Performance Measurement System for Automotive Spare Parts Supply Chain: A Categorization Approach

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Keywords: Performance, Supply chain, Spare parts, Automotive, Categorization

ABSTRACT
This article provides a categorization approach that encompasses the required categories and sub-categories for the performance measurement of automotive spare parts supply chain with a focus on independent distributor belonging to the independent channel. In fact, the special characteristics of spare parts have led to the emergence of many scientific contributions related to inventory management and demand forecasting methods. However, little research has focused on the measurement of spare parts supply chain performance despite its big importance. In this paper, we attempt to fill this gap in the literature, in particular for the automotive aftermarket, by proposing a framework that will lead to the measurement of the overall automotive spare parts supply chain performance.

Cite this article as Achetoui, Z., Mabrouki, C., & Mousrij, A. (2019). Performance Measurement System for Automotive Spare Parts Supply Chain: A Categorization Approach. Journal of Transportation and Logistics, 4(1), 31-50. doi: 10.26650/JTL.2018.04.01.03
1. Introduction

The automotive aftermarket is a diversified sector that forms a part of the automotive industry. It encompasses manufacturing and distribution of spare parts as well as maintenance and repair in order to extend the life of vehicles sold to final customers.

In spite of being a source of substantial revenues, the automotive aftermarket is subject to changes due to technological evolution of automotive industry, emerging spare parts markets and competitive pressure. These changes largely affect the manufacturers and distributors of automotive spare parts in terms of executing strategies and managing supply chains in a prospective, optimal and effective manner.

In the context of supply chain management, the literature has mentioned special characteristics of spare parts such as the intermittency of demand, the multiplicity of references, the service requirement and the risk of obsolescence (Bacchetti and Saccani, 2012). These characteristics distinguish the spare parts supply chain and have a significant influence on all supply chain processes, especially those related to forecasting and inventory management, which directly influence the performance of the spare parts supply chain as a whole.

Therefore, companies that compete on the automotive aftermarket have to go through a performance measurement step in order to determine the impact of their practices, to control the supply chain processes and to assess the extent to which customers’ expectations have been fulfilled. The performance measurement of automotive spare parts supply chain will provide many insights about the effects of supply chain strategies and opportunities for the achievement of systemic and optimal coordination and synchronization of activities and, ultimately, for the performance improvement.

The literature on spare parts management has principally been limited to inventory management and forecasting methods. Few contributions have treated the performance measurement of the spare parts supply chain. Even though the literature provides several conceptual frameworks for supply chain performance measurement, the application of the proposed frameworks for the measurement of spare parts supply chain performance is almost absent. Even more, the literature lacks performance measurement frameworks designed specifically for the spare parts supply chain and that take into account the particular attributes of spare parts.

This article aims to fill this gap, in particular for the automotive aftermarket, by providing a categorization approach that encompasses the required categories and sub-categories for the automotive spare parts supply chain performance measurement. We mainly focus on independent distributor belonging to the independent channel.

This paper is structured as follows: We initially describe the automotive spare parts distribution chain. Then, we present a literature review that covers performance notions, performance measurement frameworks and spare parts supply chain
management overview. Subsequently, we present the methodology and the proposed framework. Finally, we draw our conclusion.

2. Automotive Spare Parts Distribution Chain

The automotive aftermarket is characterized by the presence of several actors who form two main distribution channels: The car manufacturer channel presented in figure 1 and the independent channel presented in figure 2. In both distribution schemes, we do not take into account the suppliers of raw materials and semi-finished products. We start from the supplier of the final product.

The car manufacturer distribution channel includes original equipment manufacturers (OEMs), car manufacturers, dealers, authorized repairers and final customers who are either private customers or professional customers such as insurance companies, fleet owners, professional fleets and cars rental companies.

Car manufacturers produce only visible spare parts (body parts, optical spare parts and mirrors). They entrust more than 50% of original spare parts, intended for the assembly of new vehicles, to OEMs.

The design rights legally protect the visible spare parts. This protection confers monopolies on car manufacturers in the automotive aftermarket, which creates a controversy because such monopolies are accused of harming free competition, increasing prices for consumers and raising insurance premiums. In this context, some countries have opted for the liberalization of the visible spare parts market such as Spain and Italy, unlike other countries such as France, Germany, Sweden and others, who still hold their monopolies.

On the other hand, the relationship between car manufacturers and OEMs is based on an agreement that allows car manufacturers to sell spare parts through the car manufacturer distribution channel. Once the agreement effective period is over, OEMs can manufacture and sell spare parts to both car manufacturers and distributors of independent channel.

The independent distribution channel is a multilevel distribution system. It includes equipment manufacturers, independent distributors, wholesalers, retailers, independent repairers, service stations, independent body shops and final customers who are either private customers or professional customers.

Equipment manufacturers are OEMs, manufacturers of equivalent spare parts, which have nearly the same specifications as original spare parts, and other manufacturers who are typically independent small and medium sized companies that manufacture non-branded spare parts of low prices and poor quality.

Equipment manufacturers supply independent distributors directly or through subsidiaries and central buying organizations. Independent distributors sell a considerable range of automotive spare parts of different types, brands and quality, to wholesalers through their warehouses and shops. They may directly sell spare parts to retailers, independent repairers and professional customers such as insurance companies, fleet owners, professional fleets and cars rental companies.
Even though the two channels are separated, sales may take place between some actors of both distribution channels. Dealers can sell spare parts to independent repairers and independent body shops. Wholesalers and retailers can also sell spare parts to authorized repairers while independent distributors can sell spare parts to dealers.

3. Literature Review

3.1. Concepts and Notions

The literature has put forward, over time, several definitions of the word “performance”. Among the proposed definitions, Bourguignon (1995) showed that performance might have three meanings:

1- Performance is a variable success according to companies and actors.

2- Performance is the result of an action. It represents the degree of objectives achievement.
3- Performance is an action, or even a process that leads to success.

Laitinen (2002) defined performance as the ability of an entity, an individual, a group or an organization to achieve specific and determined objectives through a number of activities. Berrah (2013) also pointed out that a company performs well when the determined objectives are achieved.

The performance analysis has been associated with three fundamental dimensions: Effectiveness, efficiency and relevance.

- Effectiveness shows the ability of a company to achieve the fixed objectives;
- Efficiency shows the ability of a company to achieve the fixed objectives with an economical use of resources;
- Relevance shows that the company uses the right means to achieve its goals.

The literature has also highlighted several definitions of the performance measurement system, which has made it difficult to agree on a single definition. To simplify the complexity of defining the performance measurement system, Franco-Santos et al. (2007) examined several definitions introduced in the literature by different contributors representing various research disciplines (strategy, operations, finance, accounting, human resources management, etc). Their analysis led to a classification of different definitions in three perspectives. The operational perspective based on the use of several metrics to quantify effectiveness and efficiency as introduced by Neely et al. (1995). The strategic perspective, which considers performance measurement system as a performance metric tool used to align strategic goals with processes (Ittner et al., 2003). The third one is the accounting perspective suggested by Otley (1999) which considers performance measurement system as a tool for planning and budgeting the performance and outcomes.

The performance measurement system plays a very important role due to its major functions that are beneficial to organizations. It encompasses a set of measures that enable managers to control different processes and to make decisions for the performance improvement and for the achievement of a greater organizational excellence.

In the context of our research and in addition to the functions already mentioned, the proposed framework will lead to a better visibility of the overall automotive spare parts supply chain in order to define the future strategic orientations.

### 3.2. Performance Measurement Frameworks

Several performance measurement systems have been proposed over the years (Chan et al., 2006). Initially, the performance measurement was limited to financial measures (e.g. return on investment and profit). Over time, it turned out that financial measures were not sufficient because of the complexity of certain supply chains that require innovation and continuous improvement. It has been necessary to integrate non-financial measures such as operational measures and long-term parameters related to strategic planning into performance measurement systems.
In this context, several authors have pointed out the importance of integrating non-financial measures (Medori and Steeple, 2000) and the importance of discussing the quality of the proposed financial measures (Ittner and Larcker, 1998). Activities and processes have also been considered as relevant aspects of performance (Kaplan and Johnson, 1987; Lorino et al., 1997).

Table 1 presents a literature review of performance measurement frameworks that was carried out through a process of articles selection presented in figure 3. The selected frameworks have presented the major developments of performance measurement since 1990. They have incorporated new performance dimensions such as productivity, responsiveness, leadership, innovation, training and personal improvement.

![Figure 3. Process of articles selection](image)

The selection process has led to 15 articles chosen as the most relevant contributions that almost fit the scope of this article. This number reflects the scarcity of contributions that provide categorization approaches for the performance measurement of the supply chain as a whole.
| Framework                                      | Author(s)            | Dimension (s)                                      | Description                                                                                                                                                                                                                                                                                                                                 |
|------------------------------------------------|----------------------|---------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Economic Value Added                           | Stewart (1991)       | Financial performance                              | The framework proposes a financial performance measure called economic value added (EVA) that allows assessing the true economic profit of an enterprise and aligns decision making with the shareholder wealth.                                                                                                                                                                                                                       |
| Results and Determinants framework             | Fitzgerald et al. (1991) | Financial success, competitiveness, flexibility, resource utilization, quality, innovation | The performance model provides six dimensions that are linked to strategy plans. Two dimensions of them are the results of strategy: Competitiveness and financial success. The other dimensions are determinants of the strategy success.                                                                                                                                                                                                 |
| Performance Pyramid                            | Lynch and Cross (1991) | Market, financial performance, customer satisfaction, flexibility, productivity, quality, delivery, cycle time, waste | The framework includes a hierarchy of financial and non-financial performance measures that link the hierarchical view of business performance measurement with the business process view.                                                                                                                                                                                                               |
| EFQM – Excellence model                        | European Foundation (1991) | Leadership, people, strategy, partnership and resources, processes, people results, customer results, society results, business results | It is a practical and non-prescriptive framework, designed to improve performance through the self-assessment. It is based on nine criteria, five of them are called enablers and four are called results. Enablers are improved using feedback from results.                                                                                                                                                                                                 |
| Balanced Scorecard                             | Kaplan and Norton (1992) | Financial perspective, customer perspective, business process perspective, innovation and learning perspective | The model translates a company vision and strategy into a set of objectives and measures through four perspectives. The aim of the framework is to create a balance between financial and non-financial measures, short-term and long-term objectives, internal and external performance.                                                                                                                                                                                                 |
| Integrated Dynamic performance measurement system | Ghalayini et al. (1997) | Financial performance, customer satisfaction, quality, delivery, process technology, education and training, cycle time, defect rate | The model is developed for manufacturing companies. It integrates three main areas of the company: Management, process improvement team and factory shop floor. The three areas are linked through the specification, reporting and dynamic updating of the defined areas of success, performance measures and performance standards.                                                                                                                                 |
| Integrated performance framework               | Medori and Steeple (2000) | Quality, cost, flexibility, time, delivery, future growth | The integrated framework is developed in order to audit and enhance performance measurement systems through some competitive dimensions.                                                                                                                                                                                                                                                                   |
| Performance Prism                              | Neely et al. (2001)   | Stakeholder satisfaction, stakeholder contribution, strategies, processes, capabilities | It is a measurement framework with a comprehensive stakeholder orientation. Management teams can use it in order to orient their thinking about the key questions to ask when seeking to manage their business.                                                                                                                                                                                                                                                 |
| Kanji’s Business Scorecard                     | Kanji and Sa’ (2002)  | Stakeholder values, process excellence, organizational learning, delighting stakeholders | The model is developed in order to overcome the limitations of the Balanced Scorecard. It looks for process excellence, organizational values and stakeholders’ satisfaction.                                                                                                                                                                                                                                                   |
| Dynamic multidimensional performance framework  | Maltz et al. (2003)   | Financial performance, market, process, people and future | It integrates people development and future measures with the Balanced Scorecard perspectives in order to assess and improve the organizational success.                                                                                                                                                                                                                                                         |
| Holistic Scorecard                             | Sureshchandar and Leisten (2005) | Financial performance, customer, business process, intellectual capital, employee and social perspectives | The model is an integrated scorecard for measuring and managing business performance in the software industry. It encompasses six perspectives of performance, as well as critical success factors and key performance indicators.                                                                                                                                                                                                 |
| Total Performance Scorecard                    | Rampersad (2005)      | Financial performance, customer, internal, knowledge and learning perspectives, personal improvement, process improvement | The framework combines the goals and aspirations of individual with those of organization. It integrates personal and organizational scorecard with PDCA cycle (plan, do, check, and act), Kolb’s learning cycle and talent development cycle.                                                                                                                                                                                                 |
### Table 1. A Selected Literature Review Of Performance Measurement Systems (continued)

| Framework                          | Author(s)                  | Dimension(s)                              | Description                                                                                                                                                                                                 |
|------------------------------------|----------------------------|--------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| LogistiQual                        | Grimaldi and Rafele (2007) | Tangible components, ways of fulfillment,  | The framework is based on SERVQUAL model (Parasuraman et al., 1985) that proposes five dimensions for the service quality evaluation: Tangibles (physical facilities, equipment, personnel and communication), reliability, responsiveness, assurance and empathy. These dimensions have been the starting point of LogistiQual that includes three macro-classes:  
- Tangible components macro-class that encompasses internal and external assets (physical instruments, operative means, handling, warehousing, transport), personnel aspects, inventory and availability aspects;  
- Ways of fulfillment macro-class that includes all ways and parameters of carrying out the service, such as flexibility, lead time, supply conditions and service care;  
- Informative actions macro-class that appends communication with the customers about service activities to the model, including marketing, order management, after-sales and e-information. Two subclasses were later included: Internal communication in the order management class and forecasting in the marketing one. |
| “System Dynamics-based” Balanced Scorecard | Barnabè (2011)               | Financial performance, customer, internal process, learning and growth | The framework provides a mapping tool for a comprehensive strategy map design. It combines the traditional Balanced Scorecard and the system dynamics principles for strategic management decisions. |
| Supply Chain Operations Reference model - SCOR | Supply-Chain Council (2012) | Reliability, agility, responsiveness, costs and assets | The SCOR model was originally developed in 1996, in order to analyze and describe processes along the entire supply chain, as well as to measure and improve the supply chain performance. The model provides an approach, processes, indicators and best practices to represent, evaluate and diagnose a supply chain. It integrates the concepts of business process reengineering to model the current situation, benchmarking to position the company in its competitive environment and process measurement into a cross-functional framework. The recent version of the framework “SCOR 12.0” covers six processes: Plan, source, make, deliver, return and enable. It also includes new training information and integrated sustainability standards. |

The literature has highlighted a number of performance measurement systems that consider new performance measures beyond financial performance measures. Social and environmental dimensions have also been taken into account (Figge et al., 2002; Länsiluoto and Järvenpää, 2008) and some management terms have emerged, such as corporate social responsibility and sustainability.

However, most systems do not provide a balanced performance measurement approach and do not treat the entire supply chain. It is therefore becoming increasingly important to focus on the performance of the supply chain as a whole (Gunasekaran et al., 2001; Lambert and Pohlen, 2001) since a weak link of the supply chain leads to the degradation of its overall performance. It is particularly important in those contexts where supply chain is considered a key factor of corporate success (Olugu et al., 2011).
3.3. Judgemental Models

The special characteristics of spare parts have prompted several researchers to focus mainly on spare parts inventory management and forecasting methods. However, literature dealing with spare parts supply chain performance measurement is still very limited (see table 2).

| Table 2. Summary Of Contributions Related To Spare Parts Supply Chain Management |
|---------------------------------|---------------------------------|---------------------------------|
| Research field                  | Main purpose of publications    | Authors                         |
| Inventory management            | -Mathematical approaches to optimize spare parts inventory management | Scudder (1984), Cobbaert and Van Oudheusden (1996), Dekker et al. (1998), Kennedy et al. (2002), Teunter and Klein Haneveld (2002), Kalchschmidt et al. (2003), Aronis et al. (2004), Caglar et al. (2004), Chang et al. (2005), Wong et al. (2005), Porras and Dekker (2008) |
|                                 | -Obsolescence management        |                                  |
|                                 | -Order and stocking policies    |                                  |
|                                 | -Inventory control              |                                  |
|                                 | -Inventory levels               |                                  |
| Spare parts classification      |                                  | Gajpal et al. (1994), Partovi and Anandarajan (2002), Braglia et al. (2004), Zhou and Fan (2007), Ramanathan (2006), Ng (2007), Boylan et al. (2008) |
| Demand forecasting              | Forecasting methods to predict spare parts demand | Eaves and Kingsman (2004), Willemain et al. (2004), Hua et al. (2007), Boylan and Syntetos (2008), Romeijnders et al. (2012), Bacchetti and Saccani (2012), Hemeimit et al. (2016), Zhu et al. (2017) |
|                                 | Forecasting automotive spare parts demand | Yang and Chen (2012), Do Rego and De Mesquita (2015) |
| Supply chain performance measurement | Key performance indicators for spare parts providers | Barkawi and Partners GmbH (2002) |
|                                 | Spare parts supply chain performance dimensions | De Leew and Beekman (2008), Cuthbertson and Piotrowicz (2011) |
|                                 | After-sales service performance measurement that includes spare parts logistics performance | Cohen et al. (2000), Gaiardelli et al. (2007) |

The overview shows that there is still a need for the development of adequate spare parts performance measurement systems that enable firms to monitor the supply chain performance. It covers key performance indicators (Barkawi and Partners GmbH, 2002) and two empirical studies related to spare parts supply chain performance, in particular, for the automotive field. The first one was based on the application of LOGISTIQUAL model (see table 1) on some companies operating in the dependent channel (De Leew and Beekman, 2008). The second one was the application of a framework designed to analyze the supply chain performance measurement systems used by organizations. The model was applied in Jaguar spare parts company (Cuthbertson and Piotrowicz, 2011).

The overview also includes the after-sales service performance measurement that includes the spare parts logistics performance. The mentioned contributions related to after-sales service were also applied in the automotive field such as the famous case of Saturn Company (Cohen et al., 2000).

The most important performance dimensions mentioned by the cited authors are responsiveness, reliability, availability, inventory turnover, customer satisfaction and loyalty. In the context of our research, we confirm the importance of these dimensions given the increased competition in the automotive aftermarket, the special characteristics of spare parts and the high expectations of customers in terms of service quality and long-time availability of spare parts. However, it is essential to take into account other performance dimensions in order to increase the visibility of the entire spare parts supply chain.
4. Methodology and Framework

As already mentioned, the performance measurement systems proposed in literature do not combine several dimensions and do not provide a performance measurement of the entire supply chain performance. Besides, contributions related to performance measurement of spare parts supply chain are very limited.

Thus, the present paper aims to fill the gap existing in the literature by providing a balanced and multidimensional categorization approach for the performance measurement of automotive spare parts supply chain (see table 3). The categorization approach encompasses the performance categories and sub-categories for all supply chain links, information system performance, research and development performance, human capital performance, as well as financial performance all over the supply chain. This categorization approach will lead to the measurement of the global supply chain performance that we define as follows: “The global performance of automotive spare parts supply chain is the ability to generate, at the same time, financial profitability and customer satisfaction and loyalty, by challenging competitors in terms of service quality, innovation and operational efficiency”.

The identification of categories and sub-categories was partly based on the previous literature review and partly on our personal reasoning and the judgments of industrial experts met during a yearlong investigation at a leading automotive spare parts distribution company in Morocco.

Table 3. Performance Measurement Framework For Automotive Spare Parts Supply Chain

| Aspect                        | Category               | Sub-category       | Sub-category definition                                                                 |
|-------------------------------|------------------------|--------------------|----------------------------------------------------------------------------------------|
| Customer service performance  | Service quality        | Responsiveness     | Responsiveness means the ability of employees to provide prompt service to the customer. It encompasses the speed of response to the customer through the various communication channels (phone, e-mail, social network, website and fax), the speed of order processing, the speed of solving claims and business disputes, the speed of information transmission to the customer and the speed of information sharing between employees. |
|                               | Accessibility          | Accessibility      | Accessibility means the ease of contact with the company through the various communication channels. It also includes the diversity and the geographic coverage of the company stores. |
|                               | Reliability            | Reliability        | Reliability means that order processing and claims solving are done correctly and timely. It also means the availability of communication channels, the absence of problems and business disputes, the accuracy of information provided to customers and the accuracy of information shared between employees. |
|                               | Customer satisfaction   | Customer satisfaction | Customer satisfaction is a positive feeling that customers have when the quality of service meets their expectations. It is assessed through survey questions and other means to analyze customers’ opinions regarding the understanding and the identification of their needs, the respect of their requirements and the response to their expectations. |
|                               | Customer loyalty       | Customer loyalty   | Customer loyalty means creating and maintaining a long lasting relationship with customers by creating a climate of trust. It is conditioned by the knowledge of customers and the implementation of an action plan based on the analysis of customers’ expectations and claims, as well as on the analysis of competition. |
| Administrative productivity    | Administrative activity level | The level of administrative activity expresses the amount of administrative work executed, namely: Order processing through the various communication channels, the creation of customers’ accounts and the reminder of unpaid invoices. |
|                               | Administrative growth   | Administrative growth | Administrative growth means the evolution of the administrative productivity, compared to a previous period and considering the desired objectives. |
| Aspect                        | Category                  | Sub-category                      | Sub-category definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------------------------------|---------------------------|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Customer service performance | Commercial productivity   | Commercial activity level         | The level of commercial activity expresses the amount of commercial work carried out, namely: Prospecting and acquisition of new customers, the writing of sales pitch, the sales follow-up and the elaboration of commercial action plans.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                              |                           | Commercial growth                 | Commercial growth means the evolution of the commercial productivity, compared to a previous period and considering the desired objectives. We note that the turnover is a financial result of the executed commercial work.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                              |                           | Customer activity                 | The customer activity reflects the volatility of customers’ purchasing behavior and their reactions following commercial and marketing solicitations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                              |                           | Forecast achievement              | The measurement of forecast achievement consists in a comparison between the obtained results and the forecast in terms of turnover, market share and number of customers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                              |                           | Sales forecasting accuracy        | The sales forecasting accuracy expresses the difference between the sales forecasting and the realized sales. It enables managers to know the capacity of forecasting to anticipate customers’ demand in order to ensure the availability of spare parts. It also helps in decision-making for the continuous improvement of the sales forecasting process.                                                                                                                                                                                                                                                                                                                                 |
|                              |                           | Promotional action                | The promotional action serves a multitude of purposes, namely: To attract the attention of customers and push them to purchase in order to increase sales temporarily, to retain customers by offering temporary financial benefits, to reactivate inactive customers and to conquer new customers by facilitating their first purchases.                                                                                                                                                                                                                                                                                                                                 |
|                              |                           | Logistics infrastructure          | Logistics infrastructure includes central warehouses, regional stores and logistics platforms used for the distribution and sale of spare parts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                              |                           | Warehouse equipment               | It includes the material handling equipment and other equipment used for the execution of warehousing and cross-docking operations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                              |                           | Infrastructure utilization        | It means the degree to which central warehouses areas, regional stores areas and logistics platforms areas are exploited regarding their total surfaces.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                              |                           | Equipment utilization             | It means the degree to which the material handling equipment and other equipment are used to carry out the warehousing and cross-docking operations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Warehouse performance        |                           | Responsiveness                    | Responsiveness means the ability of employees to execute promptly the warehousing operations, namely: Spare parts reception, storage, customers’ orders preparation, preparation of periodic replenishments of regional stores, preparation of spare parts to transfer from a central warehouse to a regional store or from a regional store to another, and shipment operations. Responsiveness also includes the speed of cross-docking operations execution, the speed of solving problems and business disputes, and the speed of information sharing between employees.                                                                                                                                                                                                                                                                 |
| Service quality              |                           | Service reliability               | Service reliability means that the warehousing and cross-docking operations are carried out rigorously and timely. It also means the accuracy of information shared between employees and the absence of problems and business disputes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|                              |                           | Equipment reliability             | It means the ability of the material handling equipment and other equipment to perform the warehousing and cross-docking operations under given conditions and at the desired time.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                              |                           | Items security                    | It means the degree of protection of spare parts against the unknown shrinkage (loss, undetected errors of inventory transactions recording, etc) and the known shrinkage (damage during handling, deterioration following bad storage, etc).                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Operational productivity     |                           | Operational activity level        | The level of operational activity expresses the amount of operational work performed by employees.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|                              |                           | Operational growth                | Operational growth means the evolution of the operational productivity, compared to a previous period and considering the desired objectives.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Aspect          | Category                  | Sub-category                  | Sub-category definition                                                                 |
|-----------------|---------------------------|-------------------------------|----------------------------------------------------------------------------------------|
| Stock &         | Service quality           | Availability                  | Availability means the presence and sufficiency of items in stock at the order time.    |
| procurement     |                           | Procurement plans             | The reliability of procurement plans means the ability of procurement methods to identify the optimal order quantities and the dates of orders placing. It also means the degree of achievement of the established procurement plans. |
| performance     |                           | reliability                  |                                                                                         |
|                 |                           | Inventory turnover            | Inventory turnover means the stock periodic renewal. Certainly, the speed of the inventory turnover reflects the high level of company activity, the effectiveness of inventory management practices and the organization of the entire supply chain. |
|                 |                           | Stock coverage                | Stock coverage is the ability of the stock to fulfill customers’ orders for a specified period, through an immediate availability of spare parts without replenishment or stock-out. |
|                 |                           | Stock level                   | Stock level refers to different levels of stock (safety stock, maximum stock, minimum stock, etc). These levels are related to customers’ needs and consumption. |
|                 | Activity level            | Inventory transactions        | It means the accuracy and rigor of real time inventory transactions recording.          |
|                 |                           | accuracy                     |                                                                                         |
|                 | Control and tracking      | Stock-taking                  | The stock-taking consists in identifying and evaluating, in a rigorous and planned way, the quantity of spare parts physically present in a stock at a given moment. It makes it possible to determine the differences between the theoretical quantities, recorded in an ERP or in inventory management software, and the actual quantities determined by the physical counting teams. |
|                 | Capacity                  | Material resources            | Material resources are the internal and external road transport means used for delivery to customers, delivery to regional stores in case of periodic replenishment, and spare parts transfer. |
|                 |                           | Utilization                  | It means the degree to which internal and external road transport means are used regarding the capacity of each mean of transport. |
|                 |                           | Responsiveness                | Responsiveness means the ability of the company to provide a quick spare parts delivery to customers and to regional stores in case of periodic replenishment. It also includes the speed of spare parts transfer. |
|                 |                           | Reliability                  | Reliability means that deliveries to customers and regional stores are done correctly and at the right time. It also means the accuracy of transport documents and the availability of internal and external road transport means. |
|                 | Service quality           | Items security                | It means the degree of protection of spare parts against loss and deterioration during delivery. |
|                 |                           | Organization                 | The delivery organization includes planning, scheduling and optimization of delivery process through the massification and rationalization of flows. The delivery organization saves time and leads to a better customer service and costs reduction of delivery rounds, while respecting company and customers’ constraints. |
|                 | Operational productivity   | Operational activity level    | The level of operational activity expresses the amount of operational work executed.     |
|                 |                           | Operational growth           | Operational growth means the evolution of the operational productivity, compared to a previous period and considering the desired objectives. |
|                 | Supplier service quality   | Responsiveness                | Responsiveness means the supplier’s ability to provide prompt service to the company. It encompasses the speed of response to the purchaser through the various communication channels, the speed of order confirmation and order processing, the speed of solving claims and business disputes, and the speed of information transmission to the purchaser. |
|                 |                           | Accessibility                 | Accessibility means the ease of contact with suppliers through the various communication channels. It also includes the geographic proximity of suppliers. |
|                 |                           | Reliability                  | Reliability means that order processing, claims processing and delivery are done correctly and timely. It also means the availability of communication channels, the accuracy of information transmitted to the purchaser and the absence of business disputes. |
| Aspect                                    | Category                        | Sub-category | Sub-category definition                                                                                                                                 |
|------------------------------------------|---------------------------------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Purchasing performance                   | Customs and transit service quality | Responsiveness | Responsiveness means, on the one hand, the ability of the customs administration to carry out promptly the customs procedures and, on the other hand, the ability of the forwarding agent to provide prompt service to the company. |
|                                         |                                  | Reliability  | Reliability means that the services provided by the forwarding agent and the customs administration are carried out correctly and timely.                      |
|                                         | Internal service quality         | Responsiveness | Responsiveness means the purchaser’s ability to respond promptly to the needs of internal customer. It includes the speed of placing orders and purchasing accomplishment, the speed of claims transmission to suppliers, the speed of information transmission to internal customer and the speed of solving problems and business disputes. |
|                                         |                                  | Reliability  | Reliability means that the purchaser responds to the needs of internal customer at the right time and ensures the arrival of compliant goods along with correct transport documents. It also means the accuracy of information provided to internal customer and the absence of problems and business disputes. |
|                                         | Internal customer satisfaction   |              | Internal customer satisfaction is a positive feeling that internal customer has when the purchasing service quality meets his expectations. It is assessed through survey questions and other means to analyze the internal customer’s opinion. |
|                                         | Sourcing                         |              | The sourcing means to look for new suppliers who are able to respond effectively to the company needs in terms of cost, quality, time, innovation and payment terms. |
|                                         | Purchase activity                |              | Purchase activity includes issuing orders and completing purchases. It is reflected by the value of purchases made and the panel of active suppliers. |
|                                         | Orders follow-up                 |              | The administrative follow-up of orders consists, on the one hand, in checking if the acknowledgement of receipt sent by the supplier is consistent with the order placed in terms of price, quantity and spare parts references, and on the other hand, in relaunching the supplier in case of delay or in case of close delivery for the one who does not often respect the delivery date. |
|                                         | Purchase activity growth         |              | It means the evolution of the purchase activity, compared to a previous period and considering the desired objectives. |
| Reverse logistics performance            | Responsiveness                   |              | Responsiveness means the ability of the after-sales service to respond promptly to customers’ claims. It encompasses the speed of response to customers through the various communication channels, the speed of claims processing and returns processing, the speed of feedback transmission, resulting from interactions with customers, to the involved departments (customer service, purchasing department and logistics department), and the speed of solving problems and business disputes. |
|                                         | Accessibility                    |              | Accessibility means the ease of contact with the after-sales service through the various communication channels. |
|                                         | Service reliability              |              | Service reliability means that the customers’ claims processing and returns processing are carried out correctly and timely. It also means the availability of communication channels, the absence of problems and business disputes, the accuracy of information provided to customers and the accuracy of information shared between employees. |
|                                         | Equipment reliability            |              | It means the ability of intervention tools and inspection instruments to operate without any break down, in order to carry out the after-sales service interventions under given conditions and at the desired time. |
| Customer relationship management         | Customer satisfaction            |              | Customer satisfaction is a positive feeling that customers have after interacting with the after-sales service. It is assessed through survey questions and other means to analyze customers’ opinions regarding the resolution of their claims and the quality of interventions. |
|                                         | Customer loyalty                 |              | Customer loyalty is also conditioned by the particular attention given by the after-sales service to customers, in case of claims and returns of defective spare parts. |
### Table 3. Performance Measurement Framework For Automotive Spare Parts Supply Chain (continued)

| Aspect                        | Category                        | Sub-category                   | Sub-category definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------------------------|---------------------------------|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Reverse logistics performance | Productivity                    | Operational activity level     | The level of operational activity expresses the amount of operational work of the after-sales service.                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                               |                                 | Administrative activity level  | The level of administrative activity expresses the amount of administrative work of the after-sales service, namely: The reception of claims through the various communication channels, the creation and the follow-up of files related to claims, the writing of interventions reports, the writing and sending of information mails to customers, the follow-up of guarantees and the transmission of defective spare parts state to the involved departments.                                                                                     |
|                               |                                 | Operational growth             | Operational growth means the evolution of operational productivity of the after-sales service, compared to a previous period and considering the desired objectives.                                                                                                                                                                                                                                                                                                                                                                      |
|                               |                                 | Administrative growth          | Administrative growth means the evolution of administrative productivity of the after-sales service, compared to a previous period and considering the desired objectives.                                                                                                                                                                                                                                                                                                                                                                   |
| Information system performance|                                 | IT infrastructure              | IT resources include hardware and software used to access to information.                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                               |                                 | Utilization                    | It means the degree to which IT resources are exploited to manage, process, and store data.                                                                                                                                                                                                                                                                                                                                                                                                                        |
|                               |                                 | Availability                   | Availability refers to the proper operation of the information system and the access to information at the time of use.                                                                                                                                                                                                                                                                                                                                                                                                               |
|                               |                                 | Integrity                      | Integrity means maintaining the accuracy of information during its use.                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|                               |                                 | Confidentiality                | It means that access to information is only possible for authorized employees.                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Research & development performance| Monitoring activity           | Marketing intelligence         | Marketing intelligence consists in collecting, analyzing and transmitting information about the automotive aftermarket and the automotive industry. It encompasses the monitoring of spare parts and vehicles technical evolution, the detection of new spare parts, the monitoring of statistics related to the car fleet circulating in the country as well as the monitoring of customers’ financial health.                                                                                                                                   |
|                               |                                 | Competitive intelligence       | Competitive intelligence consists in monitoring competitors and collecting information about their pricing policies, their practices in terms of sale and distribution of automotive spare parts, as well as information about their financial and commercial performances such as turnover, market share, margin rate and number of customers.                                                                                                      |
|                               |                                 | Technology watch               | The technology watch means to be informed continuously about the recent technological evolutions and innovations, namely: New warehouses automation technologies, new IT solutions and new security technologies in warehouses and means of transport.                                                                                                                                                                                                                                           |
|                               |                                 | Digital transformation         | Digital transformation means the integration of digital technology into all supply chain processes, by investing massively in information system and commercial communication system, in order to strengthen the customer relationship quality and to share effectively information between all supply chain actors.                                                                                                                                          |
|                               |                                 | Commercial innovation          | Commercial innovation consists in renewing the offer by introducing new references and targeting new equipment manufacturers. It also includes the development of spare parts distribution network and the adoption of new sale concepts. Commercial innovation enables the independent distributor to deal with the aggressive competition in the automotive aftermarket and to adapt to the dynamics of change and to customer behavior. |
|                               |                                 | Logistics innovation           | Logistics innovation consists in integrating new strategies and advanced technologies that allow improving logistics performance in terms of time and quality of warehousing and transport operations execution, as well as the improvement of working conditions of logistics operators.                                                                                                                                                                                                                       |
|                               |                                 | Organizational innovation      | Organizational innovation consists in adopting new practices and approaches for organizing the distribution of spare parts and the work of employees.                                                                                                                                                                                                                                                                                                                                                                                   |
Table 3. Performance Measurement Framework For Automotive Spare Parts Supply Chain (continued)

| Aspect               | Category            | Sub-category                | Sub-category definition                                                                 |
|----------------------|---------------------|-----------------------------|----------------------------------------------------------------------------------------|
| Financial performance|                     | Professional training       | Professional training is a learning activity that develops and strengthens the professional skills of employees to accomplish effectively their missions and to face the work requirements. |
|                      |                     | Professional mobility       | Professional mobility refers to the change of employee’s professional situation (change of job or department within the same company, or switching to another company). Professional mobility guarantees job security and allows the improvement of employee’s working conditions. It also allows the employee’s professional skills development through the various experiences during which the employee shares ideas and practices with other professionals with varied profiles. |
|                      |                     | Promotion                   | Promotion means the appointment of the employee to a higher position. It is usually accompanied by a salary increase or other benefits to energize the employee. |
| Human capital security| Recruitment         | Recruitment                 | Recruitment is based on a set of actions implemented in order to find the suitable profile for the need of the company. The recruitment process ends with the integration of the recruit so that he knows the environment of the company, his missions and his future professional relationships. |
|                      | Professional skills assessment | Professional skills assessment | The assessment of professional skills consists in evaluating the employee’s technical and managerial knowledge, his skills, his relational behavior and his work executed. It promotes the dialogue between the employee and his supervisor so that he has a visibility on the evolution of his career by knowing his strengths and weaknesses. It also makes it possible to look for employee’s improvement areas and to make decisions regarding remuneration, professional training, new objectives and professional mobility. |
|                      | Employee satisfaction | Employee satisfaction       | Employee satisfaction is a positive feeling that employees have when the working conditions meet their expectations. It is conditioned by several factors such as the organization of work, the clarity of roles, the workload, the available resources, the business environment and its changes, the job security and the professional relationships. Employee satisfaction is assessed through survey questions and other means to analyze employees’ opinions. |
|                      | Commitment          | Commitment                  | Commitment means the devotion of employees to their company in order to achieve the desired goals. It encompasses the presence, the availability, the loyalty and the pride of belonging to the company as well as the employees’ desire to invest themselves energetically, enthusiastically and effectively in the work and in the implementation of the action plan in order to achieve the desired goals. |
|                      | Work safety         | Work safety                 | Work safety means the degree of employees’ protection against hazards and risks of accidents that may occur during working hours. |
|                      | Job security        | Job security                | Job security is the assurance that an employee will not lose his job in the near future. It depends on many factors such as the individual performance, the economic situation and the performance of the company. |
|                      | Social protection   | Social protection           | Social protection aims to prevent and manage the social risks that affect the well-being of employees (diseases, work accidents, disability, loss of retirement income, etc). |
|                      | Investment          | Investment viability        | The viability of an investment enables investors, on the one hand, to determine if an investment project (past, current or future) is profitable over a given period, and on the other hand, to make a comparison between investment projects when several choices are possible in order to choose the most viable investment. |
|                      |                     | Financing sources           | Sources of financing are the internal and external modes adopted by the company to finance an investment. Internal financing refers to self-financing, assets disposal and capital increase, while the external financing involves the resort to the third party funding, intermediaries and financial markets. |
Table 3. Performance Measurement Framework For Automotive Spare Parts Supply Chain (continued)

| Aspect               | Category     | Sub-category | Sub-category definition |
|----------------------|--------------|--------------|-------------------------|
| Financial performance| Financial wealth | Revenues generation | It represents the ratio of revenues generated by the company to resources used to obtain them. |
|                      |              | Profitability | Profitability is the ability of the company to generate profit through its activity. |
|                      |              | Activity growth | The growth of the activity means the evolution of the company activity. It reflects the degree of the activity control and the wealth level created during a given period. The growth of the activity must result from a good management since it can come from a faster increase of company expenses, which can generate an increase of indebtedness. |
|                      | Financial health | Profit growth | Profit growth means the evolution of the monetary profit generated. |
|                      |              | Solvency      | Solvency is the ability of the company to pay short, medium and long-term debts. It is positive when the sum of fixed assets, accounts receivable and inventories is higher than debts. |
|                      |              | Financial indebtedness | Financial indebtedness refers to debts from third party funding (credit institutions, banks, etc) except suppliers’ debts, fiscal and social debts. Financial indebtedness must not exceed a certain level to not generate an inability to repay the lenders, which can lead to a judicial liquidation. |
|                      |              | Liquidity     | Liquidity means the ability of the company to pay off short-term debts. This requires the company to have a sufficient amount of cash and assets that can readily be converted into cash. |

5. Conclusion

The literature on spare parts management has mainly focused on the management of spare parts inventory and forecasting methods. But comparatively, little attention has been devoted to the performance measurement of spare parts supply chain, even though the supply chain management has attracted a great deal of attention. In this perspective, we tried to fill the gap found in literature, in particular, for automotive aftermarket by providing a multidimensional and balanced categorization approach, in order to measure the automotive spare parts supply chain performance and to assess the impact of practices inside any company operating in the independent distribution of automotive spare parts. In turn, this framework will enable managers to determine weak areas where the performance can be improved.

The categorization approach encompasses financial and non-financial categories and sub-categories and consequently leads to the measurement of the global performance of automotive spare parts supply chain. It was based on academic research and experts’ judgments, as well as our personal reasoning. We regard the approach to be reliable, well designed and can serve any independent distributor of automotive spare parts since it treats all the links of the supply chain and incorporates both financial and non-financial dimensions for a better visibility.

Given the scarcity of contributions related to spare parts supply chain performance, this article will constitute a basis for future academic and practitioner research in accordance with the development of the supply chain management.
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