## MULTI-CRITERIA DECISION SUPPORT SYSTEM COUPLING LOGISTICS AND FINANCIAL PERFORMANCE IN INVENTORY MANAGEMENT

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## ABSTRACT

Inventory management, the process of providing the required items in the right quantities, at the right time, at the right place and at the right price, is one of the most critical activities for establishing an effective supply chain. On the other hand, it is a complex problem since measuring inventory management performance is typically a multi criteria decision making problem involving multiple criteria of conflicting nature. In this study, we propose a Choquet integral method to aggregate opinions of decision makers for rating the importance of criteria. We took into account both logistics and financial criteria to measure performance of inventory management. Then, we use optimization of the improvement when the overall performance achieved is deemed insufficient.

Keywords: multi criteria decision making, coupling logistics and financial performance, Choquet integral, performance measurement, Optimization of the improvement.

## 1. INTRODUCTION

Recently, inventory management has received considerable attention in both academia and industry. After introducing the inventory management definitions and properties presenting the main solutions developed in this area, we end this section by highlighting the aim of the current paper.

#### 1.1. Supply chain and Inventory management

Supply chain management is the process of integrating interdependent actors such as suppliers, manufacturers, warehouses, and retailers, so that goods are produced and delivered in the right quantities and at the right time, while minimizing costs as well as satisfying customer's requirements (Bottani et al. 2013).

Managing customer and vendor relationships is a critical aspect of managing supply chains. However, a closer examination of supply chain relationships, particularly those involving product flows, reveals that the heart of these relationships is inventory movement and storage (Waller and Esper 2014).

As such, inventory is the main part of any supply chain of a firm that plays an important role in the supply chain decisions. Furthermore, inventory management as defined by (Mitra et al. 2015) refers to the accurate tracking of the flow of goods and the managing of its movement from raw materials to the ultimate consumer. The main purpose of the inventory management practices is to have the required items ready to be processed right on the required time with the minimum cost (De Felice et al. 2014).

The process of inventory management has to cope with many challenges given the complex environment caused by unpredictable and turbulent demand, requirements on product variety, delivery lead-time and quality of product (Verwater-Lukszo and Christina 2005).

When competing in such complex environment, company must have appropriate and effective inventory management strategies to survive.Consequently, the management of inventory is a challenging topic of interest and it can provide insight into the firm's performance.

The aim of inventory decision making is to implement a tool that helps managers to make inventory decisions that maintain the optimum level and minimize the total cost of inventory (Cadavid and Zuluaga 2011).

## 1.2. How to solve inventory management problems?

This section discusses existing solutions dedicated for inventory management outlining their limits.

## 1.2.1. Analytic models limitations

Although many studies have treated inventory management problems(Braglia et al. 2004, Bottani et al. 2013), most of themuse analytic models. In fact, an analytic model can be defined as a mathematical modeling technique used for simulating, explaining, and making predictions about the mechanisms involved in complex physical processes (OpenEI 2013).

However, the use of analytic models suffers from some limitations. Moreover, in a complex environment characterized by interdependent and dynamic behaviors, it becomes difficult to provide an analytic model of the inventory management system. In addition, specific approaches for coupling financial and logistics performance in inventory management are limited in literature.

## 1.2.2. Modeling & Simulation (M&S)

Modeling & Simulation (M&S) can be exploited as a useful alternative to analytic approaches. In fact, given that inventory management requires the management of product flow at various levels as well as the performance assessment of a complex systems and the monitoring of a highly dynamic process, M&S has proved to be a valuable methodology and a highly indispensable tool for complex systems design, performance assessment, management and monitoring (Longo et al. 2015).

The use of M&S in the area of the supply chain is not recent. Indeed, the first applications of this methodology in industry and logistics dates back to 1980 (Longo et al. 2015) and it has allowed "a greater degree of similarity between the model and reality" (Solis et al. 2014). M&S has been widely applied to support supply chains design, management and optimization (Longo 2012).

## 1.3. Purpose of this paper

The main goal of this research work is to provide a decision support system in order to help managers to identify the parameters that are necessary for coupling logistics and financial criteria for performance measurement of inventory management and to identify the improvement that can be achieved when the overall performance achieved is deemed insufficient by the decision maker by the use of multi-criteria methods and optimization. Coupling can be considered as two different things turn to a system by mutual linked. Every subsystem has a dynamic association relationship based on interdependence and mutual coordination (Wang andLu2015).

The paper is structured as follows: Section 2 presents an overview of the related works of inventory management; section 3 presents the proposed multicriteria decision support inventory management model. In section 4, we present the experimental results. Conclusions and future work are presented in the last section.

## 2. RELATED WORKS

## 2.1. Decision support systems

## 2.1.1. Decision support systems definition

Decision support systems (DSS) are information technology solutions that can be used to help managers to support decision-making activities and problem solving. Given the scale and complexity of these decisions, it is essential to transforming some inputs in outputs required to make a decision (Cadavid and Zuluaga 2011).

#### 2.1.2. DSS for inventory management

Several research works examined the usage of various DSS to solve a specific set of related supply chain and inventory management problems. In order to present and design their DSS system, various approaches, models, techniques and methods were used.

#### Modeling approach

Verwater-Lukszo and Christina (2005) propose a modeling approach to improve complex inventory management of many product grades in a multi-product batch-wise industrial plant. The proposed model implemented in a decision support tool assists the decision maker(s) in revealing the performance parameters (inventory level/costs and service level) behavior concerning inventory in order to arrive at potential improvement options for inventory management. Two objectives are considered as the most important indicators: the minimization of the inventory costs and the maximization of the customer satisfaction. Therefore, the problem consists of finding the most appropriate compromise between expected inventory costs and the customer satisfaction level.

#### Framework

In order to help inventory managers to define the parameters of inventory control policies, Cadavid and Zuluaga (2011) present a decision support system framework for inventory management area by using time series models, ABC classification and inventory management models including a full definition of its parameters. The model allows companies to define all the information that an inventory control model requires to improve the effectiveness of the system. This model requires the definition of several parameters such us: reorder points, order quantities, inventory levels, security stocks, and service levels and presents the behavior that inventory and costs will have with the information defined.

## 2.1.3. DSS for inventory classification

#### FSN (Fast-moving, Slow-moving and Non-moving) Analysis

While (Verwater-Lukszo and Christina 2005, Cadavid and Zuluaga 2011) evaluate how parameters affect the inventory levels mainly in terms of service level, inventory level and/or costs, Mitra et al. (2015) analyses the items according to the turnover ratio it possesses by using FSN analysis.

FSN analysis groups materials into three categories as **F**ast-moving, **S**low-moving and **N**on-moving (dead stock) respectively. We note here that the DSS is used to help the decision maker to analyze and classify these articles and to determine the dead stock.

#### K-means algorithm

Ware and Bharathi (2014) implemented an approach to predict factors affecting the sale of products for a huge stock data mining patterns. For this, it divides the stock data in three different clusters based on sold quantities i.e. Dead-Stock (DS), Slow-Moving (SM) and Fast-Moving (FM) using Hierarchical agglomerative algorithm K-means algorithm and Most Frequent Pattern (MFP) algorithm to find property values frequencies of the corresponding items.

## ABC analysis

Another way to classify items into different groups is ABC analysis. The three categories named 'A', 'B', and 'C' respectively, lead to the term ABC analysis. Thus, the items are grouped in order of their estimated importance. 'A' items are the most important items for an organization followed by 'B' items that are important but of course less important than 'A' items followed by 'C' items that are marginally important (Rezaei and Dowlatshahi 2010).

While ABC analysis has an efficient control on a large number of inventory items, it is limited because it uses only one criterion, mostly "annual dollar", for classifying inventory items.

## Cross Analysis

To alleviate this shortcoming, Felice et al. (2014) proposes a Cross Analysis based on Analytic Network Process, a multi-criteria approach as modified version of ABC analysis. Cross Analysis suggests different materials management methods, depending on the particular criteria considered. This multi criteria approach, that allows to consider several criteria all at once that include both quantitative and qualitative criteria, is applied to inventory classification in order to propose the most suitable model for material management applied to the considered industrial system.

While Cross Analysis suggests different materials management methods depending on the particular criteria considered, considering all factors at the same time is no univocal and specific choice for the management method.

## 2.2. Multi Criteria Decision Making methods

Since, inventory management problem is characterized by the inclusion of several dimensions simultaneously like consumer's preferences, increasing complexity of products, life cycles reduction, quality of associated products and services, occurrence of failure and delay in repairing, making this processes more complex, we believe that multi criteria approaches are the best candidates to cope with this. Hereafter, we detail the most relevant Multi Criteria Decision Making methods.

## 2.2.1. MCDM Aims

The aim of MCDM is to support decision makers faced with multiple decision criteria and multiple decision alternatives (Toloie-Eshlaghy and Homayonfar 2011). MCDM has proven to be an effective methodology for solving a large variety of multi-criteria evaluation and ranking problems in the presence of numerous objectives and constraints. According to (Toloie-Eshlaghy and Homayonfar 2011), the development of MCDM methods has been motivated not only by a variety of real-life problems requiring the consideration of multiple criteria, but also by practitioners' aims to propose enhanced decision making techniques using recent advancements in mathematical optimization, scientific computing, and computer technology.

However, despite this large number of MCDA methods, there is no unique method, which is the best for all kinds of decision-making situations. Consequently, a recurrent question arises of how to choose the most appropriate method in a specific decision situation? To answer such question, we conducted a comparative analysis of the most commonly used multi-criteria decision-making methods.

## 2.2.2. MCDM categories

According to (Polatidis et al. 2006, Adomavicius et al. 2011), the following categories of global preference modeling approaches can be identified:

- Multi-attribute utility theory (MAUT) approaches: In such approaches, marginal preferences upon each criterion are synthesized into a total value function called the utility function.
- Multi objective mathematical programming (MOMP): Criteria, in such approaches, are expressed in the form of multiple constraints of a multi-objective optimization problem. The goal is to find a Pareto optimal solution for the original optimization problem.
- Outranking models: Preferences, in such approaches, are expressed as a system of outranking relations between the items, thus allowing the expression of incomparability. In such approaches, all items are pair-wise compared to each other, and preference relations are provided as relations "a is preferred to b", "a and b are equally preferable", or "a is incomparable to b".
- Non-classical approaches: Such approaches try to infer a preference model of a given form from some given preferential structures that have led to particular decisions in the past. Inferred preference models aim at producing decisions that are at least identical to the examined past ones.

## 2.2.3. MCDM for inventory management

In our comparative analysis, we study the most common MCDM methods in each category. Table 1 shows that MCDM methods have been successfully adopted in literature to deal with supply chain management in general, and their use in inventory management, in comparison with other supply chain management problems, is only limited to inventory classification. In the next sub-sections we focus on identification of the criteria used in the field of inventory management, which may be potentially adopted in the MCDA.

## 2.3. Inventory management evaluation criteria

In order to determine how each of the criteria influences the decision making process, it becomes necessary to identify and agree on the criteria that will be evaluated (Thokala et al. 2016). Taking into account the specificity of inventory management, we have to highlight the related criteria.

## 2.3.1. Logistic criteria

In general, properties like inventory costs, costs of stock-out, lead time, service level, turnover ratio, and so on (Verwater-Lukszo and Christina 2005, Cadavid and Zuluaga 2011, Mitra et al. 2015) are likely to be relevant for any set of criteria a firm may want to use to evaluate its operations in terms of overall logistic effectiveness and efficiency.

## 2.3.2. Financial criteria

Nowadays, a firm evaluates its operations not only in terms of overall logistic effectiveness and efficiency but also in financial terms.

El Miloudi et al. (2015) focus on the links between the trust and the supply chain by studying such flows and their impact on the overall performance and optimization decisions.

Buzacott and Zhang (2004) analyzed the relationship between operations management and production with funding constraints in capital, risky and uncertain market.

Dada and Hu (2008) studied the optimum amount of orders for a retailer with limited cash.

Zhou and Wang (2009) studied the impact of constraints and funding methods on the performance of the supply chain.

Moussawi-Haidar and Jaber (2013) studied the interdependence between financial decisions and operational decisions. They built a model that integrates cash costs and those of the stock. They analyzed the impact of the optimal management of cash on the total cost of the stock.

Tsai (2008) tried to measure the risk of cash flow in the supply chain with regards to some risk factors related to time, including implementation time, periods of accounts receivable, accounts payable and collecting payments.

## 2.3.3. Coupling Financial and logistics criteria

Few studies have considered both logistic and financial issues in inventory management and supply chain management.

Nakhla (2006) proposed to involve a process of rationalization of supply chains and financial performance of the company to reconcile financial strategy and operational management. It evaluated the implementation of new logistics services driven by new levels of service in terms of impact on the financial performance of the company.

Fenies and Lebrument (2011) proposed an extension of the PREVA approach (process evaluation) on a schedule in three stages. The first step is the evaluation of the performance of the physical flows using models for action coupling discrete event simulation and heuristic or optimization of the physical flows by generating more optimal solutions. The second stage concerns the evaluation of the financial flows having as input variable the elements provided by the action of the physical flow model. The last step for the results of the decision support models in the form of dashboards using the SCOPE process (supply chain operations performance).

## 2.3.4. Discussion

The state of the art survey highlights that there is a lack of research studies with a combined logistics and financial criteria in inventory management.

While logistics is recognized as a critical dimension of business success, experts believe that stocks represent 25 to 35% of fixed capital of a company (Rossi-Turck et al. 2004).

Only a combined valuation of logistics and financial requirements can assess a company's strategies. Combined financial and logistics performance measurement is vital for any business that wants to survive in an increasingly competitive environment and can lead to new decisions (Estampe et al. 2003).

Hence, coordination between logistic and financial criteria is now needed to ensure the economic profitability, customer satisfaction and to ensure the sustainability of the business. Some studies have underlined the importance of these multiple aspects for a firm (Longo et al. 2015, Kleindorfer et al. 2005, Shrivastava 1995).

Despite the importance of the combination of logistics and financial criteria, only Fenies and Lebrument (2011) took into account both of these criteria in their approach but on sequential manner i.e. the outputs of the logistics performance evaluation are the inputs of financial evaluation.

To solve these disadvantages, we presented a multicriteria decision support system that combines both logistics and financial criteria for performance measurement of inventory management that will be detailed in the next section.

## 3. MULTI-CRITERIA DSS PROPOSED MODEL

The model proposed in this paper which is presented in figure 1, relies on a multi-criteria approach for decision support in inventory management.

The main goal of our model is to enable the coupling of logistics and financial criteria for performance measurement of inventory management and thus to identify improvements needed.

The consideration of several criteria at once either logistics or financial justifies the use of multi-criteria approach.

So, as we can see in figure 1, our approach is based on three steps that are detailed in the following paragraphs. But, in order to apply our approach, data collection is a necessary step. In fact, data collection plays a crucial role and affects the development and use of the models (Longo et al. 2015).

So, in order to apply our model, the statement of the global objective of the company by stating associated criteria and information related to these criteria is necessary. To summarize, the following information should be completed:

- Criteria,
- Current measures of these criteria.
- Measures m<sub>good</sub> of these criteria, which expresses the maximum value that can achieve this criterion.
- Measures M<sub>neutral</sub> of these criteria, which expresses the minimum value that can achieve this criterion.
- Weight of the contribution of each criterion.
- Interactions between different criteria.
- Cost potentially undertaken improvement actions.

Step 1 consists in associating to any current measure defined on the interval  $[m_{neutral}, m_{good}]$ , a performance expression defined on the interval [0, 1] by linear interpolation (figure 1(a)).

Given that the overall performance is not a simple summation of the elementary expressions already calculated in step 1 but depends on the weight of each criteria and the interactions between the different criteria. Step 2calculates the aggregation of these elementary performance criteria (overall performance) by Choquet Integral (figure 1(b)). Furthermore, in order to improve this overall performance calculated in step2, optimization is applied in step 3 (figure 1 (c)).



Figure 1: Multi-criteria DSS model

Each step of the model is detailed in the following subsections.

## 3.1. The expression of elementary performance

The performance indicator returns an expression of performance that identifies the level of achievement of each objective expressed in terms of criterion. In fact, it results from the comparison of the objective and physical measurement. This comparison can be formalized by the following function (Sahraoui et al. 2008):

 $P: O \times M \to E$ (O, m)  $\to P$  (o, m) = P

O, M and E are respectively the universe of discourse of Objectives o, measures m and expressions of the performance P. Note that an essential condition to be met for the aggregation of the elementary expressions of performance is their commensurability which ensures that all values are expressed in the same logic (Sahraoui et al. 2008), i.e. the interval [0, 1] with 0 means no satisfaction and 1 means maximum satisfaction. Two possibilities exist to develop the expressions of performance (Sahraoui 2009):

- 1. Direct expression of performance in the form of mapping between the physical measurement and the associated performance through Linear interpolation, i.e. a series of points, especially for extremum 0 and 1.
- 2. Indirect performance expression by human comparisons between different situations, including the two extremum (the worst one and the best one). So, when human knowledge is available and in order to coherently translate this knowledge into numerical assessment, the MACBETH method can be used.

In our work, we use the first method i.e. the linear interpolation. So, to bring all elementary performance to the same scale i.e. the interval [0, 1], the decision maker uses the following expression: let  $m_2$  actual measure of elementary performance and  $P_2$  expression of the performance of that value on the interval [0, 1].  $m_1$  and  $m_3$  represent respectively the minimum and maximum measures of the elementary performance studied which  $P_1 = 0$  and  $P_3 = 1$  their respective expressions of the performance on the interval [0, 1]. So, we have (Fouchal 2011):

$$P_2 = \frac{(m_2 - m_1)(P_3 - P_1)}{(m_3 - m_1)} + P_1 \tag{1}$$

## 3.2. The aggregation of the performance

To evaluate criteria set, an aggregator operator is used as a common method to reduce the multi-criteria problem into a global single criterion problem (Bendjenna et al. 2012). According to the study methods MCDA presented above, we find that these methods differ in the way and the modeling structure of preferences of decision maker. Certainly there is no ideal method. Choosing a MCDA method may depend on the nature of the problem, context cultural and personality of decision makers (Dhouib 2011). A traditional method uses a weighted sum (or weighted mean). Despite its simplicity, this method assumes that the criteria are independent. Indeed, Choquet Integral will be used to take into account the interactions between the criteria. Indeed, the Choquet integral 2-additive generalizes the weighted mean in the sense that it allows one hand to model the relative importance of a criterion. On the other hand, the operator takes into account the mutual interactions between the criteria. The Choquet integral 2-Additive takes into account the interactions pair criteria (Sahraoui et al. 2008):

$$C_{2-\text{additive}}(\mathbf{P}_{1}\dots\mathbf{P}_{n}) = \sum_{i=1}^{n} \mathbf{P}_{i} \mathbf{v}_{i} - \frac{1}{2} \sum_{i>j}^{\mathbf{I}_{ij}} |\mathbf{P}_{i} - \mathbf{P}_{j}| \mathbf{I}_{ij}$$
(2)

After we calculate the overall performance, we can evaluate the overall performance according to basic performance. So, we calculated the contribution of each individual performance in overall performance and we use a graphic visualization of the effects and an identification of the factors having a significant impact on the overall performance.

$$\operatorname{Perf}_{\operatorname{agrégée}} = \sum_{i=1}^{n} P_{i} \times \Delta_{i} \rightarrow \Delta_{i} = V_{i} \times P_{i} + \frac{1}{2} \sum_{i>j}^{l_{ij}} I_{ij} - \frac{1}{2} \sum_{j>i}^{l_{ij}} I_{ij}$$
(3)

with  $\Delta_i$  is the elementary performance contribution.

#### 3.3. The improvement of the performance

In our work, we treated two optimization problems to improve the performance. The first problem concerns the minimum investment necessary to improve overall performance. The second problem allows to determine maximum expected improvement for a fixed budget increase. Let's look first at the minimum budget necessary to improve the overall performance of an initial performance at an expected final performance. Assumed that the vector of initial elementary performance  $P^1 = (P_1, P_2, \dots, P_n)$  and a final overall performance to reach  $P^* \in [0, 1]$ , where  $P^* > \operatorname{Perf}_{\operatorname{agrégée}}(P_1, P_2, \dots, P_n).$ Knowing that theimprovement cost to move from the performance P1 to the performance  $P^*$  for each criterion i is  $C_i$ , then we improvement seek the minimum of the variouselementary performances will achieve  $P^*$ at least cost. The optimization problem noted  $(P_1)$  is then stated as follows:

$$(P_{1}) \begin{cases} \text{Min C } (P, \delta) = \min \left( \sum_{i=1}^{n} C_{i}(P_{i}, \delta_{i}) \right) \\ \text{Under the constraints:} \\ \text{Perf}_{agrégée} \left( P_{1} + \delta_{1}, ..., P_{n} + \delta_{n} \right) = P^{*} \\ \forall_{i}, 0 \leq P_{i} + \delta_{i} \leq 1 \end{cases}$$

With  $C(P, \delta)$ : cost of the improvement.

The second optimization problem is to find the maximum expected improvement for a given budget increase  $\theta$ . The problem then states as follows:

$$(P_2) \begin{cases} Max \operatorname{Perf}_{agrégée}(P+\delta) \\ Under the constraints: C (P, \delta) = \theta \\ \forall_i, 0 \le P_i + \delta_i \le 1 \end{cases}$$

With  $Perf_{agrégée}(P + \delta)$ : expected aggregate performance.

#### 4. CASE STUDY

Finance and logistics are two organization functions which have always found themselves on opposite sides of each other. While financial performance is dependent on its cash management and profitability, logistics performance is dependent on low inventories, delivery time and delivery quality etc.

# 4.1. Description of financial and logistics performance

In order to measure logistics and financial performance, both logistics and financial criteria are used (figure 2). Based on literature, financial performance is measured by:

- Return on assets (ROA)characterizing the efficiency of assets in producing income.
- Return on equity (ROE) characterizing the shareholder investment.
- Earnings before interest and tax (EBIT) characterizing the profitability compared to asset-based measures.

Furthermore, for measuring the logistics performance and based also on literature, we use:

- Service level (SL) characterizing the service quality.
- Inventory turnover (IT) characterizing how the company turns over its inventory within a year.
- Logistics costs (LC) characterizing cost efficiency.



Figure 2: hierarchy of inventory management performance

#### 4.2. Experiments

To illustrate how the proposed method can be used to evaluate the performance measurement, we used a

		Characteristics							
Category	Methods	Support a large number of criteria	<i>Hierarchy</i> consideration	Ease of use	Uncertainty treatment	interdependence between criteria	Time and resources needed	Modeling Decision-Maker preference	Application areas
Multi objective mathematical programming (MOMP)	Goal programming (GP)	High +	Low -	High +	High +	Low -	Moderate +	High +	Logistics distribution network design, Product-driven supply chain selection, Resource allocation in transportation
Multi attributive utility theory (MAUT)	Analytic hierarchy process (AHP)	Low -	High +	High -	High -	Low -	Moderate -	Low -	partnership selection, Suppliers and products selection, Selection of partner in logistics value chain, Inventory classification, Global supplier development, Production and distribution, Transportation
	Technique for Order Preferences by Similarity to Ideal Solutions (TOPSIS)	High +	Moderate -	High +	Low -	Low +	Moderate +	Low -	Customer evaluation, Performance evaluation, Location site selection, Supplier selection, Selection of partner in logistics value chain, Supplier evaluation in SCM
	Classical Multi- Attribute Utility Theory (MAUT)	Low -	High +	High +	High -	Low -	High -	Low -	Distribution and Logistics Management
	Analytic Network Process (ANP)	High -	Low +	High +	Low -	Low -	Low -	Low -	Purchasing decisions, Stock selection, Supplier selection, order allocation
	Simple multi attribute rating technique (SMART)	Low -	High -	High +	High -	Low +	High -	Low -	Supplier selection, Evaluation of robustness of supply chain information-sharing strategies
Non classical approaches	Choquet integral	High +	High +	High -	High +	High +	Moderate +	High +	Evaluation of 4PL (Fourth party logistics) operating models, improving industrial performance
	Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE)	Low -	High -	Moderate +	High +	High -	Moderate -	High -	Outsourcer/supplier selection, Stock trading assessment

# Table 1: Summary of most commonly used MCDM Methods

detailed financial and logistics reports-based data extracted from (Jae 2015; Debt 2013) combined with a sub-sample of interaction data from (Töyli et al. 2008). After determining the values and the weight for each criterion and the interaction between criteria, the overall performance is then determined by Choquet integral (formula (2)). Table 2 and Table 3 show the values, the current value (Cr value) and the weight (W) for each criterion as well as interaction between criteria successively.

Criteria	2010	2011	2012	2013	2014	Cr value	W
ROE (%)	29.3	33.8	35.3	30.0	35.4	40.4	0.176
ROA (%)	18.6	22.3	23.7	17.9	17.0	18.6	0.124
EBIT (%)	11.89	9.12	9.96	8.35	11.62	10.11	0.191
SL (%)	93.83	93.95	97.12	95.83	91.88	93.83	0.256
IT (units)	52.51	70.53	112.12	83.45	57.94	62.82	0.145
LC (\$)	36.92	40.10	43.76	45.28	45.69	47.23	0.108
							1.000

Table 2: information of logistics and financial criterion

Table 3: interaction between criteria

	ROE	ROA	EBIT	SL	IT	LC
ROE	1.000					
ROA	0.0690	1.000				
EBIT	0.0466	0.0800	1.000			
SL	-0.1192	-0.1476	-0.0920	1.000		
IT	-0.0332	0.0487	0.1208	0.111	1.000	
LC	-0.0739	-0.066	0.0174	0.252	0.115	1.000

In the next step, contribution for each criterion on the overall performance is then determined. After that, we can calculate performance improvement either by minimizing investment necessary to improve overall performance ( $P_1$ ) or by determining maximum expected improvement for a fixed budget increase ( $P_2$ ). Table 4 shows the numerical results.

Criteria	Elementary performance	contributi crite	Improvement	
		without interaction	with interaction	
ROE	1.0	0.176	0.12	1.0
ROA	0.238	0.03	0.097	0.64
EBIT	0.497	0.095	0.045	0.702
SL	0.372	0.095	0.023	0.875
IT	0.173	0.025	0.013	0.775
LC	1.0	0.108	0.014	1.0
	•	0.529	0.316	0.63
				51 \$

Table 4: numerical results

#### 5. CONCLUSION AND PERSPECTIVES

In this work, we treated the coupling of logistics and financial criteria problem in inventory management by

aggregating the performance for linking elementary performance with the overall expression on the one hand and optimization of the performance improvement on the other hand. The aggregation model is based on Choquet integral to take into account the weight and the interactions between the criteria. However, it is not always easy to the decision maker to provide quantitative data. So, as a perspective, we will make him express his preferences in terms of qualitative information using the concept of linguistic variable which have the advantage of being easily comprehensible by the decision maker. Moreover, it is possible to take into account the opinion of many decision-makers at the same time. Our system will also be integrated into a multi-agent system in order to determine the equity levers that allow the company to achieve its objectives.

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