

Evaluating Total Logistics Costs at Macro and Micro Level: Literature Review

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Abstract—The purpose of this work is to establish a literature review about the evaluation of logistics costs at the micro and macro levels. We have developed this problem by addressing at first the importance and difficulties of assessing the logistics cost. Then we have discussed the logistics cost structure. Lastly we have tried to approach in a non-exhaustive way all the logistics cost evaluating methods according to two evaluation levels micro and macro.

Keywords— Evaluation; logistics; costs; Macro; Micro; level

I. INTRODUCTION

The Logistic plays a crucial role both at the micro and macroeconomic level. Given the complexity of supply chains, and globalization, and due to the changes that have taken place in the productive systems, the manufacturing and labor costs have been significantly reduced. While the *logistics* costs share has experienced a great increase (up to half of the value of commodities). Reducing these costs has become an increasingly important task for managers. At the macroeconomic level the logistics costs are regarded as one of the main factors influencing competitiveness, policy development, infrastructure development and other investments [1].

Logistic costing is complex even at the micro level, and in the national context very few attempts have been made which explains why the subject has been little covered in the research literature.

Our contribution through this article consists of an extension of literature reviews dealing with the assessment of logistics costs. Specifically, our contribution is that we are dealing with this issue by considering the micro and macro aspects these costs.

Thus, we have addressed the subject by referring, first, the importance and difficulties of assessing logistics costs. These costs, which are as important to managers as to public parties, are difficult to assess. This is largely due to the complexity of logistics activities and the dispersion and difficulties in obtaining relevant information.

In the second place, we have discussed the structure of logistic costs. These costs can be classified, at the micro level, through activities / functions or by cost type from an accounting management point of view.

In a last place, we have tried to approach in a non-exhaustive way all the logistic costs evaluating methods according to the two evaluation levels micro and macro.

II. IMPORTANCE AND DIFFICULTIES OF LOGISTICS COSTS EVALUATION

A. Importance of Logistics Cost Assessment

The evaluation of logistics costs is of great importance. Thus, flow optimization and resource integration can only take place if managers have transparent information on logistics costs at all stages of the product flow. Without this information, it is impossible to measure the impact of cost decisions along the supply chain [2]. Also, as we know, lowering the product price is a competitive advantage which could lead to an increase in its market share and since logistical costs constitutes a significant fraction of the product price; it is very important to calculate these costs and try to reduce them. Similarly, the contribution of logistical costs to the price level differs from one product to another. Therefore, the calculation of these costs form a good indicator for prioritizing investments in reduced logistics costs in different products.

At the macroeconomic level, logistics cost measurement is considered an appropriate indicator for the past and the future. As future indicator, measuring logistics costs would support the development of national policy and the targeted deployment of operational resources and capital (investment in transport infrastructure). As a past indicator, it will measure performance and pave the way for corrective action.

B. Difficulties in evaluating logistics costs

The calculation of logistics costs is a complex process, even in entities at the micro level. It should be noted that in the macro context there are only a few attempts to make such assessments [3].

Farahani, Asgari, and Davarzani were able to identify the main factors explaining the complexity of the evaluation and analysis of logistics costs. Firstly, logistics activities are very complex and involve many different processes, not to mention the difficulty of gaining transparent information about these processes [1]. In addition, calculating the depreciation of all goods and equipment involved in logistics activities increases this complexity.

In addition to these factors, business strategies and operational choices add complexity to macro-level cost measurement. These choices can cause inhibitors of costs transparency, leading to a deficiency in the information, to a narrow view of cost management or differences in allocation of indirect costs [4]. Rantasila gives an example of these choices that have a significant effect on perceived logistical costs [3]. It is indeed the strategy of outsourcing of logistics operations. According to this author, it is essential to know whether the costs of outsourcing are perceived as a part of logistics costs or not. In addition, by outsourcing several functions as a package, the cost of an individual function can be difficult to determine. Also according to the same author, and in parallel with outsourcing, another key issue for measuring logistics costs is the way the company organizes its upstream and downstream logistics. This defines the logistics functions whose costs are covered by the company. One way to recognize a company's share of logistics costs in an international context is to look at delivery terms (incoterms). For example, if a company buys its raw product in Ex work (EXW) and delivers products by Delivery Duty Paid (DDP), it can support greater logistical costs than a company that has organized its logistics in reverse.

III. STRUCTURE OF LOGISTICS COSTS

One of the first attempts to classify national logistics costs was made by Dimitrov in 1991. Dimitrov proposes four components of logistics costs: transport costs, commercial costs, communication costs and storage costs [5]. The Logistics and Distribution Management Manual of [6] also provides a five-level breakdown. The fifth level of costs added to the [7] classification is the overall logistic costs. [6] Christopher also identifies some similar cost elements in a study of logistic costing principles. It pays much attention to actual inventory costs and identifies, among other things, inventory control costs [3].

A typical supply chain management perspective is to classify logistics costs across activities or through chain functions (i.e. purchase or warehousing). From an accounting management point of view, this is less common, since it often uses a cost type classification.

A. Logistics costs Components by activities

Various logistics cost components have been proposed in the Supply Chain Management literature, varying from one publication to another. Among these publications, we will mention that of [8] who conducted a survey of 1068 Irish companies and that of [9] since several studies refer to the concept of total cost developed by these authors [3]. Of the survey respondents, 28.3% agreed that transport / freight / deliveries should be included in logistics costs. The job / salary were supported by 17% of respondents, while 16% admitted that materials should be included. A group of "Other costs" is included at 10.4%; the storage is 8.5% while the inventory is 6.6%. In addition, procurement, production, and administration were identified by less than 5% of respondents, respectively. While the approach proposed by Lambert, Grant, Stock and Ellram identifies six main cost groups:

- Customer service level. One of the major costs at this level is the cost of lost sales. Another example in this category is the cost of returned goods.

- Transport costs. The revised transport cost literature includes transportation, consolidation (cost of small shipments), transfer (mode of transportation), pick-up and delivery, and the cost of pilfering or damage during transport [10]. Weber discusses transportation costs in detail and distinguishes between internal (for example, transport from one warehouse to another) and external transport; Transport for own account and others; and regular transportation or as needed. Further examination by mode of transportation may be necessary [11]. The main factors that affect transportation costs can be divided into:

- ✓ Distance (the transport cost elasticity over distance are 0.46 (air), 0.39 (rail), 0.275 (road) and 0.22 (maritime) [12] and geography (the landlocked countries face a major cost disadvantage).
- ✓ Infrastructure and trade facilitation. Investment in infrastructure, although expensive to undertake, has a major impact in reducing transport costs. Wilson argues that the average waiting time at a border could have been used to cover 1600 km inland [13]. This may be due to physical infrastructure issues such as ports, but also due to procedural delays.
- ✓ Market power. For transportation services as derived demand, Hummels, Lugovskyy, and Skiba state that transportation prices are higher if there is a low elasticity of demand and the greater the number of shippers increases, the price and the impact of the elasticity decrease [14].
- Warehousing costs are generated by warehousing and storage activities, as well as warehouse location costs.
- Inventory costs can be divided into four categories, namely capital or opportunity costs, inventory service costs, storage costs and inventory risk costs [15].
- Quantities of supply and production. These costs include installation costs, lost capacity (for example when changing the tool) and material management.
- Processing costs and information systems those are related to activities such as order processing, communications and forecasting.

B. Logistics cost components by cost type

Another way of classifying logistics costs is by cost type. This corresponds to the accounting perspective. Cost information is likely to be classified in the accounts of many companies in this way. However, sorting out the logistics part in the account can be difficult, according to the organization [16].

- Cost of personnel or manpower constitutes probably a big part of the logistics, whether in the purely operational logistics task in the warehouse or in the logistics administration.
- Cost of facilities includes buildings used for logistical activities, rented or detained. The cost of the land can be included in this category or be a distinct element.
- Equipment includes shelves, forklifts, pallets and other equipment used for logistics operations.
- Computer systems and computers may be part of the previous group, or be in a separate category.

- Cost of operation include items such as fuel, electricity, water, maintenance, insurance, telephone charges, printing and photocopying, etc.
- Amortization of logistics assets (buildings, machinery and the transport fleet) which represents an expense influencing the declaration of losses / benefits.

IV. LEVEL OF LOGISTICS COSTS ASSESSEMENT

The notion of logistic performance and more precisely the cost can be analyzed at different levels: from the micro-economic point of view, the notion comes under the discipline of management sciences; from a macroeconomic point of view, the analysis focuses on the logistic performance of firm systems (national, regional, sectoral)

A. "Macro" Level

The macro approach examines national accounts and measures the contribution of the logistics sector to GDP. This approach therefore gives an overview of the relative size of the sector. Nevertheless, it does not provide an unambiguous performance indicator since the relationship between sector size and logistic performance is non-monotonic [17]. Similarly, there is no systematic relationship between the sector's contribution to GDP and economic outcomes [18]

Three main measures are used for the assessment of logistics costs at the national level, namely the % of sales or turnover, absolute costs and % of GDP [19]. The OECD defines turnover as the total amount invoiced by the observation unit during the reference period. Sales, meanwhile, are defined as operating revenues minus discounts, returns and sales taxes on consumers. In general, these two definitions basically mean the same thing, with some minor differences regarding the inclusion or exclusion of value added tax (VAT). While absolute cost represents the ability of a country, individual, firm or region to produce a good or service at a unit cost lower than the cost of any other entity producing the same good or service.

B. "Micro" Level

Micro-analysis of sectors, products / services and supply chains makes it possible to compare logistics costs with the final value of products / services, identify areas of inefficiency, and offer more competitive prices.

Metrics used to estimate logistics costs at this level are diverse. According to Supply Chain Digest's survey of 247 representatives from several industries in 2006, 40% use sales as the main measure of logistics costs, while 25% consider absolute costs as their main measure. The remaining respondents based their measurements on weight, sales unit or activity-based accounting [19].

V. MAIN METHODS OF LOGISTICAL COSTS ASSESSEMENT

The techniques used to evaluate costs at the micro level do not directly provide the type of information needed to assess costs at the macro level. It is important, however, to understand the basics of cost accounting techniques employed by firms, as survey participants (for macro-level costing) can use this information in their responses.

A. Logistics Costs Assessment Methods of the " Macro " Level

Several methods and tools are used to conduct a study on logistics costs at the macro (national) level. These methods differ according to the availability of data and the reliability of statistical sources. They are grouped into three categories: surveys that collect empirical data directly from respondents, studies based on statistics that create a model by combining existing data from different statistical sources, and case studies and other studies that include studies conducted with a case study methodology and studies that cannot be classified either among those based on statistics or surveys.

1) Studies based on surveys

Surveys typically use questionnaires to collect data on logistics costs from respondents. A significant difference between this approach and that based on the statistics comes from Supply Chain angle view.

While statistics-based studies usually address the "Supply" side of the chain, surveys are usually conducted with stakeholders and are interested in the "Demand" perspective. Studies at this level are divided into Multi-Country (MC) and Single Country (SC) studies. Several cost components are treated namely Transport (T), Warehousing (E), Administration (A), Inventory (I), Transport Packaging (TP) and Other Cost (O) (See table 1).

TABLE I. EXAMPLES OF QUESTIONNAIRE SURVEYS

	Definition	Areas		Costs components						
		MC	SC	T	E	A	I	O	TP	
SCI 2011	Conducted by SCI Verkehr, which publishes a monthly logistic barometer analyzing logistics indicators selected by 200 managers in the transport and logistics sectors.		x							
Davis 2010	Maintained by Establishment Management Consultants specializing in the supply chain. It's an ongoing survey that allows companies primarily in the United States to compare their logistics costs and service level.	x		x	x	x	x			
Finland 2010	In Finland State of Logistics 2012, the distribution of respondents based on the industry was: manufacturing and construction 32%, trading 28%, LSP 25%, consulting 5% and education 10%.	x	x	x	x	x	x	x	x	
ELA 2009	European Logistics Association (ELA) is a coalition of 30 national organizations covering most Western and Central European countries since 1982.	x	x	x	x					
Aslog 2009	The aim is to assess the state of logistics in France and gather information to create measures that would allow logistic costs to be compared with other countries.	x	x	x						
Japan 2007	The Japan Institute of Logistics Systems (JIL) maintains a national database for transport and logistics developments.	x	x			x				

2) *Studies based on statistics*

These studies use statistical data, models and methods to calculate the level of logistics costs (Transport (T), Warehousing (E), Administration (A), Inventory (I), Transport Packaging (PT), Cargo Processing (CP), Communication (C), Customer Service (CS), Documentation (D), Equipment (Eq), Information (In), Insurance (As)) in several countries or at one country level (see table 2). Models created by statistical studies can be of three types [20]: econometrics that presents

the phenomenon as a network of causal relationships between internal and external variables, analytic that uses mathematical manipulation to find a solution to the problem or by simulation that seeks to present the behavior of complex phenomena over long periods of time according to real-world models.

It should be noted that the distinct difference between case studies (which may also use statistics) and statistical studies is that the latter uses a well-established and verified model.

TABLE II. EXAMPLES OF STUDIES BASED ON STATISTICS

	Definition	Area		Costs components												
		MC	Sc	T	A	I	E	CP	PT	C	CS	D	Eq	In	As	
South Africa 2011	Produced by the Council for Scientific and Industrial Research (CSIR), the model uses data on the mode of transport, tonnage transported and stored, transport distances and costs, and transport time.		x	x	x	x	x									
Korea 2010	The Korea Transport Institute (KOTI) provided macroeconomic estimates by assessing various logistics cost factors.		x	x	x	x		x	x						x	
Thailand 2009	The Office of the National Council for Economic and Social Development has developed a model and database to publicize the country's official logistics.		x	x	x	x										
Canada 2008	Industry Canada has launched a project dedicated to the creation of a Logistics Costing Toolbox. The toolbox defines three cost components and classifies cost activity categories and related components.	x				x										
Morocco 2006	Trade Logistics and Competitiveness in Morocco 2006 was jointly launched by the World Bank Group and the Ministry of Transport in Morocco. The study is a combination of previous research findings, national statistics, national accounts, and multi-stakeholder hearings across different industries, government agencies, and export and import organizations. An analysis was conducted among the industries considered important for the Moroccan economy, including the automotive, electronics, textile and fruit and grocery industries.		x	x	x	x	x	x	x	x	x	x	x	x		x

3) *Case studies*

Case studies are usually used where sufficient statistics are not available and it is not possible to conduct an investigation.

Examples of the case studies are given by the table 3.

TABLE III. EXAMPLES OF CASE STUDIES

	Definition	Costs components
World Bank	Among several studies of the World Bank, we find that proposed by [21], which proceeds by a different grouping of logistics costs. This is mainly due to the subject of their study, which examines logistics costs in landlocked countries.	Authors evaluate the level of logistics costs by measuring transit transport. In their group, total logistics costs also include three components: transportation costs, other logistical costs, and lagging coverage costs.
UK Logistics Report 2011	Published by the Freight Transport Association (FTA) of the United Kingdom. The report uses data from a variety of sources, the most important being the 2010/11 FTA Logistics Industry Survey.	The study divides logistics costs into four key areas: wages, vehicle operation, storage and transportation.
Understanding transportation costs and charges 2010	The case study is undertaken by the Ministry of Transport in New Zealand	The total logistics costs were divided into direct transport costs (international / domestic movements, mode transfers), indirect transport costs (port costs, customs / biosecurity, insurance) and other costs (packaging, storage, inventory, loss). inventory, administration, information systems)
Formulation of regional logistics policy: case of Asia, 2008	[22] discuss, among other things, logistics costs in the Asian region, covering Brunei, Cambodia, Indonesia, the Lao People's Democratic Republic, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam	The results of the study are based on seven questionnaires related to logistics activities in the following sectors: customs, ports and maritime transport, rail, road, river and air transport as well as logistics services.
(Hausman, Lee and Subramanian, 2005)	Logistics indicators have been studied by [23], which examined the effect of logistics costs and time on bilateral trade relations. The study uses global logistics indicator data from 80 economies to create a three-step estimation process and logistic index, which would include several logistic indicators.	Authors apply the total landed cost model, which includes the following components of logistics cost: <ul style="list-style-type: none"> • Shipping costs (shipping). • Trade-related costs (processing, customs clearance, port operations). • Inventory costs for inventory in transit. • Inventory costs for security stocks inventory.

B. Logistics Costs Assessment Methods of the " Micro " Level

Rantasila classifies the most commonly used techniques and tools for calculating logistic costs at a micro level, according to their rates of adaptation by different links in the Supply Chain [3]. The three links identified by the author are the intra-company, the upstream of the company, and the downstream of the company. It should

be noted that this grouping is not exhaustive and that some tools can be used at different stages of the supply chain.

1) Logistics costs Assessment Methods within the company

Intra-company costing tools focus on measuring performance, primarily internal functions of the company. The table presents the most commonly used costing tools in the intra-firm context, provides a brief description of each tool, indicates some of its objectives and indicates an example of application of the tool in question.

TABLE IV. LOGISTICS COSTS ASSESSMENT METHODS WITHIN THE COMPANY

	Description	Objective	Application examples
Activity Based Costing and its derivatives (ABC)	Assign direct and indirect costs to activities that consume resources. Then, combine the costs with the resources used. This method can be applied also to upstream and downstream of the company	<ul style="list-style-type: none"> Decision making, outsourcing and profitability analysis Information on cost elements 	Baykasoglu, and Kaplanoglu presented an application of the ABC method in a transport company located in Turkey. To improve the effectiveness of ABC, an integrated approach that combines ABC, Business Process Modeling and the Analytical Hierarchical Approach is proposed. They argued that the proposed approach is more efficient than the traditional cost system in calculating the cost of international ground transportation services [24].
Balanced Scorecard (BSC)	Measure performance from four points of view: financial, customer, internal business process, and innovation / learning	<ul style="list-style-type: none"> Performance measurement Evaluation of customer service, suppliers, Third-Party Logistics (3PL) and financial performance, etc. 	Rajesh and his colleagues proposed in their study a set of strategies for the 3PL service providers. They developed a framework of strategies taking into account the four perspectives of BSC for the different service provider's functions. The weights of the different strategies are evaluated using Delphi analysis [25].
Economic Value Added (EVA)	Assesses the profit generated by the company by subtracting the capital charge from net operating income.	<ul style="list-style-type: none"> Transformation of non-financial information into financial information Evaluates the created value 	Austin in his study described and analyzed the adoption of the Economic Value Added (EVA) method as a reference for pricing and other policies of a monopolistic public airline in New Zealand, in the absence of normative comparative analysis mechanisms [26].
Kaizen Costing	Aims to reduce costs in the production phase	<ul style="list-style-type: none"> Reducing product costs currently in production 	Baykasoglu and Kaplanoglu in their study have attempted to provide a service costing framework for logistics companies that provide international land transport by truck. The framework includes three methods: ABC, Kaizen Costing and Target Costing [27].
Standard Costing	Develops standard costs for activities that are deemed to be met.	<ul style="list-style-type: none"> Budget planning Cost control Simplification of activities 	Hatzis, Koulidou, and Folinias, in their article presents and evaluates the costing systems that 3PL companies in Northern Greece use among these systems the Standard Costing method [28].

Sources: Improvement of [29].

2) Logistic costing methods upstream of the enterprise

Unlike the previous table, the table 5 presents cost analysis

tools focused on measuring the upstream level of the supply chain (inbound functions).

TABLE V. LOGISTICS COSTS ASSESSMENT METHODS UPSTREAM THE COMPANY

	Description	Objective	Application examples
Cost-To-Serve (CTS)	Assigns costs of non-production to a client and to root causes in order to determine the total cost	<ul style="list-style-type: none"> Estimation of the client's profitability Network optimization Inventory Level Decisions 	Ross, Jayaraman, and Robinson attempted to optimize the service of a 3PL using the CTS method. The aim is to use the method to identify the relevant cost drivers of 3PL services, in a research-action approach that identifies relevant operational constraints and then use the action research framework and the CTS to model different cost elements that could be incorporated into the objective function of a mathematical programming model [30].
Cost Transparency	Share information about internal costs with suppliers (expandable downstream method that helps to share information with customers)	<ul style="list-style-type: none"> Cost savings through joint development Exchange of ideas 	Schneider, and Lange, in their study, presents the need for a decision support tool that provides transparency of internal costs and thus facilitates more appropriate pricing based on several factors [31].
Open Book Costing OBC	Supplier provides cost structure information to the customer and, in return, the customer helps the supplier to reduce costs (Not expandable to downstream level)	<ul style="list-style-type: none"> Supply decisions, cost reduction Vendor Performance Assessment, 3PL. 	Romano, and Formentini presents in their article a methodology to support the selection of suppliers in OBC projects and the identification, for each buyer-supplier dyad, appropriate incentives to allow disclosure of cost data [32].
Target Costing	Method for new products that determines customer needs. It uses upstream information to adjust downstream functions. The method can be used also in downstream.	<ul style="list-style-type: none"> Cost reduction Pressure change on downstream functions 	Baykasoglu, A., Kaplanoglu, in their study have attempted to provide a service costing framework for logistics companies that provide international land transport by truck. The framework includes three methods: ABC, Kaizen Costing and Target Costing [27].
Total Cost of Ownership (TCO)	Determine the total cost of a certain acquisition by associating all the costs of the supply with the returns. This means that the tool examines costs throughout the supply chain	<ul style="list-style-type: none"> Assessment of supply sources. Measurement of total costs of a certain acquisition. Purchase decisions. 	Degraeve, Labro, and Roodhooft in their paper, developed a mathematical programming model that selects multi-service object providers and simultaneously determines the market shares of selected suppliers. The methodology is based on information gathering by the method (TCO), quantifying all the costs associated with the purchasing process across the entire value chain of the company [33].

Sources: Improvement of [29].

3) *Logistic costing methods downstream of the enterprise*
Similarly to the previous table 6, the table presents the logistics

costing tools, but this time at the downstream level of the supply chain (outgoing functions).

TABLE VI. TABLE 6. LOGISTICS COSTS ASSESSMENT METHODS UPSTREAM THE COMPANY

	Description	Objective	Application examples
Customer Profitability Analysis (CPA)	Allocate revenues and costs at the end of the supply chain to determine profitability.	<ul style="list-style-type: none"> • Determining the profitability of a customer or a segment • Reallocation of resources • Cost reduction • Network optimization • Production programming • Inventory Level Decisions 	Raaijand and his colleagues at the level of the realized article, the process of CPA implementation is illustrated with the help of a case study in a company producing and selling professional cleaning products. The study highlights specific issues related to CPA in an industrial context and the results provided examples and possible benefits of implementing a regular CPA process [34].
Life Cycle Costing (LCC)	Involves all costs associated with a system or product during its lifetime. The technique can be extended to the supply side.	<ul style="list-style-type: none"> • Reduce costs of upstream functions • Providing information on all stages of the supply chain for decision-making 	Kjaer and his colleagues proposed an environmental input / output model used for the analysis because it allows a Life Cycle analysis LCA to use the same economic input data as LCC. This approach aligns LCA and LCC while avoiding cuts in LCA. The efficiency of the method is illustrated by a real case study of a tanker [35].
Landed Costing	Captures activity costs to move the product to the final destination. Includes freight, handling, etc.	<ul style="list-style-type: none"> • Provides information for the selection of logistics service providers • Network optimization and outsourcing decisions • Reorganization of processes 	The objective of the research conducted by [36] is to create a framework to accurately assess the benefits of Hub capacity in an international distribution network for packaged products

Sources: Improvement of [29].

As mentioned above, grouping tables is not absolute. Some of the tools can be implemented, at least with minor changes, in different parts of the supply chain. The figure 1 positions all tools in two classification dimensions (optimization / analysis, upstream / intra / downstream) [3].

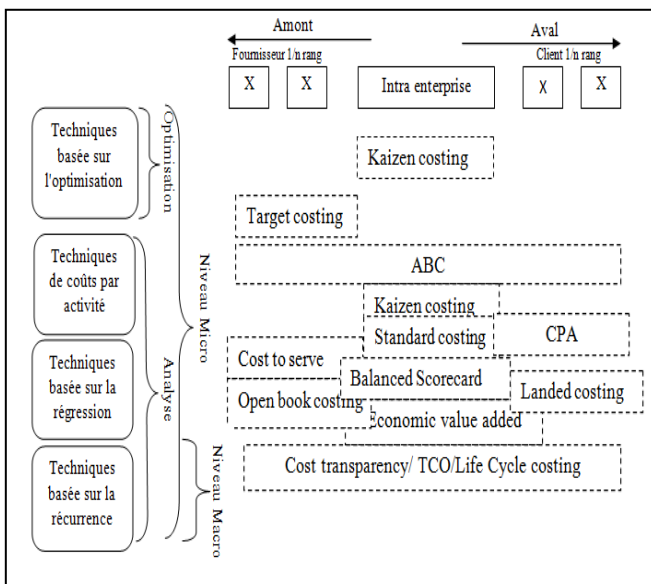


Fig. 1. Classification of Supply Chain Costing Tools

Source: Adopted from [3]

VI. CONCLUSION

Assessing the performance of logistics at the country level is of great importance as it helps to focus efforts made in transport and trade facilitation which contributes to improving the efficiency of supply chains and the functioning of infrastructures, services, procedures and regulations in connection with these chains [19]. At the supply chain level, better information on the logistics costs and chain management activities can help managers making better decisions. Besides, insufficient information about

these costs can hinder the negotiation and the cooperation between Supply chain partners [16].

Logistic costs at the micro level are generally assessed by accounting approaches. These approaches, in their traditional version, do not support inter-organizational decisions. While contemporary ones, though they overcome some of the shortcomings of traditional accounting practices, they cannot address all the problems they face in an inter-organizational context. A combination of several methods, depending on the purpose of the implementation, will cover these failures.

At the Macro level, logistics costs are usually handled in one country via multi-thematic studies. These studies are often in the form of a case study. It should be noted that methods based on surveys and statistics tend to be more reliable if they are applicable [3].

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