

Implementing the Balance Scorecard for the Improvement of the Warranty Management: The Strategic Alignment

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Abstract—Every day, companies are facing problems related to warranty management where the after sales organization and the product reliability are not always taken into account. In that context, this article attempts to integrate the management of warranty support in the overall business strategy, analyzing how decisions in this field can influence other faces of the business. With that intention, the paper introduces firstly the concept of warranty and proposes a framework for its management. This framework has been defined and used by the authors in other studies. Then, the Balanced Scorecard is depicted as a methodology to achieve the alignment of the department strategy with the overall business targets. Its application is described for the specific case of the maintenance management and later on, it is implemented to organize the technical assistance of the warranty support. The article shows finally a brief case study as an example, highlighting the most relevant points of the paper at the conclusions with the approach of future researches in this field. In few words, the analysis of this methodology is intended to help executives and after sales managers to align their local objectives with the overall goals of the business itself, avoiding the creation of a compartmentalized organization where decisions are made independently. This kind of organizational structure may negatively affect the company's future development, and consequently its image in front of the client.

Keywords—After-Sales Management, Balanced Scorecard, Customer Service, Decision Making, Process Improvement, Warranty Assistance

I. INTRODUCTION

Warranty is usually defined as a temporary commitment of the manufacturer or vendor, which is obligated to repair or replace cost free those goods or services already sold in case of failure, defects or lack in the effectiveness of its functions performance. The warranty is applied during a certain period of time after the product has been sold and its management combines technical, administrative and organizational aspects during the warranty period. The aim will therefore be to restore the item to a state in which it can perform the required function. Consequently, a structured preparation of the warranty should take into consideration that such assistance involves the risk of a high cost [1].

On the other hand, the warranty management organization includes those activities that determine the objectives, priorities,

strategies and customer service responsibilities, and implements a control, supervision and the proper organization of customer complaints. The priorities will be those purposes and goals assigned and accepted by the after-sales department and customer service, which may include the availability, cost reduction, customer satisfaction etc. In similar way, the term strategy implies those management and organization methods necessary to achieve the warranty objectives.

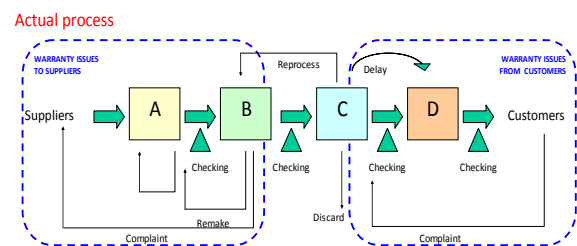


Fig. 1 The Warranty on a Company's Supply Chain

The warranty can be observed from the perspective of the buyer (customer), or from the perspective of the seller or supplier. The generic case is when a company is in the middle of the supply chain (see Figure 1), and must offer a warranty to their clients (managed by its after-sales department) and demanding a warranty service to its suppliers (managed by the department of operations or purchases). Many times, we find in practice that both efforts are themselves interrelated (i.e., cases where, for example, the complaint provided by a customer can be repaired under warranty by the supplier).

The ideal case would be that one where products are purchased from suppliers and, after the manufacturing process; they are sold to customers without defects or failures. This ideal situation is depicted in Figure 2. As mentioned, the preparation of warranty should be structured considering that the assistance involves the risk of high costs [1]. On the other hands, inefficient management of warranty programs can have a significant impact in the total operating costs [2].

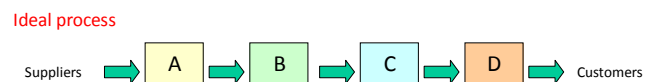


Fig. 2 Ideal Case Without Defects

Therefore, one can find methods that include economic aspects of the organization in the management of warranty (in one way and in another). Thus, different authors propose models or frameworks in order to manage systems efficiently. In this article, the warranty is seen from the perspective of the manufacturer who has to provide an after-sales service to its customers. Therefore, it is necessary first at all to emphasize the importance of a warranty management system. Here we propose a framework where one of the stages is the Balanced Scorecard. The main contribution of this paper is the appliance of a methodology as the BSC, in a specific area as the after sales organization and integrated in a reference framework that is suggested for a better management of the warranty assistances. All this is illustrated at the end of the paper with a brief case study where the essential features are easily transmitted.

II. LITERATURE AND BRIEF DESCRIPTION OF THE MANAGEMENT FRAMEWORK

On the management of warranty support and internal organization, many studies can be found dealing with the issue from different points of view [3] [4]. From these studies one can deduce characteristics and properties more or less appropriate depending on the scenario and context and, generally, conforming to a whole taxonomy of cases where the management area is possible to apply. In particular, there are different types of warranties depending on the type of product (consumer products, commercial, industrial, standard versus customized products, etc.). For example, in the market one can find:

- Standard products: FRW ("Free Replacement Warranty"), PRW ("Pro Rata Warranty"), or a combination of both.
- Commercial Products (bought in volume): A warranty applied to a fleet or group of items.
- Custom Products: RIW ("Reliability Improvement Warranty").
- Base warranty and extended warranty.
- Warranty in one or two dimensions.

This is described more deeply in reference [3]. In the literature review [3] [4], one can observe different interactions between the warranty and other disciplines, appreciating different models according to authors. Summarizing, four important interactions can be considered: warranty and maintenance [5], warranty and outsourcing [6], warranty and quality assurance [7] and warranty and cost analysis [8]. Based on the above lines and the experience observed in case studies (as the one described in reference [9]), it is provided a framework (Figure 3) where:

1) *Effectiveness*: As a first step, it is considered the effectiveness of a technical assistance program. In order to avoid contradictions between the strategic agenda of the warranty and the general business management, we propose the application of a Balanced Scorecard as the overall objective of this article. Once the warranty program objectives and strategy are defined, it is necessary to determine the criticality of the product. It is understood as the importance of a complaint for a

customer, due to a failure in the product and what the consequences to the company are. Also, the Failure Root Cause Analysis is considered in order to discover the reason for the appearance of a particular error, and how to correct the causes.

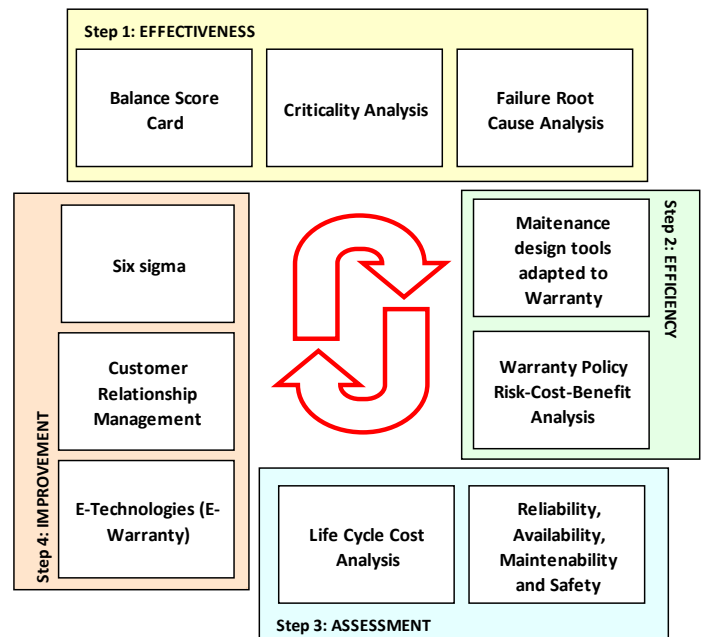


Fig. 3 Proposed Reference Framework for The Warranty Management

2) *Efficiency*: As a second step we consider the efficiency of the warranty program. Warranty for assistances with minimum expense, requires designing an appropriate plan. One method that may assist in the development of this plan can be drawn from the same management techniques as maintenance, designing tools adapted for the Analysis of Reliability and Maintenance. On the other hand, in terms of cost, the warranty policy on Risk Analysis, Cost-Benefit depends on the information available.

3) *Evaluation and control*: As a third step, we consider the evaluation and control of the assistance program. A study concerning the reliability, availability, maintenance and safety is important due to the large amount of restrictions and conditions that any complex product on the market has today in itself. To complete this third stage is important to include an analysis of life cycle costs. In this way, recommended references are [10], [11], [12] and [13].

4) *Improvement*: As a fourth step, we consider the improvement of the warranty program. The application of new technologies entails ensuring the introduction of the concept of "E-Warranty" which includes resources, services and management necessary for the decision to be proactive. This step also considers the Customer Relationship Management and Six Sigma methodology that integrates the human factor with statistical tools to perform complex mechanisms within a company, following all together a cyclical approach for the continuous improvement of the warranty management. See also [14] and [15].

For more information, this generic framework is developed and detailed in reference [16].

III. STRATEGICAL ALIGNMENT WITH THE OVERALL OBJECTIVES

The Balanced Scorecard (BSC) is a methodological tool with a multidimensional approach that can integrate corporate strategy of the organization with its own operation to determine the achievement of organizational objectives by assessing the performance of the business through management indicators [17]. Thus, the BSC helps to implement the strategies dictated from the managing board [18] and can also aligns the objectives of the departments or operating units with the overall strategic goals, controlling deviations. The BSC can be understood as a system of communication, information and training (on the strategy and the company itself), which does not replace the traditional process of strategic planning [19], but completes and helps the communication and implementation [20].

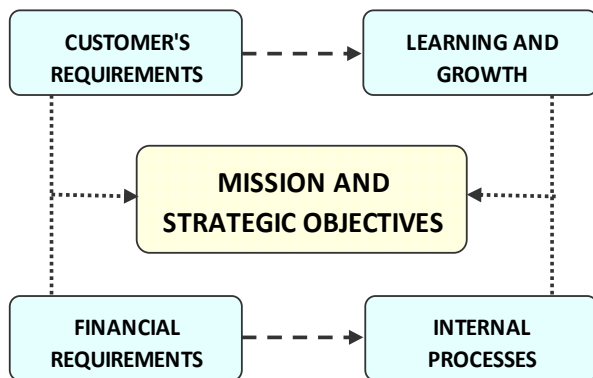


Fig. 4 BSC Perspectives

This approach transforms the vision and strategy into a set of targets and performance indicators grouped into four core perspectives (dimensions) that are considered key to the management and control [21] (Figure 4):

- 1) *Learning and growth perspective.* The aim is to ensure the adaptability and long-term renewal of the company (in response to changes caused by the environment) as well as maintaining knowledge in the areas considered core competencies.
- 2) *Internal process perspective.* It considers the quality, productivity, and costs of various processes developed by the organization's mission, including the maintenance management process (number of defective units, production cycle time, capacity of equipment, etc.).
- 3) *Customers Perspective.* It assesses how to generate value for customers. It seeks to measure the impact and satisfaction level in the organization generates its customers.
- 4) *Financial Perspective.* It searches for measuring the survival, growth and development of the organization in financial and value creation.

The BSC retains the technical and financial measures [21], but also performs a more general set of measurements, integrated linking internal processes, employees and the performance of systems with the company's success long term. In this way [24], the BSC complements financial indicators while clarifying, translates and transforms the vision and

strategy, helping to identify, plan and strategic initiatives. For its part, the indicators should be defined to measure in a clear order to which they are associated, allowing the same strategic monitoring and evaluation of their achievement by a resource assigned for that purpose. Thus, each initiative will be observed by an indicator and a resource that will monitor their compliance. Then, it defines the initiatives and strategic actions that will achieve the objectives and goals. The establishment of actions requires taking into account the implementation effort and the benefits derived from them. Finally, it must establish an adequate monitoring system to assess the degree of achievement of strategic objectives on a regular basis [24], and thus be able to make decisions and corrections to the strategy defined from them. The indicators taken into account in the BSC methodology should be relevant, practical, measurable and implementable [25]. There are two types of indicators in the BSC framework [26], [22]: performance indicators (lag measures) and performance indicators (lead measures). The BSC should be a balance between both types of indicators, since both are necessary [23]. Lag indicators reflect results of past decisions, giving information about what happened, but unable to change the outcome. On the contrary, Lead indicators generally measure the performance of processes detecting what is happening and take appropriate action to improve the outcome, being more predictive and enabling faster settings. Once defined the indicators, they need to be integrated with other information systems pre-existing in the organization [17]. In addition, it should identify each data sources needed to feed the indicators at appropriate frequency.

IV. BSC PRINCIPLES IN THE GLOBAL MANAGEMENT OF MAINTENANCE

The BSC is a process of dialogue and communication in all areas of an organization including the maintenance. Due to the fact that this communication process successfully works, it achieves greater participation, alignment and synergy. The management of financial and technical indicators allows the company to use the same language on maintenance management. The financial prospects, customers, and learning processes suggest, for example, performing calculations based on the availability of the average time to repair and the mean time to failure, improving the relationship between parameters such as production, costs and availability. The last goal of the BSC applied to maintenance management is to transform the strategic objectives of maintenance based on key performance measures that can be comparable and develop based on the four perspectives of the methodology (Table 1).

The process involves setting measures, achieving goals and action plans to accomplish them. In this way we can go aligning our management with business objectives, even more if we continue to develop key measures through a series of functional measurements, closer to the results obtained in the different business processes and therefore easier to control. The BSC enables the deployment and full implementation of the maintenance strategy at all levels of the company, encouraging the participation of everyone involved in the achieving of strategic objectives and the alignment through the organization, transforming the strategy into specific action plans.

TABLE I OVERALL APPLICATION OF THE BSC APPROACH TO MAINTENANCE MANAGEMENT

Strategical objectives	Measures (KPI's)	Goals	Action plans	Perspective
Improving the effectiveness of warranty costs	Warranty costs per unit sold	Actual (X) % Objective (X-1)%	Ensuring an appropriate data acquisition and performing criticality analysis in equipment	Finance
Improving the time to repair and the assistance	Repetitive failures MTTR	Repetitive failures < x Reducing the MTTR in a (Y)%	Failure analysis program and improvement of the after-sales support	Customers
Improving the assistance process and its documentation	Regulations compliance	Assistance certificate before a specific date	Development of procedures and outstanding technical inspections	Internal Process
Ensuring adequate levels of training to fulfil the mission	Level of training according to assistance type	Definition of adequate levels of training	Training and evaluation performance	Learning

V. APPLICATION TO IMPROVE THE EFFECTIVENESS OF THE WARRANTY MANAGEMENT

As already mentioned, this methodology aligns local targets from a department or business unit, with the overall objectives of the company. In the case of warranty management, it is used the principles of the BSC methodology within a framework of continuous improvement (Figure 5) in order to avoid possible contradictions between the warranty program and the overall business strategy. Therefore, it is proposed to apply the methodology of Balanced Scorecard (BSC)

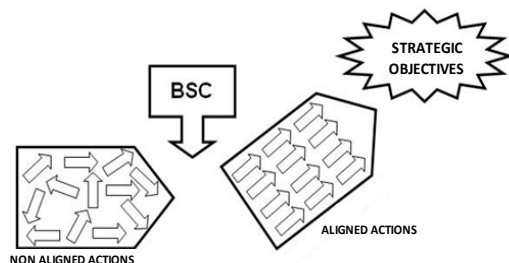


Fig. 5 Strategic Alignment with the Implementation of the BSC

Basically, this methodology considers the goals and objectives around four points of view as shown in Figure 6. The BSC applied to the management of a warranty program includes the following steps:

- 1) Strategic warranty program (such as the possible outsourcing [6] of the assistance under warranty, or the development of technical equipment versatile for warranty).
- 2) Translating after sales strategy achievable in the medium term objectives (such as the identification of measures to push the involved staff).

3) Development of action plans (to achieve the objectives identified in the previous step, and taking into account changes in the infrastructure necessary to support the organization).

4) Periodic review of the results and the strategy (to quantify precisely the progress to formulate new strategic objectives, action plans or revision of the scorecard).

After defining the objectives and strategy for the warranty program, it is needed to determine the criticality of the product. The criticality analysis is understood in this context as the impact that a claim can have in the global strategy and expected results. The decisions and actions of warranty program may involve the possibility of some deviation from business goals (in terms of lost profits, readdress of resources, possible delays, the use of manufactured components as spare parts, etc.) Therefore, it requires the application of systematic techniques to help determining which goods should have priority in the management process assurance program in accordance with the existing strategy. One of these techniques may be based, for example, on a risk assessment costs.

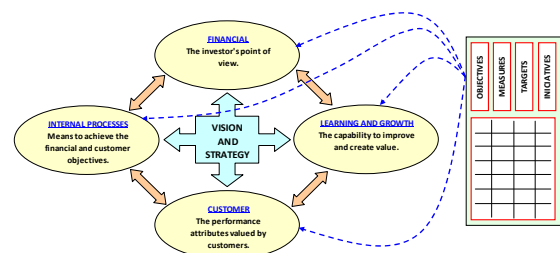


Fig. 6 Prospects for Achieving Objectives through a Balanced Scorecard

Criticality analysis based on a combined risks-costs probability that an event will happen, with the impact that this event could cause. As a result, one gets a criticality matrix that provides an overview of priorities for events likely related to issues of warranty, allowing us to align actions with goals of the after sales business. Thus, it is possible to predict where to apply resources to mitigate risks, reduce the cost of the warranty and customer dissatisfaction. Finally, when the strategy to follow has been already defined and likely events have been prioritized, it is time to focus on those customer complaints related to repetitive or chronic damage as high priority events. If it is possible to find and eliminate the causes of these failures through early intervention, this will provide an important initial advantage in the strategy and quick warranty program. In any case, there are several methods already developed for carrying out this analysis of weak points.

VI. CASE STUDY UNDER FINANCIAL PERSPECTIVE

This practical example is based on the case described in reference [27] where it is considered a company dedicated to the manufacture and assembly of agricultural machinery. In this company, its main market and a significant portion of their profits in production is the sales and repair of harvesters and harvester heads, both first- and second-hand production. A key issue for the company is to improve and optimize the delivery of support services, i.e., to improve after-sales processes to increase profits from this business and retain customers in ways that ensure future sales. Post-sales activities involve the

provision of spare parts, warranty service and maintenance contracts with customers. The company's management aims to compare from the financial point of view, which of the four sides of the business (selling new and used harvesters, and selling new and used heads) is more efficient in terms of warranty costs, so that from a global perspective, the company can re-organize the objectives and ensure proper customer service in all its products in a satisfactory way, thereby detecting which product gives higher or lower benefits. The inactivity of a harvester can cause great losses to the client, so that during the harvest season these machines must be in its best performance and, in case of failure, we must warranty a quick repair, either by the company or by one of its authorized service centres. For this reason, the company must address a new strategy to reduce the amount of technical assistance interventions, especially during the harvest season because these services of corrective repairs are completely unplanned and difficult to control. To this end, the company decides to take as measures or KPIs ("Key Performance Indicators"), the sale price of the product, the corresponding cost of the warranty, the percentage that they represent regarding the selling price, and the objectives (both percentage and monetary) about what cost should be under warranty. These data are shown in detail for each product type in Tables 2, 3, 4 and 5 according to the type of machine. In the case of data on new and used heads (Tables 3 and 5), it is considered the price taking into account the head itself as a reference and not the rest of the machine (for all practical purposes, this case study considers a base price around €180,000 for the machine). The numbering of the case study projects has been distributed according to the time evolution where, supposedly, manufacturing processes are improving and the problems in the warranty period should tend to decrease..

According to reference [28], maintenance can be defined as actions that control the process of deterioration which leads to the failure of a system (preventive maintenance) as well as restoring a system to operational status through corrective actions after failure (corrective maintenance). When a manufacturer is required to attend an assurance client, both parties must be clear about the content of such service and which should be the circumstances under which assistance is serviced under warranty or not. In the sale of agricultural machinery (both new and used), like many other sectors, there is the possibility of maintenance contracts and / or warranty extensions.

This is not the purpose of this study, but may be of interest to evaluate, using the Balance Score Card methodology, how the introduction of preventative maintenance contracts can impact customer service performance of the company. That means, this case study can be viewed from three different scenarios:

- Scenario A: There are no preventive maintenance contracts, either during the warranty or beyond.
- Scenario B: The users employ preventive maintenance services only during the warranty period.
- Scenario C: Users employ preventive maintenance services, not only during the warranty period but once it expires, along the product life cycle.

TABLE II KPI RELATING TO MODEL 554 HARVESTERS

Pro- ject	Ma- chine	Selling price (€)	Wa- rranty (€)	% Warr. / Selling price	Objec- tive %W. / Se- lling price	Impr. Obj. %W. / Se- lling Price	Warr.Obj. (€)	Impr. Obj. War. (€)
PF 102	554 BCT	156.309	528	0,3%	2%	1,8%	3.600	3.240
PF 103	554 BCT	180.000	406	0,2%	2%	1,8%	3.600	3.240
PF 114	554 BCT	171.000	918	0,5%	2%	1,8%	3.600	3.240
PF 115	554 BCT	147.090	1.818	1,2%	2%	1,8%	3.600	3.240
PF 116	554 BCT	150.000	191	0,1%	2%	1,8%	3.600	3.240
PF 117	554 BCT	150.000	226	0,2%	2%	1,8%	3.600	3.240
PF 118	554 BCT	182.000	314	0,2%	2%	1,8%	3.600	3.240
PF 119	554 BCT	176.724	1.065	0,6%	2%	1,8%	3.600	3.240
PF 120	554 BCT	147.500	532	0,4%	2%	1,8%	3.600	3.240
PF 121	554 BCT	173.748	1.686	1,0%	2%	1,8%	3.600	3.240
PF 122	554 BCT	175.000	4.561	2,6%	2%	1,8%	3.600	3.240
PF 123	554 BCT	165.000	243	0,1%	2%	1,8%	3.600	3.240
PF 125	554 BCT	165.000	946	0,6%	2%	1,8%	3.600	3.240
PF 128	554C	170.791	901	0,5%	2%	1,8%	3.600	3.240
PF 129	554B	190.790		0,0%	2%	1,8%	3.600	3.240
PF 130	554B	191.000	2.268	1,2%	2%	1,8%	3.600	3.240
PF 131	554C	193.000	2.239	1,2%	2%	1,8%	3.600	3.240
PF 132	554C	188.476	3.227	1,7%	2%	1,8%	3.600	3.240
PF 133	554C	179.740		0,0%	2%	1,8%	3.600	3.240

TABLE III KPI ON LM MODEL HEADS

Pro- ject	Ma- chine	Selling price (€)	Wa- rranty (€)	% Warr. / Selling price	Objec- tive %W. / Se- lling price	Impr. Obj. %W. / Se- lling Price	Warr.Obj. (€)	Impr. Obj. War. (€)
MC 00	LM 6000	55.524	4.678	8,4%	2%	1,8%	1.200	1.080
MC 01	LM 5000	67.000	2.581	3,9%	2%	1,8%	1.200	1.080
MC 02	D225 +LM 6000	206.750	5.279	2,6%	2%	1,8%	1.200	1.080
MC 03	D210 +LM 6000	237.154	978	1,7%	2%	1,8%	1.200	1.080
MC 04	DX1 80 +LM 5000	215.000	190	0,5%	2%	1,8%	1.200	1.080
MC 05	LM 6000	74.000	947	1,3%	2%	1,8%	1.200	1.080
MC 06	LM 5000	58.000	1.396	2,4%	2%	1,8%	1.200	1.080

TABLE IV KPI ON USED HARVESTERS

Pro- ject	Ma- chine	Selling price (€)	Wa- rranty (€)	% Warr. / Selling price	Objec- tive %W. / Se- lling price	Impr. Obj. %W. / Se- lling Price	Warr.Obj. (€)	Impr. Obj. War. (€)
OP 02	CAT 574	115.000	439	0,4%	2%	1,8%	2.600	2.340
OP 09	CAT 574	85.000	297	0,3%	2%	1,8%	2.600	2.340
OP 36	EL 574B	162.000	2.259	1,4%	2%	1,8%	2.600	2.340
OP 51	TJ1210Y	60.000	570	0,9%	2%	1,8%	2.600	2.340
OP 63	P Bisón	90.000	3.840	4,3%	2%	1,8%	2.600	2.340
OP 67	P Bisón	70.000	933	1,3%	2%	1,8%	2.600	2.340
OP 70	CAT 574	75.000	3.540	4,7%	2%	1,8%	2.600	2.340
OP 72	CAT 574	70.000	-		2%	1,8%	2.600	2.340

TABLE V KPI ON USED ON HEADS

Pro- ject	Ma- chine	Selling price (€)	Wa- rranty (€)	% Warr. / Selling price	Objec- tive %W. / Se- lling price	Impr. Obj. %W. / Se- lling Price	Warr.Obj. (€)	Impr. Obj. War. (€)
OP 66	CAT 550	110.000		0,0%	2%	1,8%	3.000	2.700
OP 10	CAT 570	121.052	258	0,2%	2%	1,8%	3.000	2.700
OP 15	CAT 580	172.133	1.334	0,8%	2%	1,8%	3.000	2.700
OP 18	CAT 550	120.000		0,0%	2%	1,8%	3.000	2.700
OP 21	V 921.1		4.666		2%	1,8%	3.000	2.700
OP 25	CAT 550	94.828	1.293	1,4%	2%	1,8%	3.000	2.700
OP 27	CAT 580	155.000	7.366	4,8%	2%	1,8%	3.000	2.700
OP 35	DX 225	220.444	469	0,2%	2%	1,8%	3.000	2.700

This case study is based on the scenario A. That means, only warranty costs are considered. However, the results of this analysis can be very different if we consider the influence of a maintenance contract. Continuing with our particular case, Figure 7 shows four graphics that result from the above tables. In these graphics, the percentage values (blue dots) represent the cost of warranties regarding to price; the solid blue lines represent the tendency of such warranty; the red lines represent the target value; and the green lines represent the "challenge" or better target proposed. The upper right corner of each graphic shows the average total cost of warranty on the sale price. Summarizing, these graphics show the trends of warranty costs: upward (if harvesters used), down (if heads LM) or oscillating to a higher or lower degree. Those products with trends upwards are marked with a red triangle, while the contrary trend is marked with a green rectangle. Similarly, one product with a percent average of warranty costs that exceeds the target value is marked in red, while the opposite (those that improve the objective) are marked in green. In conclusion, we observed that the business of selling heads LM Model does not present an appropriate behaviour in the after-sales service from the financial point of view. At the other extreme is the case of

the Harvester Model 554. On the other hand, in the case of the sale of used or second hand we see that, despite the compliance in both cases the goal of warranty costs, the tendency for after sale service of used harvesters is that these costs will exceed the target value in a future. These values, trends or changes observed in the different graphics also show the results derived from the decision-making (restructuring of staff, or upgrades of repair tools etc). In any case, the methodology of Balanced Scorecard is a simple aid for the detection of problems, being able to quickly represent in front of a steering committee problems of the circumstances that could generate them.

VII. CONCLUSIONS

With the sale of a product, the manufacturer is contractually obligated to provide warranty support to the buyer. Logically, the cost reduction is not the only aspect to achieve here, but decisions should be comprehensive and strategic within the company to bring to the market a robust and reliable product offering also an appropriate after-sales service for the user. For that reason, the key issues that have been presented in this article are intended for the company to take the right decisions to achieve successfully its objectives. To this goal, not only executives and managers should participate in a well established and controlled organization also will be important to have the expertise provided by technical staff and post-sales maintenance.

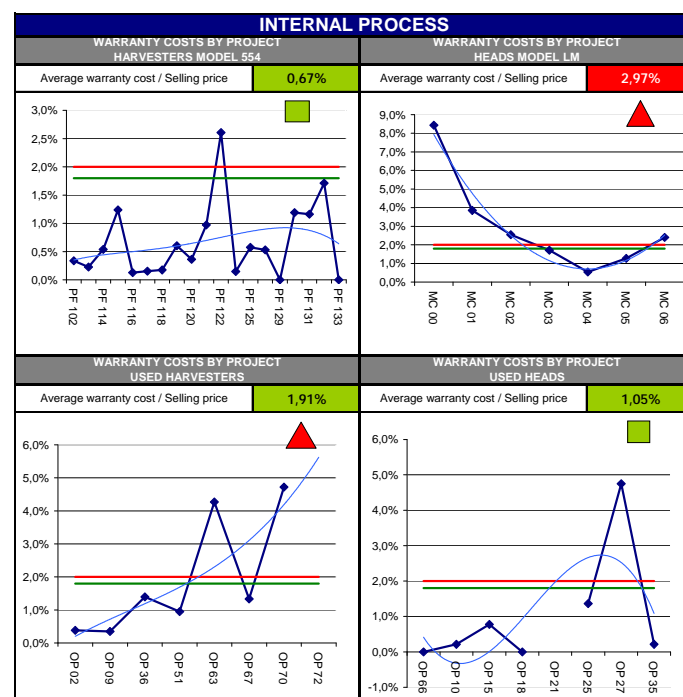


Fig. 7 BSC Financial Perspective

In this article we have suggested a framework (Figure 3) for the management of warranty support that uses engineering techniques already developed for similar processes. The different steps of this generic framework have been sorted into four sequential phases in which each technique plays a crucial role. Within this framework has been noted as essential to apply the methodology of the Balanced Scorecard to align and

harmonize local customer service goals with overall business objectives.

In few words, following this scheme we have tried to support the management of a warranty program, offering a practical view of the managerial stages, improving not only the reliability of the product, but also the relationship between manufacturer and user. Especially, this paper has dealt with the relationship of the department responsible for customer service with other departments. The engineering management processes, the feedback information and proper application of the warranty organization not only determine the quality of the product but also the attention given to the user, to influence the final satisfaction of the customer and the self image of the company in the market.

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