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Proposal of a Module to Measure Economic Performance of Supply Chain

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Abstract: *Economic performance is a hot topic for researchers in management science. It is also one of the major concerns of supply chain leaders. To assess this performance, there are increasingly many management tools. It is then appropriate to wonder the role of these tools in supply chain: are these tools meet real organizational needs? Or they are used to promote supply chain image face institutional constraints increasingly strong?In this context, many modules and methodologies have been established in literature in order to evaluate economic performance of supply chain, because of the strategic importance of this dimension. However, few of them radically analyze the economic issues of supply chain. So, this work presents an integrated methodology to perform this evaluation, based on issues which significantly affect the economic dimension of supply chain. We purpose a module which will allow the assessment of this performance. This module was tested in an automotive supply chain in north of Morocco.*

Keywords: *Economic performance; Supply chain; Performance evaluation; Economic indicators; Composite economic index, Mathematical module.*

I. Introduction

Any firm is located at the intersection of several supply chains, each finalized in terms of creating value for an end customer, and sharing between these channels its resources to meet competing contractual commitments taken by its orders donors. The economic performance of a supply chain depends therefore increasingly heavily on its ability to optimize its relations with its partners, to interface and integrate its information systems and decision-making processes and to synchronize its product flows and its activities.

Hitherto the main goal in supply chain management is to improve industrial competitiveness by minimizing costs, ensuring the level of service required by the customer and efficiently allocating the activities on the production actors, distribution, transport.

Supplier partnerships and strategic alliances refer to the co-operative and more exclusive relationships between organizations and their upstream suppliers and downstream customers. Today many firms have taken bold steps to break down both inter and intra firm barriers to form alliances, with the objective of reducing uncertainty and enhancing control of supply and distribution channels. Such alliances are usuallycreated to increase the financial and operational performance of each channel member through reductions in total cost and inventories and increased sharing of information [1]. Rather thanconcerning themselves only with price, manufacturers are looking to suppliers to work co-operatively in providing improved service, technological innovation and product design. This development has produced a significant impact by expanding the scope of SCM (Supply chain management) through greater integration of suppliers with organizations.

To meet objectives, the output of the processes enabled by the supply chain must be measured and compared with a set of standards. In order to be controlled, the process parameter values need to be kept within a set limit and remain relatively constant. This will allow comparison of planned and actual parameter values, and once done, the parameter values can be influenced through certain reactive measures in order to improve the economic performance or re-align the monitored value to the defined value. For example, an analysis of the layout of facilities could reveal the cause of long distribution time, high transportation and movement costs and inventory accumulation. Using suitable approaches like re-engineering facilities, subsequent improvements can be possible from analysis of the new design. Thus, control of processes in a supply chain is crucial in improving economic performance and can be achieved, at least in part, through measurement. Well-defined and controlled processes are essential to better supply chain.

There are number of conceptual frame works and discussions on supply chain economic performance measurements in the literature; however, there is a lack of empirical analysis and case studies on economic performance metrics and measurements in supply chain. Our research questions can be briefly stated as follows:

- Which economic criteria are considered in the economic performance of supply chain?
- How are they integrated into mathematical model?

So, our goal in this article is to provide a tool which will enable the determination of economic performance of supply chain.

II. Literature Review

2.1. Supply chain

2.1.1. Definition

There are in literatures many definitions of supply chain. Of these, we adopt the following one: "A supply chain is a system of subcontractors, producers, distributors, retailers and customers between which exchanges the material flows in the sense from suppliers to customers and information flow in both senses" [2]. In supply chain, we distinguish three types of flows: physical, informational and financial. Physical flows relate to all materials that pass through the supply chain from upstream to downstream (raw materials, intermediate products and finished products). Other materials can flow from downstream to upstream, such as containers, packaging, pallets, product returns or end-of-life products in the case of reverse logistics. Informational flows concern exchange of information and data between actors of supply chain (stocks and outstanding level, customer demand, etc.) which are made in both sense. Finally, financial flow are the cash flows associated with the physical flow.

2.1.2. Types of supply chains

Typologies of supply chains different following the properties of players involved there:

- If the sites are located in different countries, it is called global supply chain.
- If partners all belong to the same legal entity (even if the firm is multi-sites) it is called internal supply chain.
- If several firms are working within supply chain, but one of them plays a dominant and central role, it is called an extended enterprise.
- In case where several firms are working within the supply chain, but where steering is decentralized or at least semi decentralized with bilateral negotiations between pairs of partners, it is called a virtual firm.

2.1.3. Supply chain functions

The supply chain functions ranging from raw material purchase to sale of finished products through production, storage and distribution:

- Supplying: is the most upstream function of supply chain.Supplied materials and components constitute from 60% to 70% of costs of manufactured products [3] in a majority of firms.
- Production: the production function is central in supply chain, this is the skills hold by firm to manufacture, develop or transform raw materials into products or services.
- Storage: the storage includes all quantities stored throughout the process beginning with raw material, components, work in progress and finally finished products.
- Distribution and transport: transportation of raw materials, transportation of components between plants, transportation of components to storage centers or to distribution centers and delivery of finished products to customers.
- Sale: The sale function is the ultimate function in a supply chain; its effectiveness depends on performance of functions upstream.

2.1.4 Decisions in supply chain

Supply chain management is a widely studied topic in scientific literature. We will approach it from a sustainable point of view, which today is more innovative.

We can classify decisions about supply chain management in three categories [4]:

Strategic decision:concerns decisions taken by senior management on long term (from six months to several years).

Tactical decision: is concerned with decisions taken by the company's executives over the medium term that is to say from a few weeks to few months.

Operational decision: has a more limited scope in space and in time. Thesedecisions are taken by team leaders during day or week.

2.1.5. Supply chain management

Like supply chain, the concept of supply chain management has led to several definitions, among these, we adopt the following one:

"Supply chain management is a set of approaches used to effectively integrate suppliers, producers, distributors, so that merchandise is produced and distributed in the right quantity, at the right place and at the right time in order to minimize costs and ensure the service level required by customer." [5].

2.2.Economic performance

The measurement of economic performance of supply chains, which focuses on improving the functioning of the process and increasing overall productivity, is widely discussed in the literature theme. Performance is today inherently multi-criteria and is measured on the scale of the supply chain of one or more phases of the product life cycle. Approaches of economic performance measurement in the perimeter of a company have adapted to the economic performance evaluation context in supply chain.

2.2.1.Need to measure the economic performance of the supply chain

Any production system, it is limited to a company or an extended supply chain is seen as an organization whose function is to provide goods or services with quality, time and cost required. The outcome of these actions taken for meeting these objectives is measured by performance indicators which should be defined in advance. Economic performance measurement must be precisely because it affects the implementation of corrective actions such as the reconfiguration of some processes, load balancing or an increase in production capacity.

Decision makers responsible for organizing the activities of each company, with the aim of meeting the objectives assigned to them, while seeking to provide dashboards based on local performance assessment indicators of each player, but also of the global supply chain. So, dashboard is defined as a measuring instrument in which a set of indicators allows decision makers to take notice of the state and evolution of the systems which are piloted by them[6]. Evaluatingeonomic performance of supply chain should be based on the modeled value chain and especially allow to follow the activities which create value [7].

2.2.2. What is a performance indicator?

The characteristics of a performance indicator are reflected in the following definitions:

1. A performance indicator is a quantified data that expresses the effectiveness and / or efficiency of all or part of a system, compared to a standard and determined and accepted plan as part of a company strategy [8].
2. A performance indicator is a numerical translation of the strategic objectives of the organization [9].
3. A performance indicator is an information to help an individual actor or organization to conduct the course of action to achieve a goal, or to enable it/him to assess the result. [10]
4. A performance indicator is associated with an "action to pilot " which it must disclose the operational relevance [6].

2.2.3. Typology of performance indicators

The objectives of any organization can be declined at any company decision level. They are characterized by their nature and their time horizon. It is the same for the performance indicators.Thus we can make a difference between strategic, tactical and operational indicators [10].The boundaries of the horizons (strategic, tactical, and operational) have no fixed value; the terminals are based on the case study. Indicators are not always generic and can be specific to each production system, according to the objectives pursued. Nevertheless, some approaches as the SCOR model offer some metrics which give a measurement reference based on the definition of a large number of indicators.

III. Proposal of a Mathematical Module to Assess Economic Performance of Supply Chain

3.1 Mathematical module for economic planning of supply chain

Customer demand and resource capacity being known, how supply chain could be configured and exploited optimally, to meet customer demand without exceeding the capacity of available resources while guaranteeing a "good" economic performance?

We consider the case of a multi-echelon supply chain which is composed from several potential suppliers and subcontractors, several production sites and several clients (Figure 1). The assumptions of our mathematical module are as follows:

1. Supply chain is managed centrally by a single entity which coordinates all operations.
2. Planning horizon is multi-periods.
3. Part of production can be outsourced on one or more periods.
4. Suppliers and subcontractors are assumed to be logistics partners usual of the supply chain.
5. Supply chain does not have its own transport fleet and use external providers.
6. Production processes are convergent: more incoming products are mixed or assembled together to get the outgoing product (for example the automotive industry).

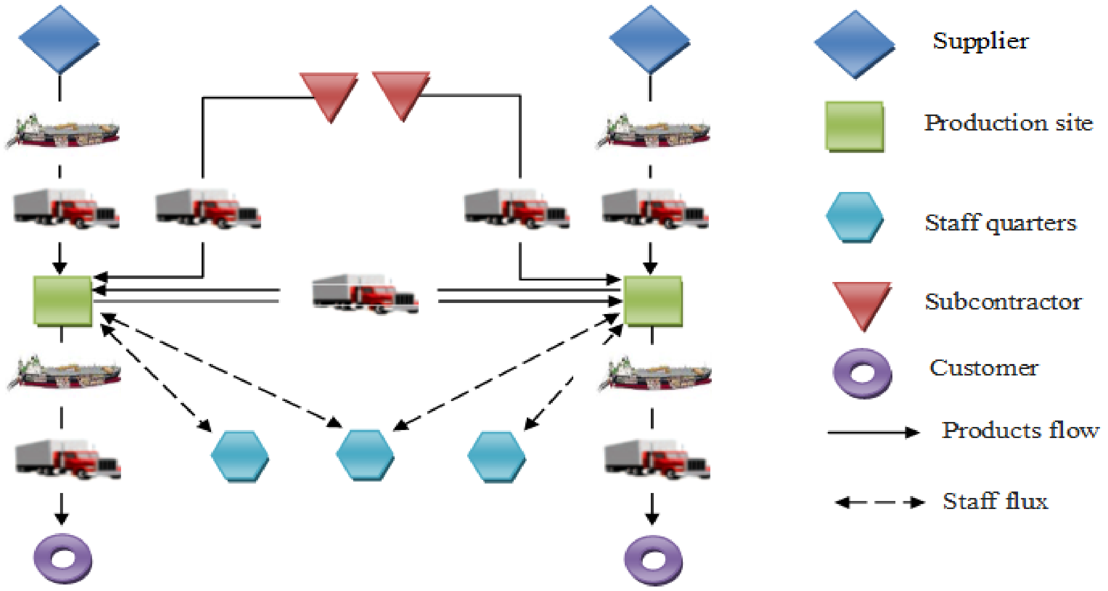

Figure 1: A supply chain example

3.2.Identification of economic performance indicators which we need to assess

We based our selection of indicators on the three recommended requirements by Roy (1985)[11]:

- **Completeness**: we must not it has too few criteria; otherwise, it means that some assessment elements were not taken into account.
- **Non-redundant**: it should not be that there are indicators that are duplicated, thus more than necessary.
- **Consistency**: global preferences (all indicators) are consistent with local preferences (for single indicator).

Numerous studies focus on the economic and financial dimension of performance measurement of supply chain.The models offer different typologies and classify indicators and issues following different categories.

The analysis of this inventory highlights five key issues, which are reliability, reactivity, flexibility, quality and financial performance.

Decision variables of our mathematical module are as follow:

We consider that economic performance of supply chain is measured over a time period t (year in general).

Table 1: Decision variables of our mathematical module

Decision variable	Meaning
Entity	Any site of supplier, subcontractor or customer
F	All production sites.
i	Production site
j	Region
f	Supplier
S	All potential suppliers of raw materials
SC	All potential subcontractors for semi-finished products
p	Product
P	All products
RM	Raw materials
MP	All manufactured products
MPsf	All semi-finished manufactured products
MPf	All finished manufactured products
OMPsf	All semi-finished manufactured products which can be outsourced $P = PM \cup MP; MP = MP_{sf} \cup MP_f;\ OMP_{sf} \complement MP_{sf}$
CM_{pi}	Unit cost to manufacture product p in site i
X_{pi}	Quantity of product p manufactured in site i
CL	Unit cost of labor
Lab_{ji}	All employees residing in region j and working in site i
CI_{pi}	Unit cost of ownership of stock of product p in site i
I_{pi}	Quantity in stock of product p in site i at the end of period t
CA_{pf}	Unit acquisition cost of product p from the supplier f
QS_{pfi}	Quantity of product p purchased from supplier f by site i
CS_{ps}	Unit acquisition cost of product p from the subcontractor s

QSC_{psi}	Quantity of product p purchased from subcontractor s by site i
CTU_{pfi}	Unit transport cost of product p between supplier f and site i
YSF_{pfi}	Quantity of product p transported from supplier f to site i
CTU_{psi}	Unit transport cost of product p between subcontractor s and site i
$YSCF_{psi}$	Quantity of product p transported from subcontractor s to site i
$CTU_{pii'}$	Unit transport cost of product p between site i and site i'
$YF_{pii'}$	Quantity of product p transported between site i and site i'
CTU_{pic}	Unit transport cost of product p between site i and customer c
YFC_{pic}	Quantity of product p transported from site i to customer c

Table 2 presents economic indicators of our module:

Table 2: Economic indicators of supply chain

Issue	Indicator	Unit	Symbol	Impact	Value
Reliability	Orders reliability	%	P_{od}	Negative	Average of all percentages of orders delivered in good conditions in all entities
	Stocks reliability	Number	Ns	Positive	Total number of times which the stock was ruptured in all entities
	Forecasts reliability	%	Pq	Negative	Absolute value of average of gap between realized and requested quantity of products in all entities
Reactivity	Conception reactivity	%	P_c	Negative	Average of gap between realized and requested conception time in all entities
	Procurement reactivity	%	P_{pc}	Negative	Average of gap between realized and requested procurement time in all entities
	Production reactivity	%	P_{pd}	Negative	Average of gap between realized and requested production time in all entities
	Distribution reactivity	%	P_d	Negative	Average of gap between realized and requested distribution time in all entities
	Reactivity to treat returned products	%	P_t	Negative	Average of gap between realized and requested treatment time of returned products in all entities
Flexibility	Ability to meet change orders	%	P_{co}	Positive	Average of percentages to meet the change orders in all entities
Quality	Percentage of defective products	%	P_{dp}	Negative	Average of percentages of defective products in all entireties
Financial performance	Total cost of supply chain	MEUR*	T_c	Positive	F

MEUR* = millions of euros.

Financial performance of supply chain is measured by the total cost of supply chain, expressed in terms of monetary units. Function (F) allow us to calculate and minimize this cost.

$$F = \sum_{i\in F}(CM_{pi}.X_{pi} + CL\sum_{j\in RS(i)} Lab_{ji} + \sum_{p\in P} CI_{pi}.I_{pi}) + \sum_{f\in S;p\in RM} CA_{pf}\sum_{i\in F} QS_{pf} + \sum_{s\in SC;p\in MP_{sf}} CS_{ps}\sum_{i\in F} QSC_{ps} + \sum_{f\in S;i\in F;p\in RM} CTU_{pf}.YSF_{pf} + \sum_{s\in SC;i\in F;p\in OMP_{sf}} CTU_{ps}.YSCF_{ps} + \sum_{i,i'\in F;p\in MP_{sf}} CTU_{pii'}.YF_{pii'} + \sum_{i\in F;c\in C;\,p\in MP_f} CTU_{pic}.YFC_{pic} \qquad (1)$$

3.3. Measuring economic performance of supply chain

Integrated information on economic performance of a supply chain is very essential for decision-making, but it is very difficult to evaluate because of too many indicators. The proposed module reduces the number of indicators by aggregating them into a composite economic index ($I_{E,t}$) which reflects economic performance of supply chain (Figure2).

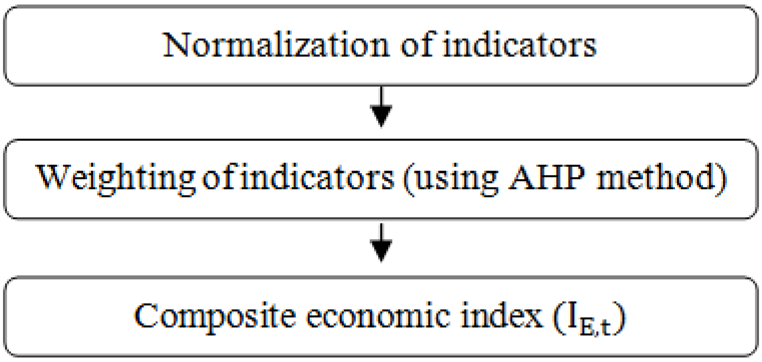

Figure 2: Calculation procedure of $I_{E,t}$

Economic indicators are divided into two groups:

- Indicators whose have a positive impact (I_A^+) on economic performance of supply chain (Table 2).
- Indicator whose have a negative impact (I_A^-) on economic performance of supply chain (Table 2).

The main problem of aggregating indicators into $I_{E,t}$ is the fact that indicators are expressed in different units. One way to solve this problem could be normalizing each indicator i by dividing its value over time t by its average value over all the time measured (Equations (2) and (3)).

$$I_{N,it}^{+} = \frac{I_{A,it}^{+}}{\bar{I}_{A,i}} \qquad (2)$$

$$I_{N,it}^{-} = \frac{I_{A,it}^{-}}{\bar{I}_{A,i}} \qquad (3)$$

The second way could be normalizing each indicator *i* using Equations (3) and (4).

$$I_{N,it}^{+} = \frac{I_{A,it}^{+} - I_{min,it}^{+}}{I_{max,it}^{+} - I_{min,it}^{+}} \qquad (4)$$

$$I_{N,it}^{-} = 1 - \frac{I_{A,it}^{-} - I_{min,it}^{-}}{I_{max,it}^{-} - I_{min,it}^{-}} \qquad (5)$$

Where $I_{N,it}^{+}$ is the normalized indicator i (with positive impact) over the time t and $I_{N,it}^{-}$ is the normalized indicator i (with negative impact) over the same time t.Thus the possibility of incorporating different kinds of quantitieswith different units of measurement is offered. Among the advantages of the proposed normalization of indicators is the clear compatibility of different indicators, since all indicators are normalized.Next procedural part of calculation of$I_{E,t}$ involves determining weights, which should be combined with each indicator. The weights of economic indicators can be obtained from economic expert surveys or from public surveys about economic themes. Therefore, to derive the weights practically, the Analytic Hierarchy Process (AHP) was used in this module.

We build a matrix *A*= (n x n) (in our case n=11); where indicators are compared 2 by 2 by the decision maker. The comparisons are made by posing the question which of two indicators i and j is more important from economic point of view. The intensity of preference is expressed on a factor scale from 1 to 9 (Table 3).

Table 3: Comparison scale of AHP method [12]

Preference factor, p	Importance definition
1	Equal importance
3	Moderate importance of one over another
5	Strong or essential importance of one over another
7	Very strong or demonstrated importance of one over another
9	Extreme importance of one over another
2,4,6,8	Intermediate values
Reciprocal, 1/p	Reciprocal for inverse comparison

The value of 1 indicates equality between the two indicators while a preference of 9 indicates that one indicator is nine times more important than the one which it is being compared. This scale was chosen, because in this way comparisons are being made within a limited range where perception is sensitive enough to make a distinction. In the matrix A, if indicator i is "p-times" the importance of indicator j, then necessarily, indicator j is "1/p-times" the importance of indicator i, where the diagonal $a_{ii} = 1$ and reciprocal property $a_{ji} = \left(\frac{1}{a_{ij}}\right)$ $such\ as\ i, j = 1.., n.$

Weight of indicators i $(W_i)$is given by the formula:

$$\mathrm{W_i} = \frac{\sum_{k'=1}^{n} \frac{\mathrm{a_{ik'}}}{\sum_{\mathrm{k=1}}^{\mathrm{n}} \mathrm{a_{kk'}}}}{\mathrm{n}} \qquad (06)$$

One disadvantage of AHP method outlined in literature [13] is the problem ofintransitivity preferences. Indeed, pair wise comparison may lead to the non-transitivity that cannot be removed as part of AHP method.However, perfect consistency rarely occurs in practice. In AHP method the pair wise comparisons in a judgment matrix are considered to be adequately consistent if the corresponding consistency ratio (CR) is less than 10% [14]. CR coefficient is calculated as follows: first a consistency index (CI) needs to be estimated. This is done by adding the columns in the judgment matrix and multiply the resulting vector by the vector of priorities (i.e., the approximated eigenvector) obtained earlier. This yields an approximation of the maximum eigenvalue, denoted byλ_{max} . Then, CI value is calculated by using the formula:

$$CI = \frac{\lambda_{max} - n}{n - 1} \qquad (07)$$

Next, CR is obtained by dividing CI by random consistency index (RI) as given in Table 4.

Table 4: RI values for different values of n

n	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

Otherwise matrix A should be evaluated:

$$CR = CI/RI \qquad (08)$$

Finally, composite economic index ($\mathrm{I_{E,t}}$) in period t can be derived as shown in equation (09):

$$\mathrm{I_{E,t}} = \sum_{\mathrm{i=1}}^{3} \mathrm{W_i} \times \mathrm{I_{N,it}^{+}} + \sum_{\mathrm{i=1}}^{8} \mathrm{W_i} \times \mathrm{I_{N,it}^{-}} \quad \text{where} \quad \sum_{\mathrm{i=1}}^{11} \mathrm{W_i} = 1 \ \text{ and } \ \mathrm{W_i} \geq 0 \quad (09)$$

IV. Application

The reliability of the proposed module has been tested in a case study. We chose an automotive supply chain installed in north of Morocco (Tangier). Its principal business activity is electrical harnesses for cars. Achieving economic leadership of its branch is therefore a core principle at the supply chain. Neededdata have been obtained from General Managementteam.

This supply chain is constituted of:

- Three production sites (in Tangier)
- Eight suppliers (in Tangier)
- Three customer (In United Kingdom,France and United States)

To evaluate economic performance of this supply chain, the proposed module was applied to the case chain and $\mathrm{I_{E,t}}$ was delivered for the three years 2013, 2014 and 2015.

4.1 Creating the composite economic index for a case supply chain

Table 4 presents economic indicators of the case supply chain.

Table 5: Indicators of the case supply chain

Indicators	**Unit**	**Impact**	**2013**	**2014**	**2015**	**Average**
Orders reliability	%	Negative	0.870	0.910	0.930	0.903
Stocks reliability	Number	Positive	70.000	85.000	65.000	73.333
Forecasts reliability	%	Negative	0.890	0.830	0.920	0.880
Conception reactivity	%	Negative	0.140	0.070	0.040	0.083
Procurement reactivity	%	Negative	0.120	0.170	0.090	0.127
Production reactivity	%	Negative	0.070	0.030	0.030	0.043
Distribution reactivity	%	Negative	0.150	0.170	0.110	0.143
Reactivity to treat returned products	%	Negative	0.220	0.190	0.200	0.203
Ability to meet change orders	%	Positive	0.900	0.870	0.930	0.900
Percentage of defective products	%	Negative	0.020	0.050	0.070	0.047
Total cost of supply chain	MEUR	Positive	10007.000	12000.000	12800.000	11602.333

To determine the weights of indicators, pair-wise comparisons of indicators according to their impact to economic performance assessment of the supply chain have been performed. Priorities are assumed and may vary following the opinion of decision-makers of the supply chain. The results are shown in Table 6.

Table 6. Pair-wise comparison matrix for evaluation of estimated weights of indicators

I		P_{od}	Ns	Pq	P_c	P_{pc}	P_{pd}	P_{dt}	P_{tr}	P_{co}	P_{dp}	T_c	**Weights**
P_{od}		1	3	3	3	3	3	3	3	2	1	1	
Ns		1/3	1	1	1	1	1	1	1	1/2	1/2	1/2	
Pq		1/3	1	1	1	1	1	1	1	1/2	1/2	1/2	
P_c		1/3	1	1	1	1	1	1	1	1/2	1/2	1/2	
P_{pc}		1/3	1	1	1	1	1	1	1	1/2	1/2	1/2	
P_{pd}		1/3	1	1	1	1	1	1	1	1/2	1/2	1/2	
P_{dt}		1/3	1	1	1	1	1	1	1	1/2	1/2	1/2	
P_{tr}		1/3	1	1	1	1	1	1	1	1/2	1/2	1/2	
P_{co}		1/2	2	2	2	2	2	2	2	1	1	1	
P_{dp}		1	2	2	2	2	2	2	2	1	1	1	
T_c		1	2	2	2	2	2	2	2	1	1	1	
$\sum$		5.833	16.000	16.000	16.000	16.000	16.000	16.000	16.000	8.500	7.500	7.500	
P_{od}		0.171	0.188	0.188	0.188	0.188	0.188	0.188	0.188	0.235	0.133	0.133	**0.181**
Ns		0.057	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.059	0.067	0.067	**0.062**
Pq		0.057	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.059	0.067	0.067	**0.062**
P_c		0.057	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.059	0.067	0.067	**0.062**
P_{pc}		0.057	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.059	0.067	0.067	**0.062**
P_{pd}		0.057	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.059	0.067	0.067	**0.062**
P_{dt}		0.057	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.059	0.067	0.067	**0.062**
P_{tr}		0.057	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.059	0.067	0.067	**0.062**
P_{co}		0.086	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.118	0.133	0.133	**0.122**
P_{dp}		0.171	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.118	0.133	0.133	**0.130**
T_c		0.171	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.118	0.133	0.133	**0.130**

Data of the case supply chain does not measure all economicindicators usingcommon units. However, that is neither expected nor possible. To get rid of units the normalizationof indicators was performed using equation2 and 3. In that wayindicators became combinable and the derivation of $(I_{E,t})$was possible. Normalizedresults are presented in Table7.

Table 7: Normalized indicators of the case supply chain

I	**Indicator**	**Symbol**	**Weight**	**2013**	**2014**	**2015**
1	Orders reliability	P_{od}	0.181	0.963	1.007	1.030
2	Stocks reliability	Ns	0.062	0.955	1.159	0.886
3	Forecasts reliability	Pq	0.062	1.011	0.943	1.045
4	Conception reactivity	P_c	0.062	1.680	0.840	0.480
5	Procurement reactivity	P_{pc}	0.062	0.947	1.342	0.711
6	Production reactivity	P_{pd}	0.062	1.615	0.692	0.692
7	Distribution reactivity	P_{dt}	0.062	1.047	1.186	0.767
8	Reactivity to treat returned products	P_{tr}	0.062	1.082	0.934	0.984
9	Ability to meet change orders	P_{co}	0.122	1.000	0.967	1.033
10	Percentage of defective products	P_{dp}	0.130	0.429	1.071	1.500
11	Total cost of supply chain	T_c	0.130	0.862	1.034	1.103

To calculate composite economic index $I_{E,t}$ in time t, the normalized value of each indicator was multiplied by its weight (Equation 09).

Table 8. Values of composite economic index $I_{E,t}$

Years	2013	2014	2015
$I_{E,t}$	0.908	0.951	0.931
$I_{E,t}$ (%)	90.8%	95.1%	93.1%

4.2. Interpretation of results

Eleven economic indicators were aggregated into a composite economic index $I_{E,t}$ for a case supply chain over three period of time 2013-2015 (Figure 3).$I_{E,t}$ of the case supply chain reached the highest value in the year 2014, but in the year 2015 it decreased.Following these results, the case supply chain is not on a truly economic path.

Economic performance of this supply chain has been increasing between 2013 and 2014 with a small decrease in year 2015. It had some issues on which its economic performance was not progressing like it should. We can explain this decrease in economic performance between 2014 and 2015mainly by the increasing of rate of defective products in this supply chain (Table 5). Increasing and decreasingof economicperformance between 2013 and 2015 indicate that this supply chain should improve its economic performance more than its level of 2014.

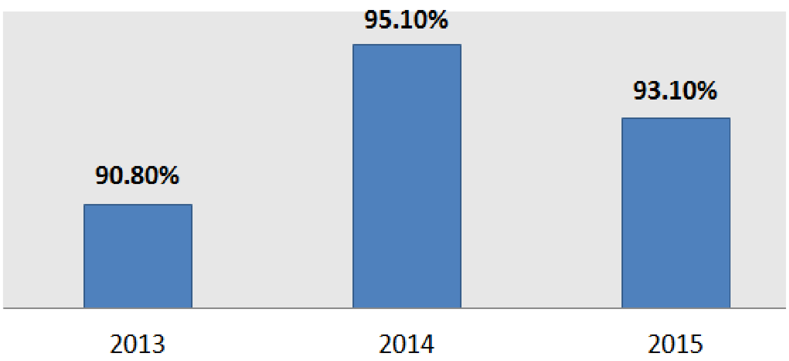

Figure 3: Variation of composite economicindex $I_{E,t}$of the case supply chain over the time interval 2013–2015.

4.3.Contribution of composite economic index and its pertinence

The importance of economic dimension in our daily life requires the measurement of it. So, by this composite economic index, we can get a simplified and quantified expression of economic performance of any supply chain. This index (composite economic index), can be used to inform decision-makers about economic performance achieved throughout their supply chain, and then the determination of actions which should be applied. However, it may also be used toprovide informationto critical decision processes.$I_{E,t}$ helps us to improve economic performance and allow us to know where the best practices might be found. The decision-makers of supply chain could easily interpret this index, then finding the correct sense which they should react. If enclosed in the periodic economic report, the $I_{E,t}$could also be used to present the progress of the supply chain to the various parties interested in economic performance of supply chain. As $I_{E,t}$would be applied to different supply chains, it would be possible to compare and rank them (supply chains) in terms of economic performance.

By this module, we provide tothe decision maker a tool which allows him:

- To analyze the current and potential value of activities implemented andto consider actions to strengthen this value as such the implementation of economic best practices. This analysis allows him to define the scope of activities and to consider several options for this end.
- To analyze the profile of the economic performance related to supply chain decisions during the planning phase, choose the configuration of the chain and the way to exploit it in advanced and optimized manner in order to ensure target level of economic performance. This level of economic performance defines the strategy that the decision maker wishes to implement.
- To know precisely the additional investment in terms monetary, which he/she must engage to achieve the level of economic performance desired.
- To have quantitative performance indicator which used to control the supply chain and for the purposes of communication.

V. Conclusion

Applying the principles of sustainable development in industrial management is still a difficult task. In this sense, companies have a very little knowledge and tools. Consulting firms are often helpless against the demands of companies that want to engage in CSR (Corporate social responsibility). Since the concept of CSR was first proposed, it has remained a challenge to organizations that struggle to determine how it can be operationalized and measured [15].In the origin of this paper, was the problem of taking into account the economic dimension of supply chain practices. In this context, our goal has been to provide an assessment module of economic issues. It was also for us, to assist in the definition of judicious and targeted axis of the progress allowing evolving evaluation systems of economic performance in supply chain.

We proposed a module for economic decision in supply chain. We mobilized, among others, the value chain and AHP method. The primary objective of this study is to lay the foundations for a new generation of economic indicators that will allow us to know our level in terms of economic performance.

Finally, we considered the realistic case of a supply chain issue of the Moroccan automotive industry, which served us the application framework for our mathematical module.To assure the reliability of this module, we considered core economic indicators during thier construction. The module presented in this paper promises advance in economic performance assessment of supply chains and makes economic information more useful to the decision-makers. Any supply chain and based on this module, could know their achievements towards economy. Even though further development is called for, it is evident that this module has the potential to become very useful as one of the tools available.

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