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**A BALANCED PERFORMANCE MEASUREMENT SYSTEM FOR
AUTOMOTIVE SPARE PARTS SUPPLY CHAIN**

Summary. This paper aims to provide a performance measurement system for the automotive spare parts supply chain. We focus on an independent distributor belonging to an independent channel. The framework encompasses different performance aspects for a high supply chain visibility, as well as the required categories, subcategories and key performance indicators for the automotive spare parts supply chain performance measurement. The framework is the first contribution that advances the performance measurement in the automotive aftermarket and allows assessing the performance of the automotive spare parts supply chain as a whole.

Keywords: supply chain management, spare parts, automotive aftermarket, performance measurement

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1. INTRODUCTION

The automotive spare parts business is very complicated due to the technological evolution of the automotive industry, emerging spare parts markets and competitive pressure. The spare part itself has particular features that distinguish it from other finished products such as the intermittence of demand, the multiplicity of references, the service requirement and the risk of obsolescence [1, 2]. These factors form the source of uncertainty and complexity in the supply chain and largely affect the management of the supply chain processes for competing manufacturers and distributors in the automotive aftermarket.

To identify the real influence of these factors, companies have to pass upon the performance measurement. This step allows companies to control the supply chain processes, assess the achievement of objectives and, ultimately, improve the supply chain performance [1-6].

The spare parts supply chain performance measurement has not been much discussed in the literature. Whether it is about the application of the existent frameworks to measure the spare parts supply chain performance or the proposition of frameworks designed specifically for the spare parts supply chain. In this context, this article aims to fill this gap, in particular, for the automotive aftermarket, by providing a performance measurement system that encompasses aspects, categories, subcategories and key performance indicators for the automotive spare parts supply chain performance measurement. We focused on an independent distributor belonging to an independent channel.

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.

2.1. Car manufacturer channel

The car manufacturer channel includes original equipment manufacturers (OEMs), car manufacturers, dealers, authorized repairers and the final customers who are individual customers and business customers such as insurance companies, fleet owners and car rental companies.

The car manufacturers entrust the manufacturing of more than 60% of the original spare parts intended for the assembly of new vehicles to OEMs. They usually produce visible spare parts that are legally protected by design rights. The car manufacturers generally negotiate the conditions of spare parts supply with OEMs from the manufacturing stage of the original spare parts intended for the assembly of new vehicles. The competition between OEMs is intense for obtaining contracts that represent nearly 80% of their turnovers and frequently allow them to position themselves favorably in the automotive aftermarket.

The manufacture of an original spare part generally requires specific tooling designed and/or manufactured by the OEM or purchased from the tool manufacturer. A new tool requires a very heavy investment. Thus, it is generally financed by the car manufacturer, who in return, requires becoming the owner.

The relationship between the car manufacturer and the OEM is based on a contract that provides the terms of use for the tooling. The contract generally limits the OEM's ability to produce spare parts for the independent channel. The contract may prohibit the use of the tool,

except with the prior authorization of the car manufacturer or payment of a fee. Otherwise, it can impose an exclusive supply to the car manufacturer who will sell the spare parts intended for the repair of vehicles through the car manufacturer channel for a limited period. Once the contract expires, the OEM can manufacture and sell the spare parts to the car manufacturer and the independent distributors. Thus, the OEM becomes the main competitor of the car manufacturer when he has the right to market spare parts to independent distributors.

2.1.1. Dealers

Dealers play a very important role in the car manufacturer channel. They allow the car manufacturer to hold a significant market share and control the sale of the full range of spare parts for vehicles of his brand, but only his brand, especially when they are located in areas with high added value.

Dealers can sell a low quantity of spare parts to wholesalers, retailers, independent garages, body shops and service chains [7].

2.1.2. Authorized repairers

The authorized repairers belonging to the car manufacturer channel are passionate about cars. They have all the means to detect breakdowns, as well as the means to control pollution, lighting and other safety equipment.

Being part of a well-structured channel allows them to benefit from regular training, qualifications and technical documentation to better understand vehicles' operations and retain their customers despite high repair costs.

2.1.3. Final customers

The final customers are mainly the owners of premium vehicles who are loyal to this network and constitute a significant portion of customers. There are also insurance companies, fleet owners, car rental companies and owners of vehicles under warranty.

2.2. Independent channel

The spare parts independent manufacturing industry plays a pivotal role in the automotive aftermarket, as it produces a wide range of spare parts needed to meet customers' needs and ensure competition between the car manufacturer channel and the independent channel.

The independent channel is more complicated than the car manufacturer channel. It is a multilevel distribution system. It includes equipment manufacturers, independent distributors, wholesalers, retailers, independent repairers, service stations, independent body shops and the final customers who are individual customers and business customers such as insurance companies, fleet owners and car rental companies.

2.2.1. Equipment manufacturers

The equipment manufacturers are OEMs, second-tier equipment manufacturers who manufacture spare parts that fulfill the functions required for the proper functioning of a vehicle and meet the safety requirements and environmental quality, but with a lower quality than the

spare parts produced by OEMs. In addition, there are small and medium-sized companies that manufacture cheap and poor quality spare parts.

2.2.2. Independent distributors

There are two types of independent distributors: independent distributors focused on spare parts manufactured by OEMs and independent distributors of cheap and poor quality spare parts.

➤ **Independent distributors deal on spare parts manufactured by OEMs**

Most of the spare parts sold by these distributors come from original equipment manufacturers. This category also distributes a wide variety of spare parts manufactured by second-tier equipment manufacturers.

They sell different types and brands of automotive spare parts to wholesalers through their shops. They may directly sell spare parts to retailers, independent repairers, body shops, service stations and business customers such as insurance companies, fleet owners and car rental companies.

➤ **Independent distributors of cheap and poor quality spare parts**

This category similarly includes a large number of independent distributors. Some are medium in size, while others are small and specialize in a limited number of products and brands.

Some of these distributors sell spare parts of uncertain quality, which are very dangerous, as they do not meet the requirements of safety and environmental quality.

2.2.3. Wholesalers

Wholesalers usually sell all types of spare parts. However, a minority deals in certain types of products, such as radiators and tires.

2.2.4. Retailers

Retailers are the main customers of wholesalers. They rarely buy spare parts from independent distributors. Their customers are independent repairers, business customers and individual customers.

2.2.5. Prescriber to the final consumer

Prescribers are independent repairers, service stations and independent body shops. They sell spare parts as such or through a repair intervention. At this level, the quality of spare parts is often categorized according to the purchasing power of the final consumer and the final margins of the prescriber.

In general, the final consumer has the choice between the car manufacturer channel and the independent channel to obtain the desired spare part and repair the vehicle. The freedom of choice and the diversity of products offered by the two channels make it possible to maintain healthy and effective competition to meet customers' demands.

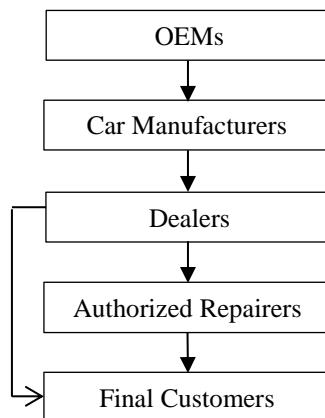


Fig. 1. Car manufacturer distribution channel

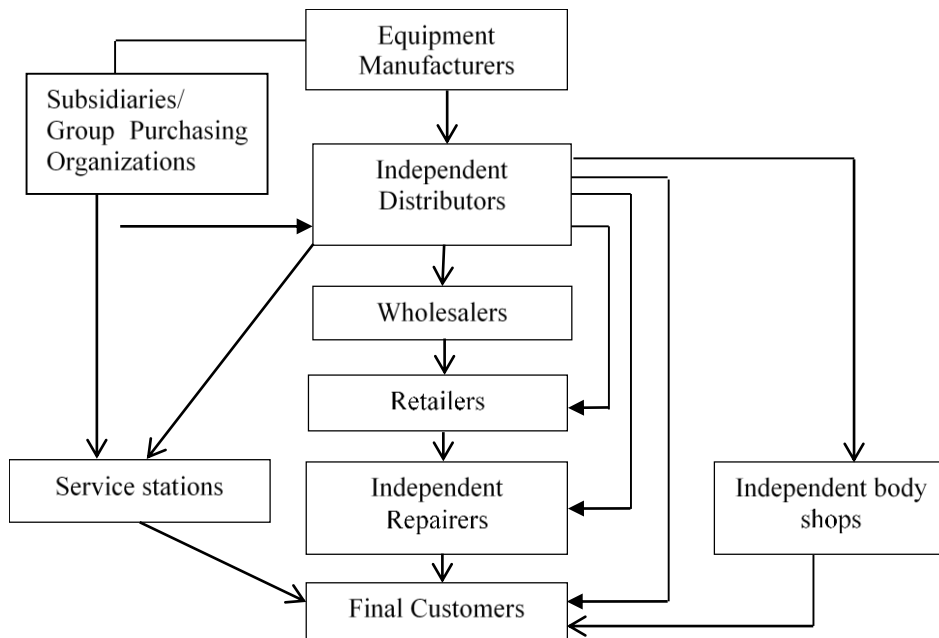


Fig. 2. Independent distribution channel

3. AN OVERVIEW OF THE AUTOMOTIVE SPARE PARTS SUPPLY CHAIN PERFORMANCE MEASUREMENT

The automotive spare parts supply chain performance measurement is essential for any company operating in the automotive aftermarket to strengthen customers’ confidence and gain a sustainable competitive advantage in a dynamic sector known for intensive competition. Manufacturers or distributors of automotive spare parts will not be able to improve their position in the automotive aftermarket without measuring the supply chain performance.

The measurement of the automotive spare parts supply chain performance enables managers to identify the gaps existing in practice, which helps to develop strategic relationships, reduce expenses and improve human capital performance. Charan [8] adds that the main concern of the automotive spare parts supply chain performance measurement is how to manage the

dependency between different members of the supply chain, as well as the combined effort of all members to achieve mutually established goals.

The research related to the measurement of the automotive spare parts supply chain performance is limited to identifying certain key performance indicators. No performance measurement system has been proposed for measuring the overall supply chain performance of a company operating in the manufacture or distribution of automotive spare parts.

Barkawi and Partners GmbH [9] identified a set of key performance indicators used by some providers of spare parts, namely: on-time delivery performance, inventory turnover, service level, availability rate, accuracy of delivery, accuracy of forecasts, inventory level, complaint rate and customer satisfaction.

De Leeuw and Beekman [10] submitted an empirical study on the measurement of the automotive spare parts supply chain performance. They surveyed several companies belonging to the car manufacturer channel. Further, they provided a set of key performance indicators that were important according to the interviewees, namely: availability rate, stock-out, lead time, delivery frequency, completeness, correctness, regularity and punctuality. The investigation was based on the application of the LogistiQual model [11].

Charan [8] analyzed the automotive spare parts supply chain performance issues through a case study of an OEM in India. The author used the SAP-LAP model to explain the supply chain performance problems in a managerial context. The SAP-LAP model is subdivided into two steps: SAP which includes three components (situations (S), actors (A) and process (P)), and LAP, which also forms three components (learning issues (L), recommended actions (A) and anticipated performance improvement (P)).

The author noted that measuring the performance of the OEM's supply chain helps to identify gaps in practices. In terms of performance evaluation, Charan [8] offered some indicators used by the OEM to measure supplier performance, namely quality, cost, delivery and new product development parameters.

Gaiardelli et al. [12] proposed an integrated framework for measuring after-sales service performance that includes the performance of spare parts logistics. The framework was evaluated through multiple-case studies, including two companies in the automotive sector. The authors provided several key performance indicators for measuring automotive spare parts logistics performance, such as error rate, picking time, delivery time, inventory obsolescence, supplier delivery performance, supplier quality performance and the number of stock-outs per month.

We confirm the importance of the performance indicators provided by the authors given the particular characteristics of spare parts and the high expectations of customers for service quality and availability of spare parts. However, it is essential to consider other performance measures for effective spare parts supply chain performance measurement, which largely promote customer satisfaction in the automotive aftermarket. Indeed, automotive spare parts manufacturers and distributors face the typical trade-off between cost and service given the intermittent nature of demand and the high inventory levels. They must act to satisfy their customers by ensuring the availability of spare parts and offering high-quality services while minimizing the costs associated with keeping stocks and the risk of obsolescence.

The proposed indicators are not enough to measure the overall performance of the automotive spare parts supply chain. The literature lacks systems that are designed specifically for measuring the supply chain performance of manufacturers or distributors of automotive spare parts and that considers the particular characteristics of automotive spare parts, leading to the measurement of the automotive spare parts supply chain performance as a whole.

4. A BALANCED PERFORMANCE MEASUREMENT SYSTEM

We propose a full performance measurement system consisting of aspects, categories, subcategories and key performance indicators to measure the performance of the overall automotive spare parts supply chain for an independent distributor belonging to the independent channel. The system aims to fill the gap existing in the literature by providing a balanced and multidimensional framework.

The framework encompasses different performance aspects inspired from all supply chain links, besides other particular aspects of performance that create value within the supply chain and significantly affect the overall supply chain performance, namely: the financial performance aspect all over the supply chain, research and development performance aspect, information system performance aspect, as well as the human capital performance aspect (Figure 3).

The design of the performance measurement system was partly based on the literature resources 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. The content of the framework is ultimately an answer to the fundamental question “What to measure?” to rigorously assess the performance of the automotive spare parts supply chain.

The principle is as follows: for each performance aspect, we defined the required performance categories. Then, we fixed the required subcategories for each category. Finally, we established a set of key performance indicators for each subcategory.

We used seven criteria for the identification of appropriate key performance indicators, namely: clear, understandable, measurable, relevant, reliable, decisive and economic. The identification of key performance indicators considered the particular characteristics of automotive spare parts, the needs of each decision-maker and the specificities of the automotive spare parts distribution.

4.1. Customer service performance

The automotive aftermarket is known for intensive competition and perpetual changes. Thus, customer service continues to gain importance as customers become increasingly aware of service requirements. Besides, the competitive trends have raised their expectations. In this regard, high-performance customer service is an essential element for the independent distributor to stand out from the competition in the automotive aftermarket, gain a competitive advantage and retain customers.

We propose to evaluate the customer service performance through four categories: service quality, customer relationship management, administrative productivity and commercial productivity.

Leonard and Sasser [13] state that service quality is a major strategic variable in the battle for market share. Along the same lines, Berry et al. [14] believe that service excellence is a key strategic weapon. Thus, service quality is often a key variable in strategic planning and organizations that become leaders are characterized by management commitment, as well as a customer-oriented and quality-oriented corporate culture throughout the company.

In the automotive aftermarket, the customers are increasingly critical of the quality of service they receive. Thus, high service quality allows the automotive spare parts distributor to strengthen his credibility, meet and anticipate customer expectations.

Evaluating the service quality is therefore essential to improve the customer service, which is one of the most difficult tasks that can influence the long-term success of an automotive spare parts distributor. We have settled three subcategories to assess the quality of service: responsiveness, accessibility and reliability.

Customer relationship management is closely related to the quality of service. It is a strategic weapon for attracting and retaining customers and one of the most important factors for business success [15].

Many researchers have suggested that companies should reorient their operations toward effective customer relationship management to build and maintain their competitive advantage [16]. In this context, measuring customer relationship performance is an essential step to consider improvements. For an automotive spare parts distributor, we suggest evaluating it through customer satisfaction and customer loyalty. The result of the evaluation reflects the excellence of the customer relationship and the effectiveness of the strategy of customer loyalty.

Measuring customer service productivity enables the company to obtain timely feedback and helps the staff to adjust and align efforts in the right direction and consistently move toward goal achievement. The choice to divide productivity into administrative productivity and commercial productivity emanates from the nature of the missions carried out. The customer service in automotive spare parts distribution company is characterized by external and internal commercial tasks and internal administrative tasks. We selected two subcategories for the evaluation of administrative productivity: administrative activity level and administrative growth.

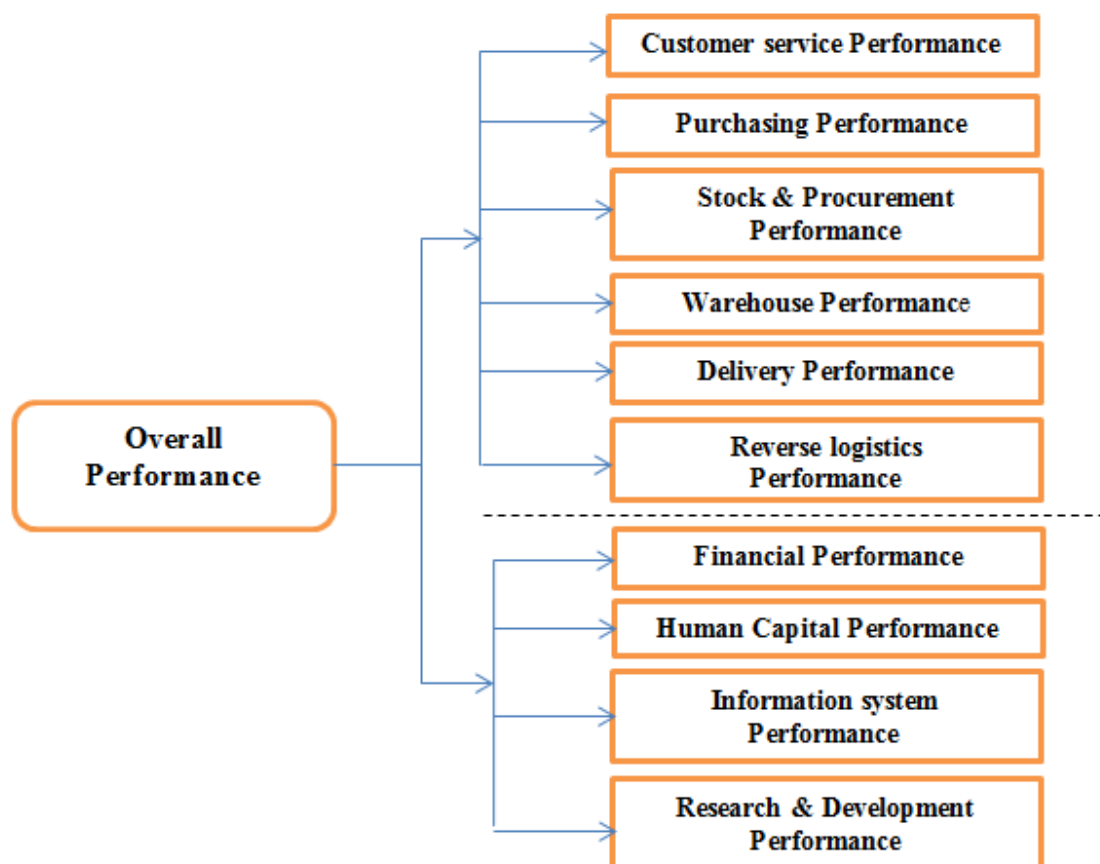


Fig. 3. Performance measurement aspects for the automotive spare parts supply chain

To evaluate the commercial productivity, we created six subcategories: commercial activity level, commercial growth, customer activity, forecast achievement, sales forecasting accuracy and promotional action.

The two common subcategories between administrative and commercial productivity are the level of activity, which reflects the real work performed and the growth, which indicates the company’s vitality. At the commercial level, we have other subcategories as the commercial function encompasses several value-creating tasks.

Table 1 encompasses the categories, subcategories and key performance indicators for the measurement of customer service performance.

Tab. 1

Dimensions and key performance indicators for customer service performance measurement

Aspect	Category	Subcategory	Key performance indicators
Customer service performance	Service quality	Responsiveness	1- Average response time to customer 2- Average call processing time 3- Average order processing time 4- Average claim processing time 5- Average time of information transmission to customer 6- Average time of information sharing between employees
		Accessibility	1- Rate of calls picked up 2- Rate of lost calls 3- Average customer waiting time to get a response 4- Average number of contacts needed to resolve a claim 5- Geographic coverage rate
		Reliability	1- Billing error rate 2- Response delay rate 3- Order processing delay rate 4- Service rate 5- Rate of claims processed 6- Rate of claims processed within the reference time 7- Availability rate of communication channels 8- Disputes rate per order 9- Reliability of information transmitted to customers 10- Reliability of information shared between employees
	Customer relationship management	Customer satisfaction	1- Customer Satisfaction Score (CSAT) 2- Customer Effort Score (CES)

	Administrative productivity		3- Net Promoter Score (NPS)	
		Customer loyalty	1- Repurchase rate 2- Customer attrition rate	
		Administrative activity level	1- Rate of calls processed 2- Rate of orders processed 3- Number of customers' accounts created 4- Number of unpaid invoices reminders per customer	
	Administrative growth	1- Growth rate of the number of calls processed 2- Growth rate of the number of orders processed 3- Growth rate of the number of customers' accounts created		
	Customer service performance	Commercial productivity	Commercial activity level	1- Rate of new customers 2- Number of commercial actions established 3- Number of sales pitch revisions 4- Obsolescence rate 5- Rate of active references
			Commercial growth	1- Growth rate of the number of new customers 2- Growth rate of the number of commercial actions established 3- Growth rate of the number of active references 4- Growth rate of obsolescence
Customer activity			1- Rate of active customers 2- Rate of orders cancellation	
Forecast achievement			1- Achievement rate of the overall forecasted turnover 2- Achievement rate of the forecasted market share 3- Achievement rate of the forecasted customers' number	
Sales forecasting accuracy			1- Mean absolute deviation 2- Mean absolute percentage error 3- Rate of missed sales	
Promotional action			1- Value of turnover discounts 2- Value of trade discounts 3- Value of derogations	

4.2. Purchasing performance

The purchasing department plays a central role in the supply chain of an independent distributor of automotive spare parts. It must provide the right spare part at the right time and

at the lowest possible cost. Thus, measuring purchasing performance allows for decision-making. Further, it allows for the identification of priorities and the allocation of resources, appropriately improving the purchasing management.

Several studies have been conducted on purchasing performance, and the results have shown that there is no single method that covers every purchasing department. There are certain indicators found to be common in performance assessment. However, the weight given to the proposed indicators is by no means uniform and varies between industries and companies.

To measure the purchasing performance of an independent distributor of automotive spare parts, we have selected four essential performance categories: supplier service quality, customs and transit service quality, internal service quality and administrative productivity.

For each category, we secured a set of subcategories, which relate to different points such as purchasing process, internal customer, suppliers and purchasers. For the evaluation of the supplier service quality, we have three subcategories: responsiveness, accessibility and reliability. Whereas for the evaluation of customs and transit service quality were two subcategories: responsiveness and reliability.

To evaluate the internal service quality, we defined three subcategories: responsiveness, reliability and internal customer satisfaction. Whereas for the evaluation of administrative productivity, we have four subcategories: sourcing, purchasing activity, order follow-up and purchasing activity growth.

Table 2 presents the categories, subcategories and key performance indicators for the measurement of purchasing performance.

Tab. 2

Dimensions and key performance indicators for purchasing performance measurement

Aspect	Category	Subcategory	Key performance indicators
Purchasing performance	Supplier service quality	Responsiveness	1- Supplier’s average response time 2- Average time of order confirmation 3- Average order processing time 4- Average claim processing time 5- Average time of information transmission to purchaser
		Accessibility	1- Average waiting time to get a response 2- Average number of contacts needed to resolve a claim 3- Rate of local suppliers 4- Rate of suppliers located abroad
		Reliability	1- Billing error rate 2- Response delay rate 3- Order processing delay rate 4- Rate of claims processed 5- Rate of claims processed within the reference time 6- Rate of delivery delay 7- Disputes rate per supplier

	Customs and transit service quality		<ul style="list-style-type: none"> 8- Reliability of information transmitted to purchaser 9- Rate of non-compliant deliveries 10- Supplier's service rate 	
		Responsiveness	<ul style="list-style-type: none"> 1- Average customs clearance time 2- Average goods waiting time in the forwarding agent's warehouse 	
		Reliability	<ul style="list-style-type: none"> 1- Delay rate of transit service 2- Delay rate of customs clearance 3- Reliability of information transmitted to company 	
	Internal service quality	Responsiveness	<ul style="list-style-type: none"> 1- Average response time to internal customer's needs 2- Average time for placing an order 3- Average time of a claim transmission to supplier 4- Average time of information transmission to internal customer 	
		Reliability	<ul style="list-style-type: none"> 1- Delay rate of placing purchase orders 2- Number of claims reminders per supplier 3- Reliability of information transmitted to internal customer 	
		Internal customer satisfaction	<ul style="list-style-type: none"> 1- Internal Customer Satisfaction Score (ICSAT) 2- Internal Customer Effort Score (ICES) 	
	Purchasing performance	Administrative productivity	Sourcing	<ul style="list-style-type: none"> 1- Degree of satisfaction of the need for suppliers 2- Rate of appropriate suppliers for the company 3- Effectiveness of appropriate suppliers' selection 4- Degree of the sourcing mastery
			Purchasing activity	<ul style="list-style-type: none"> 1- Rate of orders issued to suppliers 2- Value of purchases made 3- Rate of imports 4- Rate of active suppliers 5- Rate of potential suppliers 6- Purchase rate of new references 7- Value of turnover discounts 8- Value of trade discounts on products or quantities purchased
			Order follow-up	<ul style="list-style-type: none"> 1- Acknowledgments of receipt rate compliant to purchase orders 2- Number of orders reminders per supplier

			3- Rate of closed matters in favor of the company
		Purchasing activity growth	1- Growth rate of the number of orders issued to suppliers 2- Growth rate of the value of purchases made 3- Growth rate of imports 4- Growth rate of suppliers' number 5- Growth rate of active suppliers' number 6- Growth rate of potential suppliers' number 7- Growth rate of new references purchasing 8- Growth rate of discounts on turnover value 9- Growth rate of trade discounts value

4.3. Stock and procurement performance

The particular characteristics of automotive spare parts influence the stock and procurement management. They can generate high inventory levels or stock-outs, which are usually disastrous to the company. Therefore, the evaluation of the stock and procurement performance is essential to reveal the functioning of the company, the internal communication and the external relationships with customers and suppliers. In this context, we arranged three categories to evaluate the stock and procurement performance of an independent distributor of automotive spare parts: service quality, activity level, control and tracking.

To evaluate the quality of service, we selected two subcategories: the availability to get information about the presence of items in the physical stock and the reliability of procurement plans to assess, on the one hand, the accuracy of procurement methods and, on the other hand, the degree of achievement of the established procurement plans.

We specified three subcategories to evaluate the activity level: inventory turnover, stock coverage and stock level. These subcategories are known to reflect the activity of the company and the effectiveness of inventory management.

We determined two subcategories for the evaluation of control and tracking category: inventory transactions accuracy to assess the records reliability of inventory movements and the stocktaking subcategory, which forms an information source about the differences between theoretical and physical stock and allows the assessment of stocktaking operation effectiveness. Table 3 details the categories, subcategories and key performance indicators for the measurement of stock and procurement performance.

Tab. 3

Dimensions and key performance indicators for
stock and procurement performance measurement

Aspect	Category	Subcategory	Key performance indicators
Stock and procurement performance	Service quality	Availability	1- Stock-out rate 2- Stock-out frequency 3- Average time to obtain the items ordered 4- Average duration of stock-out
		Procurement plans reliability	1- Degree of achievement of the established procurement plans 2- Reliability of the procurement methods used
	Activity level	Inventory turnover	1- Inventory turnover rate
		Stock coverage	1- Stock coverage rate
		Stock level	1- Average stock level 2- Safety stock level 3- Minimum stock level 4- Maximum stock level 5- Alert stock level
	Control and tracking	Inventory transactions accuracy	1- Error rate of inventory transactions recording 2- Error rate of computer modification of stock
		Stocktaking	1- Average time of stocktaking achievement 2- Rate of controlled references 3- Inventory discrepancy rate

4.4. Warehouse performance

The strategic role of warehouses is well recognized in a supply chain [17, 18]. According to De Koster and Warffemius [19], the complexity of warehouse activities depends mainly on the number and variety of items to be handled, the daily workload to be performed, and the number, nature and variety of the processes necessary to meet customers' needs and demands. For an automotive spare parts distributor, warehousing operations are complicated given the particular characteristics of automotive spare parts, service requirements and customers' expectations. In an automotive spare parts distribution warehouse, there are the four known operations as defined by van den Berg and Zijm [20], namely reception, storage, preparation of customers' orders and shipping.

Over the past two decades, most successful companies have integrated the analysis and measurement of the warehousing activities performance among their best practices for better use of space, work methods and technologies deployed. This is due to companies' interest in

controlling costs and to the existence of a variety of very accessible technologies that can support the operations of a warehouse or distribution center. It is therefore of utmost importance for a company to analyze and measure the performance of its warehousing activities.

Measuring warehouse performance has become an important factor in making decisions [21]. However, there is no consensus on a group of indicators to assess warehouse performance [22]. Therefore, it is difficult for managers to choose the most suitable indicators to monitor a warehouse.

For an automotive spare parts distributor, the high performance of a warehouse reflects good management and organization of warehousing operations, the adoption of good practices and effective software, as well as the existence of a productive work environment that is propitious to innovation. Measuring the performance of a warehouse is therefore essential to allow the automotive spare parts distributor to control the various warehousing operations and optimize the warehouse management.

To measure warehouse performance, we determined three performance categories: capacity, service quality and operational productivity. We established four subcategories to evaluate the capacity: logistics infrastructure, warehouse equipment, infrastructure utilization and equipment utilization. In addition, the evaluation involves an enumeration of the existing logistics infrastructures and warehouse equipment, as well as the degree of exploitation.

The service quality provided by a warehouse is part of the corporate image seen, as such warehousing operations require accuracy and promptness of execution. In this context, we fixed four subcategories to evaluate the quality of service: responsiveness, service reliability, equipment reliability and items security.

Operational productivity is fully a part of the categories considered for performance measurement, as the warehouse is a place where many day-to-day warehousing operations take place. We have fixed two subcategories to evaluate operational productivity: operational activity level and operational growth.

Table 4 comprises the categories, subcategories and key performance indicators for the measurement of warehouse performance.

Tab. 4

Dimensions and key performance indicators for warehouse performance measurement

Aspect	Category	Subcategory	Key performance indicators
Warehouse performance	Capacity	Logistics infrastructure	1- Number of central warehouses 2- Number of regional stores 3- Number of logistics platforms
		Warehouse equipment	1- Number of material handling equipment 2- Number of equipment for goods preparation and packing
		Infrastructure utilization	1- Fill rate of central warehouses 2- Fill rate of regional stores

			<ul style="list-style-type: none"> 3- Utilization rate of shipment areas of warehouses and stores 4- Utilization rate of reception areas of warehouses and stores 5- Utilization rate of logistics platforms areas
		Equipment utilization	<ul style="list-style-type: none"> 1- Utilization rate of material handling equipment 2- Utilization rate of equipment for goods preparation and packing
	Service quality	Responsiveness	<ul style="list-style-type: none"> 1- Average processing time of goods received 2- Average storage time of goods received 3- Average time of goods preparation 4- Average time of goods loading during a shipment 5- Average time of a cross-docking operation 6- Average time of information sharing between employees 7- Average response time to spare parts transfer requests 8- Average waiting time during unloading 9- Average waiting time during loading
		Service reliability	<ul style="list-style-type: none"> 1- Processing delay rate of goods received 2- Error rate of quantitative control of goods received 3- Storage delay rate of goods received 4- Delay rate of goods preparation 5- Error rate of goods preparation 6- Delay rate of goods loading

			<ul style="list-style-type: none"> 7- Delay rate of cross-docking operations achievement 8- Error rate during cross-docking operations 9- Reliability of information shared between employees 10- Service rate
Warehouse performance	Service quality	Equipment reliability	<ul style="list-style-type: none"> 1- Failure rate 2- Mean time between failures 3- Mean time of repair 4- Availability rate of equipment
		Items security	<ul style="list-style-type: none"> 1- Rate of unknown shrinkage 2- Rate of known shrinkage 3- Reliability of surveillance systems
	Operational productivity	Operational activity level	<ul style="list-style-type: none"> 1- Number of customers' orders prepared 2- Number of replenishments prepared 3- Number of transfer requests prepared 4- Number of items picked 5- Number of items checked during preparations 6- Number of items checked during receptions 7- Number of items shipped 8- Number of receptions performed 9- Number of shipments performed 10- Number of cross-docking operations performed

		Operational growth	<ol style="list-style-type: none"> 1- Growth rate of the number of customers orders prepared 2- Growth rate of the number of replenishments prepared 3- Growth rate of the number of transfer requests prepared 4- Growth rate of the number of items picked 5- Growth rate of the number of items checked during preparations 6- Growth rate of the number of items checked during receptions 7- Growth rate of the number of items shipped 8- Growth rate of the number of receptions performed 9- Growth rate of the number of shipments performed 10- Growth rate of the number of cross-docking operations performed
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4.5. Delivery performance

Delivery performance reflects the ability of the automotive spare parts supply chain of an independent distributor to deliver the right spare part to the right place and at the right time. Delivery is a step that completes warehousing operations and proves the quality of service provided by the independent distributor of automotive spare parts. In this regard, achieving a high-performance delivery is one of the main goals of an effective automotive spare parts supply chain to stand out from the competition in the automotive aftermarket. In this context, we established three categories to assess delivery performance: capacity, quality of service and operational productivity. We set two subcategories to assess the capacity: material resources and utilization. The evaluation involves an enumeration of the existing means of transport, their capacities as well as the degree of exploitation.

The quality of delivery service is also of paramount importance. It refers to the customers' comparison between their expectations and perceptions of what is actually delivered by the supplier. In general, the customer always expects prompt delivery and receipt of complete, compliant and properly documented merchandise. In this context, we have defined four essential subcategories to evaluate the quality of service: responsiveness, reliability, items security and organization.

We chose to assess operational productivity as the delivery is mainly based on operational work. To do this, we identified two subcategories: operational activity level and operational growth.

Table 5 shows the categories, subcategories and key performance indicators for the measurement of delivery performance.

Tab. 5

Dimensions and key performance indicators for delivery performance measurement

Aspect	Category	Subcategory	Key performance indicators
Delivery performance	Capacity	Material resources	1- Number of vehicles 2- Load carrying capacity of vehicles
		Utilization	1- Average time of vehicles utilization 2- Fill rate of vehicles
	Service quality	Responsiveness	1- Average delivery time to customer 2- Average delivery time to regional store 3- Average time of spare parts transfer
		Reliability	1- Rate of complete, compliant, correct and timely deliveries to customers 2- Rate of complete, compliant, correct and timely deliveries to regional stores 3- Rate of delivery delay 4- Rate of non-compliant deliveries 5- Rate of vehicle availability
		Items security	1- Rate of deterioration 2- Loss rate 3- Reliability of vehicles' surveillance systems
		Organization	1- Rate of express deliveries 2- Rate of planned deliveries 3- Cost of delivery rounds 4- Cost of ton-kilometer
	Operational productivity	Operational activity level	1- Number of deliveries made 2- Total mileage 3- Average drive time per driver
		Operational growth	1- Growth rate of the number of deliveries made 2- Growth rate of total mileage 3- Growth rate of average drive time

4.6. Reverse logistics performance

In the setting of automotive spare parts distribution, reverse logistics refers to the movement of automotive spare parts from a customer to the distributor. In other words, goods and information flow in the opposite direction of normal logistics activities.

Good reverse logistics design allows for reducing costs, increasing revenues and gaining a competitive advantage. In this regard, measuring the performance of reverse logistics is a task of paramount importance for an independent distributor of automotive spare parts to determine the ability of the after-sales service to solve complaints and process returns rigorously and effectively. In this context, we defined three categories for evaluating the performance of reverse logistics: service quality, customer relationship management and productivity.

The quality of service reflects the ability of the after-sales service to provide prompt and accurate service when it comes to processing claims and returns. In this context, we have defined four essential subcategories to evaluate the quality of service: responsiveness, accessibility, service reliability and equipment reliability.

For the after-sales service, the customer relationship performance is closely related to the quality of service. We propose to evaluate it through customer satisfaction and customer loyalty. The result of the evaluation reflects the effectiveness of claims and returns processing and the ability to maintain a sufficient level of attention toward customers in case of claims.

The activity of the after-sales service encompasses administrative and operational activities. Hence, we drew four subcategories to measure productivity: operational activity level, administrative activity level, operational growth and administrative growth. The subcategories are defined to evaluate the amount of work done, as well as the evolution of the administrative and operational activities of the after-sales service. The evolution should not be interpreted in a positive sense. On the contrary, it indicates an increase in complaints and returns, which can dramatically decrease business profit. It is therefore important to decrease returns by encouraging sales and offering products that satisfy customers and allow obtaining sustainable competitive advantage.

Table 6 contains the categories, subcategories and key performance indicators for the measurement of reverse logistics performance.

Tab. 6

Dimensions and key performance indicators for reverse logistics performance measurement

Aspect	Category	Subcategory	Key performance indicators
Reverse logistics performance	Service quality	Responsiveness	1- Average response time to customer 2- Average claim processing time 3- Average return processing time 4- Average time of information transmission to the involved departments 5- Average time of information transmission to customer
		Accessibility	1- Rate of calls picked up 2- Rate of lost calls

			<ul style="list-style-type: none"> 3- Average customer waiting time to get a response 4- Average number of contacts needed to resolve a claim
		Service reliability	<ul style="list-style-type: none"> 1- Response delay rate 2- Error rate of claims processing 3- Rate of claims processed and closed 4- Rate of claims processed and closed within the reference time 5- Returns processing delay rate 6- Availability rate of communication channels 7- Disputes rate per customer 8- Reliability of information transmitted to customers 9- Reliability of information shared between employees
		Equipment reliability	<ul style="list-style-type: none"> 1- Availability rate of intervention tools 2- Availability rate of inspection instruments
	Customer relationship management	Customer satisfaction	<ul style="list-style-type: none"> 1- Customer Satisfaction Score 2- Customer Effort Score
		Customer loyalty	<ul style="list-style-type: none"> 1- Customer attrition rate because of after-sales service
	Productivity	Operational activity level	<ul style="list-style-type: none"> 1- Rate of interventions performed compared to the number of sales 2- Rate of returns processed
		Administrative activity level	<ul style="list-style-type: none"> 1- Rate of claims received compared to sales 2- Rate of files created and followed compared to received claims 3- Rate of reports written compared to processed claims 4- Rate of information Emails sent compared to received claims

Tab. 6

Dimensions and key performance indicators for
reverse logistics performance measurement (continued)

Aspect	Category	Subcategory	Key performance indicators
Reverse logistics performance	Productivity	Operational growth	1- Growth rate of the number of interventions performed 2- Growth rate of the number of returns processed
		Administrative growth	1- Growth rate of the number of claims received 2- Growth rate of the number of files created and followed 3- Growth rate of the number of reports written 4- Growth rate of the number of information Emails sent

4.7. Financial performance

The measurement of financial performance is of paramount importance for an independent distributor of automotive spare parts to assess the achievement of value creation objectives. In this context, we selected three essential categories for the evaluation of financial performance: investment, financial wealth and financial health.

The investment category reveals principally the financial contribution of the investment projects and their capacity to strengthen the financial structure of the company. In this context, we defined two subcategories for the investment category evaluation: investment viability and financing sources.

The financial wealth category reveals the success of the company. We offered to evaluate it through the following three subcategories: revenue generation, profitability and activity growth.

The financial health category enables us to know if the company's financial structure is balanced. It also determines the ability of the company to cope during a recession and seize development opportunities. In this context, we determined four subcategories to evaluate financial health: profit growth, solvency, financial indebtedness and liquidity.

Table 7 highlights the categories, subcategories and key performance indicators for the measurement of financial performance.

Tab. 7

Dimensions and key performance indicators for financial performance measurement

Aspect	Category	Subcategory	Key performance indicators
Financial performance	Investment	Investment viability	1- Net Present Value (NPV) 2- Internal rate of return (IRR) 3- Return on investment
		Financing sources	1- Self-financing rate 2- Growth rate of capital 3- Value of assets disposal

			4- Proportions related to external financing
	Financial wealth	Revenue generation	1- Return on equity 2- Return on assets
		Profitability	1- Rate of profitability 2- Gross profit margin 3- Net profit margin
		Activity growth	1- Growth rate of annual turnover 2- Growth rate of value added
	Financial health	Profit growth	1- Growth rate of profit
		Solvency	1- Financial autonomy ratio 2- Repayment capacity
		Financial indebtedness	1- Net financial debt
		Liquidity	1- Current ratio 2- Quick ratio 3- Operating cash flow ratio

4.8. Human capital performance

Human capital is a crucial element to create value in a company, improve the overall performance of the supply chain and profit to gain a significant competitive advantage. It is an intangible aspect that needs to be rigorously evaluated to identify any existing weaknesses and convert them to strengths.

Armstrong [23] pointed out that developing the performance of individuals and teams is a part of the systematic process of improving organizational performance to achieve better results. Thus, measuring the performance of human capital is an essential step toward developing it. It involves the elaboration of an appropriate set of indicators that should be driven by the overall success of the business and the achievement of its most important goals.

To measure the human capital performance, we adopted three relevant performance categories: professional skills development, employee well-being and human capital security. We fixed five subcategories to evaluate the professional skills development category: professional training, career mobility, promotion, recruitment and professional skills assessment.

Furthermore, to evaluate the employee well-being category, we established three subcategories: employee satisfaction, motivation and commitment. Whereas, for the evaluation of the human capital security category, we determined three subcategories: work safety, job security and social protection.

Table 8 encompasses the categories, subcategories and key performance indicators for the measurement of human capital performance.

Tab. 8

Dimensions and key performance indicators for human capital performance measurement

Aspect	Category	Subcategory	Key performance indicators
Human capital performance	Professional skills development	Professional training	<ol style="list-style-type: none"> 1- Average number of hours per training 2- Number of training 3- Rate of employees trained per year 4- Rate of achievement of the annual training plan 5- Dropout rate in training 6- Absenteeism rate in training
		Career mobility	<ol style="list-style-type: none"> 1- Rate of internal mobility 2- Rate of external mobility
		Promotion	<ol style="list-style-type: none"> 1- Promotion rate
		Recruitment	<ol style="list-style-type: none"> 1- Average candidacy processing time 2- Response rate to candidacies 3- Average number of candidacies received for a job offer 4- Hiring rate 5- Average time to fill a position 6- Voluntary turnover rate of recruits 7- Involuntary turnover rate of recruits 8- Satisfaction rate of recruits toward the recruitment process 9- Satisfaction rate of managers toward recruits
		Professional skills assessment	<ol style="list-style-type: none"> 1- Rate of employees with at least five years of experience 2- Rate of employees evaluated annually

			<ul style="list-style-type: none"> 3- Satisfaction rate of employees toward evaluation 4- Rate of managers trained for evaluation interview 5- Rate of high-potential employees 6- Rate of satisfactory employees 7- Rate of employees having insufficient performance
	Employee well-being	Employee satisfaction	<ul style="list-style-type: none"> 1- Satisfaction rate of employees toward attributions 2- Satisfaction rate of employees toward salaries 3- Overall satisfaction rate 4- Rate of employees' grievances
Human capital performance	Employee well-being	Motivation	<ul style="list-style-type: none"> 1- Value of bonuses paid 2- Rate of employees benefiting from bonuses 3- Rate of bonuses granted to successful employees 4- Rate of employees achieving the objectives 5- Rate of employees exceeding the objectives 6- Evolution rate of bonuses 7- Evolution rate of salaries
		Commitment	<ul style="list-style-type: none"> 1- Rate of unjustified absenteeism 2- Average duration of unjustified absences 3- Frequency of unjustified absences 4- Rate of voluntary involvement in improvement projects 5- Rate of voluntary recommendation of the company

	Human capital security	Work safety	1- Number of work accidents 2- Frequency of work accidents 3- Severity rate of work accidents 4- Number of fatal accidents 5- Number of accidents generating work stoppages 6- Total number of days lost due to work accidents 7- Rate of musculoskeletal disorders due to mishandling
		Job security	1- Rate of employees with temporary employment 2- Rate of employees with indefinite duration employment contract
		Social protection	1- Rate of employees covered by social protection insurance

4.9. Information system performance

The performance of the information system contributes significantly to the overall performance of the supply chain and the company. In the context of the distribution of automotive spare parts, a high performance information system allows the distributor to better exercise his profession. It promotes the marketing of products in a fast and effective manner, the improvement of the customer relationship, the ability to deal with complex situations, the optimization of processes to reduce costs, time saving due to replacement of tasks through automated processing, the improvement of productivity, and the effective communication through the exchange of computerized data between employees and with customers.

Thus, the evaluation of information system performance constitutes the cornerstone in ensuring business continuity. In this context, we defined two categories to evaluate the information system performance: IT infrastructure and information security.

The IT infrastructure is evaluated by two subcategories: IT resources and utilization. The evaluation involves an enumeration of the existing IT resources and the degree of exploitation.

The information security category primarily indicates whether the information security guarantees the legal and secure use of information and IT resources. To evaluate it, we selected three subcategories: availability, integrity and confidentiality.

Table 9 presents the categories, subcategories and key performance indicators for the measurement of information system performance.

Tab. 9

Dimensions and key performance indicators for information system performance measurement

Aspect	Category	Subcategory	Key performance indicators
Information system performance	IT infrastructure	IT resources	1- Number of IT equipment 2- Coverage rate of software used
		Utilization	1- Utilization rate of IT equipment
	Information security	Availability	1- Availability rate of IT equipment 2- Availability rate of information
		Integrity	1- Number of unauthorized information modifications
		Confidentiality	1- Number of data leaks following computer attack

4.10. Research and development performance

The measurement of research and development performance is less implemented in companies for the following reasons: the result of the efforts made is not directly observable, high uncertainty regarding the success of an investment project and the delay in realizing profits. This does not preclude the need to measure the performance to have continuous feedback and improve the research and development function. In this context, we postulated two categories to evaluate the performance of research and development: monitoring activity and innovation.

The monitoring activity reveals the ability of the research and development function to provide information related to the evolution of automotive aftermarket, automotive industry and technology. To evaluate the monitoring activity, we chose three subcategories: marketing intelligence, competitive intelligence and technology watch.

The innovation category reveals the effort of the research and development function to lead innovation projects. We propound to evaluate it through four subcategories: digital transformation, commercial innovation, logistics innovation and organizational innovation.

Table 10 highlights the categories, subcategories and key performance indicators for the measurement of research and development performance.

Tab. 10

Dimensions and key performance indicators for research and development performance measurement

Aspect	Category	Subcategory	Key performance indicators
Research and development performance	Monitoring activity	Marketing intelligence	1- Average time of information collection and processing 2- Relevance of disseminated information

			<ul style="list-style-type: none"> 3- Degree of influence of marketing intelligence on decision-making 4- Frequency of marketing intelligence
		Competitive intelligence	<ul style="list-style-type: none"> 1- Average time of information collection and processing 2- Relevance of disseminated information 3- Degree of influence of competitive intelligence on decision-making 4- Frequency of information updating about competitors
		Technology watch	<ul style="list-style-type: none"> 1- Average time of information collection and processing 2- Relevance of disseminated information 3- Degree of influence of technology watch on decision-making 4- Frequency of technology watch
	Innovation	Digital transformation	<ul style="list-style-type: none"> 1- Degree of digital maturity 2- Contribution of digital transformation to strategic objectives 3- Impact of digital transformation on internal processes 4- Degree of compatibility of deployed projects with needs
		Commercial innovation	<ul style="list-style-type: none"> 1- Rate of new introduced references compared to the aftermarket 2- Frequency of introduction of new references 3- Rate of adoption of new sale concepts 4- Rate of adoption of new distribution channels 5- Number of applied projects of distribution network development
		Logistics innovation	<ul style="list-style-type: none"> 1- Rate of adoption of new technologies compared to the need

			2- Rate of automated processes compared to the need 3- Rate of large investment projects compared to the need
		Organizational innovation	1- Rate of adoption of organizational approaches 2- Frequency of updating documents and procedures

5. CONCLUSION

Manufacturers and distributors of automotive spare parts usually face several challenges due to customers' expectations changes, the technological evolution of the automotive industry, emerging spare parts markets and competitive pressure. Thus, companies have to react by evaluating and improving the performance of the supply chain to maintain strong positions in the future. Consequently, it is essential to rely on a reliable performance measurement system to effectively measure the overall performance of the supply chain.

The literature on spare parts management focuses mostly on inventory management and demand forecasting methods. However, comparatively, little attention has been given to the spare parts supply chain performance measurement. Thus, we have attempted to fill the gap observed in the literature, particularly for the automotive aftermarket, by proposing a multidimensional and balanced performance measurement system to measure the overall performance of the automotive spare parts supply chain and assess the impact of practices within companies operating in the independent distribution of automotive spare parts.

This framework will allow managers to identify weak points where performance can be improved. It will also form a basis for future academic and professional research following the development of supply chain management.

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