Warehouse Management System Implementation

The Case Study of Sociedade Central de Cervejas e Bebidas

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Abstract

The growth strategy of Sociedade Central de Cervejas e Bebidas (SCC) is based, partly, in cost reduction. The set of initiatives taken to achieve this reduction include the implementation of a Warehouse Management System (WMS) in the finished product warehouses of this company's Vialonga plant.

The problem analyzed in this work is the determination of all the benefits and costs that this implementation is expected to bring as well as the determination of which system best meets SCC's needs and which company should be responsible for its implementation.

Based on the literature review, a methodology divided in two stages is proposed, one for each part of the problem analyzed. The application of these methodologies to the case of the Portuguese company shows that a minimum NPV of € 529,201 and a maximum Payback Period of 2.5 years should be expected with the implementation of a WMS and that SAP EWM system 7.0 EHP 2 suits the company needs.

Keywords: Warehouse Management System, Sociedade Central de Cervejas e Bebidas, Warehouse Management, Business Case, Software Selection.

1. Introduction

A Warehouse Management System is a software developed in the mid-1970's that allows companies to control the movements and storage of their products by directing the workers in a warehouse (Hill, 2003a). The development of a business case that will be presented to managers in order to convince them in investing on a WMS is the first step a company should make after identifying the need to implement a WMS. To build this business case, the identification of all the benefits and costs a company expects to face after acquiring such system is needed (Barnes, 2002).

After managers are convinced, the next step is to select the software and the company responsible for its implementation (Hill, 2003b). There are several publications and reports on these subjects but none that presents in a structured way how these two steps should be conducted and accompany this explanation with a practical application. The main objective of this paper is to eliminate this gap and contribute to future Warehouse Management System implementations by creating a methodology which can be understood and used by any company. The methodology is tested by the application to the SCC case.

2. Case Study

2.1. Sociedade Central de Cervejas e Bebidas

Sociedade Central de Cervejas e Bebidas is a Portuguese company whose main business is the production of beverages that are distributed both in the domestic and international market and is part of the Heineken group since 2008. In Portugal, the SCC produces and bottles the Sagres beer brands in its Vialonga plant and captures and bottles mineral and spring waters, Luso and Cruzeiro in its Vacariça industrial unit where Luso Fruta is also produced. The Warehouse Management System (WMS) will be implemented in Vialonga's finished product warehouses.

2.2. Vialonga's Plant

It is in this plant that SCC produces bottles and stores Sagres beer brands and their variants, with and without alcohol, as well as stores imported products belonging to the Heineken portfolio. It has 8 warehouses from which 3 are finished product warehouses that store the products produced in the production lines, the imported products and the products returned by customers. The items contained in these warehouses are used to fulfil orders from the domestic market customers as well as orders from the export market customers. The WMS will be implemented in these finished products warehouses.

2.3. Finished Product Warehouses

There are several processes occurring in these warehouses every day such as the receipt of imported products, management of returns, customer sales, replenishment of picking areas and inventories. Currently, these processes are heavily dependent on the knowledge and decisions made by forklift drivers and team leaders. In contrast with the current situation, WMS will guide operators in their daily tasks (based on a real time control of inventory) indicating them, for example, the storage location where they should put the products that are received in the finished product warehouses and where they should pick the pallets that are going to be shipped to fulfil an order. This system also allows the automation of some processes such as the replenishment of the picking areas (automation of processes means that employees are warned when they have to be made). Furthermore, WMS supports a paper-free environment, sending instructions *wirelessly* to the warehouse workers (Hobkirk, 2007). Due to the contrast between the current way of working in these finished product warehouses and WMS's way of functioning, SCC expects that the implementation of such a system will bring improvements such as better organization and use of available space in storage, assurance that FEFO (First Expired First Out) is maintained and that the specifications of each client are met which will lead to a reduction in returns due to products delivered with limited shelf life or undue palletization and perpetual inventory system where errors are almost inexistent.
The differences between the current and future processes after the WMS implementation as well as the improvements identified are the basis for the application of the methodology developed in this paper.

3. Literature Review

3.1. Justify the WMS Acquisition

Top management approval is necessary after the need to acquire a WMS has been identified. To obtain this approval, a document (business case) containing all the benefits (quantitative and qualitative) and costs expected must be built. Qualitative benefits should be included in the narrative form while quantitative benefits should be included together with the costs in the economic justification of the project. Among the most used economic justification tools is the calculation of the Net Present Value (NPV) and Payback Period. The first calculates the net monetary gain that is expected of a project by discounting all future cash flows up to the present time using the rate of return required by the company. Cash flows can be negative (costs) or positive (income or savings). Given n the planned time frame, CF the total expected cash flows for each period and i the rate of return, the NPV can be calculated as follows:

$$NPV(CF) = \sum_{t=0}^{n} a_t CF_t = \frac{CF_0}{(1+i)^0} + \frac{CF_1}{(1+i)^1} + \cdots + \frac{CF_n}{(1+i)^n}$$

If the NPV of a project is greater than or equal to zero, the project should be accepted because the project rate of return equals or exceeds the rate of return required by the company. If the NPV is negative, the investment is not justified. The Payback Period is the period of time required for the savings of a project to pay back the initial investment, or in other words, when the NPV becomes zero. In general, the shorter the Payback Period, the more desirable the project. One way to strengthen the credibility of the economic justification is by performing a sensitivity analysis to examine how the results will change if the anticipated financial results are not achieved or if one of the underlying assumptions changes. The sensitivity analysis allows managers to evaluate the safety margin associated with the project and the key assumptions that drive the justification. The business case can be developed by an external consultant or a team made up of company employees who have a great knowledge of how the WMS will change the way you work and the advantages that these changes will bring (Barnes, 2002).

3.2. WMS Selection

After obtaining the top management approval, the company needs to select the software and the company responsible for its implementation (Hill, 2003b). There are situations where the company that developed the WMS is not the one to ensure its proper implementation, and this task is assign to a consultant who has a strong experience in system implementations (Harrington, 2001). The selection of the best combination between the software and implementing company can be divided into six steps: form a project team that will not necessarily be the same as the team that developed the justification for the acquisition of WMS (Hill, 2003b), this team should include representatives of the various areas affected by the implementation of the system, such as logistics, customer service and information systems (Finkel, 1996); analyze the gap between current operations and the desired changes identified during development of the business case allows the establishment of technical requirements; pre-select three or four combinations that seem to be the most suitable to meet the company's needs, taking into account not only the technical requirements but also a set of other criteria (Hill, 2003b); thoroughly evaluate these combinations by contacting a few references of the implementing company (Friedman, 2005), trying to understand what was the working relationship between it and the company where the WMS was implemented (Finkel, 1996); decide which combinations are attractive enough that a visit to one or two references is worth (Friedman, 2005); make a decision. The entire collection of information made should not be seen as a simple ranking, a company must be confident that all the information and all alternatives were analyzed (Finkel, 1996).

4. Proposed Methodology

4.1. Business Case Development

The part of the proposed methodology developed to assist in the business case development for the WMS acquisition can be divided into 8 steps and is represented in Figure 1.

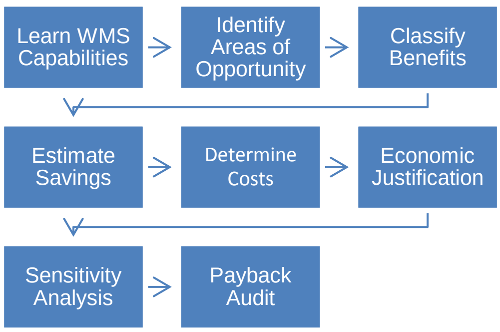

Figure 1 – Methodology for the Business Case Development

A thorough understanding of how a WMS works, how it supports optimized practices and how these practices fit within the company environment is required when a company wants to start developing the business case. Various sources can be used to learn more about WMS, including case studies, contact with suppliers, consultants and other users of this software. After gaining more knowledge about the WMS, it is necessary to identify the benefits that result from implementing this type of system. However, not all of these benefits will be a reality for every company that is considering acquiring this type of software. For this reason it is necessary that each business analysis the various processes occurring in their warehouses as well as the performance metrics used in order to identify the changes that the WMS will cause both in the processes as in the metrics values, allowing them to identify opportunities for improvement for their particular case. This analysis should not be limited to the warehouse but include other areas that will also be affected, such as customer service (Hill, 2002). As already mentioned, the benefits identified can be classified into qualitative and quantitative. This classification will influence how each benefit will be included in the business case being that the qualitative benefits should be included in the narrative form and quantitative benefits should be included together with the costs constituting the economic justification of the project. According to Barnes (2002) and Hills (2002), the set of benefits which are classified in most cases as being quantitative includes labor productivity improvements, error reduction, equipment and respective maintenance costs elimination, space utilization improvements, equipment repair area reduction, inventory accuracy improvements, inventory levels and carrying costs reduction, physical inventory counts elimination, shelf life losses due to expiration issues reduction, shipping accuracy improvements, legacy support reduction, legacy hardware and software elimination, returns and respective penalties from clients reduction and paper reduction. According to the same publications, the set of benefits which are classified in most cases as being qualitative includes employee morale improvements, employee turnover and training reduction, product damage reduction, expedited shipments and fees payed to the transportation company reduction, customer satisfaction, orders visibility and value added services increases and consequently sales growth. The quantitative benefits are also called savings and will be included in the economic justification as positive cash flows (Barnes, 2002). The methods used to estimate the quantitative benefits that apply to the SCC's case are explained in the next chapter of this paper. Once identified all the benefits, it is necessary to quantify the costs associated with the WMS implementation which will be included in the economic justification as negative cash flows. The actual costs of a WMS can only be quantified after its acquisition and implementation so, when developing a business case, the company needs to estimate these costs. The data needed for this estimation can be obtained using WMS solutions suppliers or experienced consultants. The costs can be divided in seven categories and each category can be assigned a percentage of the total project cost. This information is summarized in Table 1.

Table 1 - Costs Categories (adapted from Barnes, 2002)

Investment Category	% of Total
Software & Hardware	30-60
System Integration	30-35
Software Vendor Assistance	10-15
Host System Modifications	5-10
Internal Corporate Costs	5-10
Contingency & Other Costs	5-15
Annual Maintenance	15-20

The first category includes the WMS license cost but also the costs with databases, servers, printers, PCs and scanners. In the second category are included costs with consultants and operational changes and in the third category are included costs with professional services provided by the company responsible for the implementation, such as project management. Costs associated with the interface programming are comprised in the fourth category. The investment made in special training and employee retention is considered to be part of the fifth category. Contingency and other costs include “just in case” money. The annual maintenance cost is normally priced as percent of contract value (Barnes, 2002). After estimating the savings and costs that are expected with a WMS implementation is then necessary to compare these cash flows in order to understand if the project is economically profitable for the company. Various tools can be used for this comparison being the most common the calculation of the NPV and Payback Period. The use of these tools requires the determination of the time period over which the savings and costs should be compared. The value most often used for this time horizon is five years. There are three key issues that will impact the values obtained with the application of the two tools. The first is related to the time over the five years in which the savings are considered. The identified quantitative benefits are not immediately felt by companies because in the months after the company begins to use the system the workers are still getting used to it. For this reason, some companies choose to consider the value of savings in the 1st year as half the value of savings in the following years (KOM International, 2006). The second aspect is related to the number of times each saving is considered. These may be one-time or recurrent savings and the classification of each quantitative benefit under this concept is important to classify. The third aspect to consider is how the savings vary over the five years. To calculate these variations, data such as the average increase in the cost of employees and the annual business growth must be taken into account (Barnes, 2002). One way to strengthen the credibility of the business case is to perform a sensitivity analysis on the economic justification in order to analyze how the results (NPV and Payback Period) will change if the anticipated savings are not achieved or if one of the assumptions made changes (for example, the initial cost of the project may have been underestimated). This analysis allows top management to assess the safety margin associated with the project and the fundamental assumptions that lead to economic justification and it is built by comparing the NPV and Payback Period calculations under different assumptions of annual cash flows (Barnes, 2002). After the implementation of the system, it is important for the company to make a comparison between estimated savings and costs and the current situation. This analysis should be done regularly (after 6, 12, 18 and 24 months) and the real costs and benefits should be used to update the business case (Hill, 2002).

4.2. Software and Implementation Company Selection

There are hundreds of combinations between WMS systems and companies able to implement them. This diversity makes the software and implementation company selection process rather complex (Hill, 2003b). Ideally, when a business starts this selection process, all combinations of systems and companies able to implement them, should be consider. This is difficult to achieve due to lack of a database that consolidates the entire offer. Even if such database exists, getting information relevant to select the best combination would be a time-consuming process that would require the use of many resources. In this paper the online WMS selection tool provided by Fraunhofer Institute for Material Flow and Logistics (FIMFL) is used. It is based on a database of more than 80 combinations of systems and implementing companies which eliminates the difficulty mentioned above by bringing together supply and respective relevant information. Even if a company chooses not to follow the combination suggested by the tool, its use will allow a greater awareness of the business needs and what to look for in a system and the company that will be responsible for its implementation. Thus, the use of this tool can be seen as a pre-selection of combinations based on the established technical requirements and can be combined with the evaluation of these combinations by contacting/visiting one or two references of the implementing company. The 3 major steps for using this tool are described in Figure 2.

Figure 2 - Methodology for the Software and Implementation Company Selection

The first step is the determination of the K.O. attributes. The tool provided by the FIMFL has 54 of this attributes which can be selected. Two examples are showed below:

- In which countries must the WMS vendor be able to perform sales activities (pre-sales, proposal preparation, contract negotiations) in the local language?
- Does the system have to support Pick-by-Voice technology?

As perceived by the examples given, some of these attributes allow more than one answers (first example) whereas others are questions of yes or no (last example). All combinations between WMS systems and implementation companies that do not fulfilled the selected K.O. attributes are excluded from the list of potential choices. Therefore, this step will result in a list of combinations that comply with the requirements of the company that will acquire the WMS. To distinguish these combinations and evaluate which one is the best for the business, weights must be assigned to an extensive list of function attributes. The version of the tool used in the development of this work features 19 functional groups which are subdivided into 311 function attributes. Some of these attributes correspond to questions whose answer can vary only between "yes" or "no" while others correspond to questions with several possible answers. A weight, from 0 to 5, must be assigned to each functional groups, function attribute and potential responses according to their importance for the decision maker, which means that, altogether, more than 1,000 weights should be assigned. After this, it is time to assess the combinations still under consideration (the ones that fulfilled the K.O. attributes). The tool allows the automatic comparison between customer requirements and the features offered by each WMS and companies responsible for its implementation. This evaluation is based on the conversion of the assigned weights in the previous step into scores according to the relation shown in Table 2.

Table 2 - Relation between Weights, Importance of Attributes and Respective Responses and Scores (adapted from Fraunhofer IML, 2014)

Weighting	Importance of the Question or Possible Answer	Score
0	The question is not included in the analysis	0
1	The question is not important	1
2	The question is not very important	2
3	The question is important	4
4	The question is very important	9
5	The question is extremely important	16

The observation of the Table 1 allows concluding that a combination needs to have many positive responses in not important attributes to overcome other combinations with an affirmative answer on an attribute that is extremely important (Fraunhofer IML, 2014).

5. Results Analysis

5.1 Business Case Development

The stage of the proposed methodology developed for the business case development begins with learning the WMS capabilities. In this paper, this knowledge was obtained by performing the literature review. Semi-structured interviews were conducted with some Vialonga's plant employees in order to realize the extent to which tasks they perform daily will be affected after the WMS implementation and identify improvement opportunities that SCC can expect with the acquisition of this system. From the benefits identify in section 4.1 of this paper, those who apply to the Vialonga's plant are shown below, divided into quantitative and qualitative benefits.

Quantitative benefits – labor productivity improvements, equipment and respective maintenance costs elimination, inventory accuracy improvements, inventory levels and carrying costs reduction, physical inventory counts elimination, shelf life losses due to expiration issues reduction, shipping accuracy improvements and clients' returns reduction.

Qualitative benefits – employee training reduction, space utilization improvements product damage reduction, expedited shipments reduction, customer satisfaction, orders visibility and value added services increases, sales growth and paper reduction.

It is important to mention that, although space utilization improvements and paper reduction were defined as quantitative benefits in section 4.1, they are classified in this section as qualitative benefits because their quantification it's difficult in the case study analyzed in this paper.

Once identified and classified the benefits it is necessary to quantify the savings (quantitative benefits) and costs. It should be noted that due to confidentiality reasons, the data presented do not correspond to reality and were obtained by multiplying the actual data with a common factor. In this paper, this quantification will be performed under three different scenarios. The first scenario presented is the worst case scenario as it is the one that presents higher costs and lower savings; the second scenario presents cost and savings with values in between the other two, and the last scenario analyzed is the best case scenario because it is the one that presents lower costs and higher savings. The difference between the analyzed scenarios lies in the percentages attributed to the labor productivity improvement, to the inventory accuracy after the WMS implementation and to the internal corporate costs, contingency costs and annual maintenance because these are the variable data necessary for the calculations conducted in this paper. This calculations will only be explain to the worst case scenario as this is the most conservative among the three and it is the one that is going to be used in the sensitivity analyses. It is also important to note that the values presented are rounded and for this reason if the reader tries to do the calculations some inconsistencies may appear because the results presented were calculated using the exact values. In 2014 were shipped from Vialonga's plant 23,213,912 sales units. In the expedition of these units are involved several employees, however, the implementation of a WMS will change more significantly the tasks of truck drivers and will eliminate multiple tasks performed by team leaders and checkers. As regard to forklift drivers, there were in 2014, 44.2 FTEs (Full Time Equivalents) in the finished products warehouses. Each of these workers costs around € 33,460 per year (including wages, insurances among others). The productivity of each FTE is 525,042 sales units per FTE. Considering a business growth of 3% per year, in 2016 Vialonga's plant will ship 24,627,639 sales units. With a productivity of 525,042 sales units per FTE, 46.9 forklift drivers would be required to handle this business volume. With WMS implementation, a minimum productivity improvement of 10% (worst case scenario) (Robocom, 2015) can be expected which translates to 577,546 sales units per FTE. With this productivity, 42.6 forklift drivers would be required to handle the shipment of 24,627,639 sales units in 2016. This means that a saving of 4.3 forklift drivers is expected which translates to € 146,772 (the annual increase in labor cost is 1% per year; in 2016 each FTE costs € 34,133). The reason why 2016 is the first year in which we consider savings is because the WMS will only be implemented in the second half of 2015. Furthermore, in this paper we will consider the savings in the first year to be half of their value because, as mention before, in the months after the company begins to use the system the workers are still getting used to it. For this reason, in 2016 the savings only consider 2.15 FTEs. The savings for the following 5 years (until 2020) can be calculated using the same logic, always considering the annual increase in labor cost and business growth. For the best case scenario, an increase in productivity of 20% (Barnes, 2002) should be used and in the scenario in between should be used an increase in productivity of 15%. As regard to team leaders and checkers, there were in 2014, 16.4 FTEs in the finished products warehouses. Each of these workers costs around € 34,887 per year. With the implementation of a WMS, approximately

800.8 hours each year will be saved in activities that will be eliminated. Considering a business growth of 3% per year, this value would be of 849.6 hours in 2016. With a cost of € 35,589 per FTE (1% increase a year), this elimination of hours means a saving of € 6,608 (the real value is € 13,216 but only half is considered in the first year) in 2016. The savings regarding this elimination of hours are the same for the three scenarios analyzed. There were 17 forklifts in the finished products warehouses in 2014, the lease of each one costs € 12,088 a year and the maintenance costs € 2,015 a year (this cost is fixed). As said before, in the worst case scenario, there will be required 2.15 FTE less in 2016 than without WMS implementation. There are three shifts in the finished products warehouses which mean that none of the forklifts can be eliminated. In 2017 this number grows to 4.4 FTEs which means that one forklifts can be eliminated (if two were eliminated, in two of the shifts there would be shortage of forklifts). The inventory count performed in 2014 in the finished products warehouses revealed that the value of the inventory that actually exists in storage is € 2,331,895 and the inventory accuracy is 98%. From this value, 30% are considered to be carrying costs. Considering a business growth of 3% per year, in 2016 the inventory value would be of € 2,473,908. With WMS implementation, a minimum inventory accuracy of 99% (worst case scenario) (Hill, 2003a) can be expected which means that in 2016 the inventory would be of € 2,449,168 resulting in savings of € 12,370 (the real value is € 24,740 but only half is considered in the first year). This savings are calculated by multiplying the inventory value by the improve in inventory accuracy (€ 2,473,908x0,01). The calculations for 2017 are the same but in this case the total amount is considered not only half. From 2018 to 2020 only the carrying costs are considered which means that from the calculations only 30% represent savings. For the best case scenario, an inventory accuracy of 99.99% (Sage Software, 2006) should be used and in the scenario in between should be used an inventory accuracy of 99.495%. The value of lost inventory (due to expiration issues) in these warehouses in 2014 was about € 137,500. This value will be eliminated with the WMS implementation and the savings for each year between 2016 and 2020 can be calculated using 3% of business growth. The WMS implementation will eliminate the inventory counts made for internal control. These counts required, in 2014, 274.6 hours of team leaders and checkers time to be made which represents about 0.12 FTEs. Considering the business growth and the annual increase in labor costs, the savings can be calculated for the five years. The shipping accuracy improvements accomplish with the acquisition of a WMS will translate in a reduction in the number of returns. The returns that will be eliminated after the WMS acquisition are caused by several reasons, such as products delivered with limited shelf life, quantities supplied differ from those agreed with customers and products delivered with improper palletizing. In 2014, the costs associated with these returns were € 9,504 and the revenues associated were € 127,318. The savings associated with this elimination are calculated considering the annual business growth and considering that 33% of revenues returns are considered lost sales. After obtaining the savings, it is necessary to determine the costs that SCC expects to incur with the acquisition of a WMS. Through budget requests to three implementing companies, approximately € 495,000 were obtained as the overall cost of the project This value does not include three of the seven categories identified in Table 1, internal corporate costs, contingency & other costs and annual maintenance. For this reason this cost were estimated using the percentages set out in Table 1. For the worst case scenario were assigned the higher percentages for this three categories identified in Table 1, for the best case scenario were assigned the lower percentages and for in between scenario were assigned intermediate percentages. The application of the savings and costs calculated for each scenario considering a rate of return of 10.2% results in the value represented in Table 3.

Table 3 – NPV and Payback Period obtained in each Scenario.

Scenarios	NPV (€)	Payback Period (years)
Worst Case	529,201	2.5
In Between	961,503	1.8
Best Case	1,287,752	1.5

The next step of the methodology involves making a sensitivity analysis. As mention before, this analysis was made using the results calculated for the worst in case scenario and takes into account the variation of the values that differentiate each scenario. This analysis allows the conclusion that from these values the one that most alters the NPV and Payback Period calculation is the value attributed to the increase in labor productivity and the one that least alters the NPV and Payback Period calculation is the value attributed to the annual maintenance cost.

5.2 Software and Implementation Company Selection

The stage of the proposed methodology developed for the system and respective implementing company selection starts with defining the K.O. attributes from a set of 54 possible choices. In the case of Vialonga's plant, this definition was done by the responsible of the Warehouse & Distribution area as this is the area most affected by the WMS. As a result, 27 K.O. attributes were defined which corresponds to half of the available attributes. The application of these attributes to the tool provided by FIMFL shows that none of the 84 combinations available for evaluation fulfils all of them. When selecting the first K.O. attribute, the number of available combinations is reduced from 84 to 8. This number decreases as the remaining 26 attributes are selected and at the end of the first six K.O. attributes no longer remains any combination that meets the requirements. However, a closer look at the first six K.O. attributes shows that most of them are related to the implementing company. For this reason, it was decided to not consider the K.O. and function attributes related to the implementing company in the evaluation of combinations. This allows evaluating only the systems and at the end of the assessment have an idea of which system best suits the needs of Vialonga's plant. After selecting the system, the K.O. and function attributes related to the implementing company can be used to assess candidates to the WMS implementation. Of the 27 attributes K.O. selected, only 12 are concerned merely with the systems evaluation. The application of these attributes to the tool provided by FIMFL allows the reduction of the combinations available from 84 to 15. The systems that are part of these 15 combinations are only five, SAP EWM 7.0 EHP 2 (one combination), SAP EWM 9.0 (one combination), SAP EWM 9.1 (nine combinations), SAP ERP 6.0 EHP 6 (three combinations) and SAP ERP 6.0 EHP 7 (one combination). The next step in the methodology involves weighting the function attributes. In the case of Vialonga's plant, the assignment of weights from 0 to 5 to each function attributes, possible answers and functional groups was done by the responsible of the Warehouse & Distribution area since most questions focuses on warehouse operations but also by the responsible of the Customer Service area in relation to the attributes related to the processing and release of orders. The next step of the proposed methodology is the assessment of the combinations that fulfils the K.O. attributes based on the weights assigned to the function attributes. The tool provided by the FIMFL gives the degrees of performance of each one of the 15 combinations still in consideration. The combination composed by SAP EWM 7.0 EHP 2 had the highest degree of performance, 94%. The mode value (value that occurs most frequently) obtained for the nine combinations composed by SAP EWM 9.1 system was 93% (the different levels of performance obtained shows that some of the selected function attributes are related with the implementing company and not with the system itself). The combination composed by SAP EWM 9.0 had also a degree of performance of 93%. The combination composed by SAP ERP 6.0 EHP 7 had a degree of performance of 89% and the three combinations composed by

SAP ERP 6.0 EHP 6 had a degree of performance of 87%.

6. Conclusions

The application of the developed methodology to the case of a WMS implementation in the finished product warehouses of Vialonga's plant revealed that, in the worst case scenario, SCC can expect a NPV of € 509,201, and a Payback Period of two and a half years for the implementation project. This means that even in the worst case scenario the NPV obtained is positive and therefore the implementation of a WMS in the finished product warehouses of Vialonga's plant is a good investment for the company. This economic justification together with the sensitivity analysis showed that the savings related to labor productivity improvements are the ones who weigh the most in the calculation of total savings. In fact, sensitivity analysis showed that if SCC does not get any improvement regarding direct labor productivity, the project NPV will only be € 4,776 and the Payback Period will be almost four years. For this reason, SCC should heavily invest in training their workers prior to system implementation in order to try to mitigate any negative effects that this implementation can bring.

The application of the methodology to the Portuguese company also showed that SAP EWM 7.0 EHP 2 system is the best suited to the needs of Vialonga's plant. However, the average degree of performance of the five considered systems was 91% so the three systems whose performance is above this value should be evaluated intensively. Even if companies that are considering implementing a WMS do not opt for the combination indicated by the tool as the most appropriate, the selection of K.O. attributes and the weighting of the function attributes encourages a deeply thought about the various aspects that are important both in the system as in the implementing company. This thought could lead to a reduction in the time spent in the later stages of implementation because the decision maker already thought in part on how he wants the system to work. As a final conclusion, it is expected that this paper will contribute to future WMS implementations.

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