database. It is important to keep it well maintained and up to date in order to obtain easy access and analysis at any time.

Table 16 contains a ranking with the final result of the prioritization of flexible pipes delivery obtained using AHP method.

Table 16 - Delivery priority level by AHP.

Delivery	Delivery final score	Priority level
Delivery 5	6	1
Delivery 6	5	2
Delivery 15	5	3
Delivery 12	5	4
Delivery 35	5	5
Delivery 2	5	6
Delivery 7	5	7
Delivery 36	5	8
Delivery 34	5	9
Delivery 1	5	10
Delivery 38	5	11
Delivery 40	5	12
Delivery 3	4	13
Delivery 32	4	14
Delivery 26	4	15
Delivery 18	4	16
Delivery 4	4	17
Delivery 16	4	18
Delivery 21	4	19
Delivery 20	4	20
Delivery 28	4	21
Delivery 30	4	22
Delivery 23	4	23
Delivery 27	4	24
Delivery 24	4	25
Delivery 22	4	26
Delivery 19	4	27
Delivery 8	4	28
Delivery 31	4	29
Delivery 13	4	30
Delivery 37	4	31
Delivery 9	3	32
Delivery 25	3	33
Delivery 33	3	34
Delivery 29	3	35
Delivery 39	3	36
Delivery 10	3	37
Delivery 17	3	38
Delivery 11	3	39
Delivery 14	3	40

Source: Author's study, 2016.

In the priority order established through use of the AHP, delivery 5 is the most important and delivery 14 the less important one to meet the strategic objectives according to the performed weighting.



The results obtained with the prioritization of deliveries must be discussed and evaluated by top management staff. If they do not meet the experts' expectations, all data, their sources, criteria and weightings made must be reviewed and adjusted so that the managers feel comfortable and safe to base their decisions.

It is relevant to note that the results found were obtained based on real data and analyses. However, the analysis of obtained prioritization is part of the scope of this study. This was used to contribute to the reproduction of the model in any organization and allow a better understanding regarding the results obtained with its application.

4.4 Strategic deliveries selection

Since these are contractual commitments, all deliveries have to be managed to meet the terms and conditions negotiated and, therefore, selecting those to be carried out is not part of the scope of this work. However, the activities associated with the delivery of flexible pipes are subject to all kinds of challenges, as well as to physical and financial limitations of the organization, its suppliers and subcontractors, and there may be deviations that affect supply premises and other conditions. The selected deliveries are those most relevant from the point of view of meeting the organization short, medium and long-term strategic goals, according to the chosen prioritization criteria and their relevance in a global context. These deliveries were then classified as strategic and are now monitored and controlled through a differentiated management system, entitled Strategic Delivery Management System.

The model adopted allows great flexibility in the selection method of deliveries, to ensure it meets the corporate strategy. The selection can be made based on the result of the prioritization or on one or more prioritization criteria. Although both forms of selection use the prioritizing obtained by weighting the criteria and business prospects, their results are different from the strategic point of view.

A selection based on the result of the prioritization allows decision makers to choose the 15 first deliveries or an amount corresponding to 10% of the total, for example. However, this kind of selection does not allow the maximization of one or more strategic goals.

On the other hand, in a quantitative selection based on prioritization criteria, the decision makers may opt to select a quantity of deliveries with a total gross margin of 40%, for example, of the total margin of delivery portfolio. Another option would be to combine more than one criterion. Thus, among other options, the organization select a quantity of deliveries representing in sum 30% of money in total cash

forecast for the current year, considering only the Brazilian-manufactured material deliveries.

4.5 Communication and deployment

The top management shall highlight deliveries seen as strategic for all levels of the organization and ensure that the operation departments understand the decision and become committed to achieving the desired results. For successful communication and deployment of delivery strategy, the following three important steps are important: cascading strategic goals for all organizational levels through formal performance evaluation tools; differentiate the strategic delivery from the others using management tools, such as meetings and reports; and implementing a structured process of escalating problems related to those deliveries for quick decision-making to solve them, establishing roles, duties and decision competence levels.

4.6 Monitoring and control

As stated in the communication and deployment step, the deliveries categorized as strategic shall be accompanied in different way by top management of the organization. Any actual or anticipated deviation shall receive priority treatment, so that decisions can be taken and actions implemented to reverse or minimize them. It is worthy to note that the purpose of marking a delivery as strategic is to define its relevance to organizational strategy, as well as to monitor and control its supply in a more transparent and detailed way, to prioritize actions and resources needed for its good performance and to achieve or exceed the expected results with such. This does not imply in anticipating, but in maximizing the achieved results.

4.7 Continuous improve

The top management staff shall revisit the SDMS every six months, as well as analyze the results of the strategic goals measured in the period. After this evaluation, a new cycle (Figure 1) of strategic delivery management starts, with a review of the system for the current situation, taking into account, but not limiting to, the possibility of occurrence the following events: deliveries carried out; new deliveries contracted; change in strategic goals and/or targets; relevant changes in internal and/or external environments; opportunities found for improvement in the current management system.

Any prioritization and selection reanalysis must be made in anticipation from the six-month period end, whenever there are relevant disruptions or facts that demand a new decision-making.



4.8 Results

We developed the SDMS based on the case study presented, using a combination of BSC and AHP methods to support decision-making with a focus on organizational strategy. The system can be used by any organization, as long as its staff sets its goals and targets, select the appropriate criteria and use the available data as described in this work. By using AHP method and the proposed selection model, the system provides the required flexibility to balance the performance criteria according to the current context and strategic goals. The prioritization of deliveries is carried out in a structured, objective and well-based way, allowing greater speed, efficiency and assertiveness in the results analysis and decision making process. Through communication and deployment of the selection performed, the organization ensures the implementation of short-term actions aligned with corporate strategy. The monitoring and control ensure that the expected results are achieved and the continuous improvement process enables the adoption of a successful strategy in a market increasingly competitive and in constant change.

4. CONCLUSION

In this work we propose a model called Strategic Delivery Management System, based on the integrated application of BSC and AHP methods to support the decision making process regarding the provision of flexible pipes, focusing on an organization strategic long-term goals.

We built a hierarchy for decisions based on four perspectives of the BSC and selected performance evaluation criteria. The AHP methodology was used to balance the evaluation of criteria of levels 1 and 2. We established a systematic management that structures the decision-making process according to the strategic relevance of deliveries, guides the tactical and operational force in the development of their daily activities and promotes continuous improvement.

The implementation of a delivery management system with the application of a multicriteria support method brings benefits to the process of supply of flexible pipes, allowing better alignment with organizational strategy, better results for stakeholders, greater control over deliveries critical for expected results and more speed in a decision-making process based on objective criteria and reasoned analysis.

In this context, we suggest for further research the application of SDMS in organizations that operate in the Brazilian and international markets for system improvement and enhancement of its results.

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