



Review article

## The importance of subcontracting and its relationship with Lean philosophy in automotive industry

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### ABSTRACT

The automotive industry represents one of the largest economic sectors in the world and most companies in this industry involve subcontracting in their strategy. However, subcontracting is one of the possible processes that can lead to inefficiencies for companies. Since lean arises as a response to the most varied problems of companies, the main goal of this work is to understand the importance of subcontracting in the automotive sector and to understand how lean and subcontracting are related. For this, an empirical study of papers and books related to these topics was performed, concluding that subcontracting is frequently used in the automotive sector, to obtain strategic advantages, and that it supports the foundations of the lean concept, as well as the lean can help manage subcontracting. The trade-off of the transfer of activities enables organizations to be flexible, lean and agile; they can then focus on their core activities, which generate more value, while the option to subcontract generates a significant reduction in costs by transferring non-core activities. In short, these two concepts are related to each other in the context of the automotive industry.

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## 1. Introduction

Businesses are today confronted by several challenges, such as heightened competition, more demanding customers, and economic instability. According to (Drohomeretski et al.) in [1], companies are thus required to produce at a lower cost, while also ensuring that the manufacturing process is faster and more reliable. They are additionally expected to be able to adapt to external changes and to improve

their processes continuously [1]. Furthermore, it should be noted that companies still generate waste in their production process; this representing costs and losses in productivity, which ultimately jeopardize sustainability, and must therefore be eliminated [2].

Lean methodology has emerged as a response to these problems; it provides simple, low-cost solutions that contribute to the enhancement of business performance, promoting efficiency, improving customer response time, reducing costs, ensuring better qual-

ity, increasing the production rate and, consequently, generating higher business profits [2–4]. In addition, the implementation of lean techniques will lead to a reduction in one or more types of waste in the production process, thus providing companies with a more competitive edge [5].

One of the processes which can potentially lead to inefficiencies for companies is that of subcontracting [6]. Admittedly, there are associated risks in all the operations and tasks implemented by a business. However, when it comes to subcontracted activities, this risk may increase due to the greater complexity of the task at hand, as well as the higher number of interested parties involved, namely the stakeholders [7]. Bearing in mind that no subcontracting activity is risk-free and may constitute a source of waste, Aigbavboa and Mbohwa [8] recommend carrying out a cost-benefit analysis before making the strategic decision to execute tasks through subcontracting.

The automotive industry represents one of the world's largest economic sectors in terms of revenues [9]. In the specific case of Portugal, in 2016, this sector represented 5.9% of GDP [10]. Many of the companies in this industry include subcontracting in their strategy, particularly in processes which involve design, manufacture and assembly [11]. Examples of this are European companies such as BMW, Fiat, Mercedes Benz, Volkswagen and Porsche, as well as the American manufacturers of Chrysler and the Ford Motor Company [12]. It should be noted that, despite maintaining the internal production of key components, Ford also outsources other components and tasks, with about 70% of vehicles' components being provided by the subcontracting [9].

The aim of this paper is to understand the importance of subcontracting in the automotive sector, as well as to gain a better insight on how lean methodology is related to subcontracting. The main novelty of this paper is to correlate Lean and Subcontracting aspects regarding the Automotive Industry (AI). In fact, other previous works have devoted some attention to this correlation, but not focused just on that sector (AI). The structure of this paper is divided into seven sections. The first consists of the introduction, the second describes the methodology used in this work, the third section deals with the subject of subcontracting; the fourth explains the importance of subcontracting in the automotive sector; the fifth presents several case studies in subcontracting business in the automotive sector; the sixth section describes the relation between subcontracting and lean; and, finally, the seventh presents the conclusions drawn from the paper.

## 2. Methodology

The methodology used in this study went through a bibliographic research on subcontracting and lean topics, as well as the relationship between both concepts, in the context of the automotive industry. The sources of information used were the databases of B-on, Science Direct and Google Books. The inclusion criteria were the analysis of books and scientific papers, in Portuguese or English, that address the variables under study. In turn, the exclusion criteria were papers or books with dates prior to 1990 and unrelated to the topic. Based on this methodology, 50 papers and books were analyzed in this study.

## 3. Subcontracting

Subcontracting can be defined as the acquisition of products or services from external companies [12]. However, the meaning of subcontracting goes further. According to Grossman and Helpman [13], subcontracting means finding partners with which a company can establish a bilateral relationship, and that those partners make investments which benefit this association. To this end, they can produce goods or services which meet the specific needs of the company in question. Companies subcontract activities that range from the design of a product to its assembly, and include activities from research and development to marketing, distribution and after-sales service [13, 14]. Subcontracting constitutes a strategic decision for companies [8]. Indeed, it is particularly important in the context of the management of operations and supply chains [11]. Subcontracting is used within the framework of “make or buy” decisions [15], as it allows companies to choose to convert fixed-cost production into a basis of variable costs [11]. From the point of view of strategic flexibility, subcontracting is a way of adjusting the company's supply in order to respond to the evolution of global markets, thus eliminating the uncertainties inherent to production [15].

Several authors have claimed that the factors which motivate companies to adopt subcontracting in their supply chain are: gaining a competitive advantage, enhancing operational efficiency and reducing costs [8, 12, 16]. Through subcontracting, companies are able to offer the customer more value and the creation of differentiation [15, 17, 18], as well as greater flexibility [19]. Besides these, other reasons which explain why companies choose to subcontract are related to a lack of expertise, as well as the at-

tempt to reduce risks and operating costs [20].

Beulen et al. (1994), cited by Fill and Visser [21], have suggested that there are five reasons that motivate subcontracting: quality, cost, finance, fundamental functions and cooperation. In the case of quality, one can seek to enhance it. In relation to costs, the goal is to gain greater control of this area and follow a strategy of cost leadership. Finance is primarily related to a limited budget for investment. Regarding the issue of fundamental functions, these authors state that, if companies are to focus on these activities, they must subcontract what are support activities. Finally, and in relation to cooperation, the authors suggest subcontracting activities performed by companies between which cooperation already exists.

Traditionally, companies have carried out diversified and often non-fundamental activities. However, market developments have imposed the reassessment of key activities. Consequently, an increase in operations related to fundamental activities has been observed; in some cases, there has also been a reduction in the value chain within the organization [16]. With a view to more competitive business, companies can focus on their core competencies by resorting to subcontracting, thus becoming more efficient in their key activities [12]. In this way, according to Sharpe [14], the non-core competencies performed by companies are transferred - whether partially or totally - to external suppliers, whose fundamental competencies consist of the specific activities for which they have been subcontracted.

Despite the benefits of subcontracting, there are potential risks associated with this decision. Of these, one should highlight a loss of control, as well as the high risks inherent to markets, quality and production, which are all subjected to different laws and methods. Moreover, subcontracting usually involves supplementary transport, which invariably generates a negative impact, including the added risks of having to deliver within the stipulated deadlines [19]. Another competitive disadvantage for businesses is the risk of a limited learning capacity [22]. Harland [22] points to the lack of formal decision-making processes as being one of the main reasons for unsuccessful subcontracting, which include performing cost-benefit analyses for the medium- and long term. He also highlights the increased complexity of the supply network as being one of the factors that compounds this problem. Subcontracting has often been used in the field of manufacture; however, this trend has clearly spread to the service area as well [17]. Whether in the manufacturing sector or in the service industry, subcontracting is increasingly implemented in companies around the

world [20], particularly in small and medium-sized enterprises [6].

For each activity or component included in products, companies decide if these should be produced either internally or externally, by means of subcontracting. When an activity is subcontracted, the company may explore a specific cost advantage, for example, through the subcontractor's negotiating power, the extent of competition and the wage bracket in the subcontractor's country [23]. Companies often choose to proceed simultaneously with both subcontracting and internal production. According to Du et al. [24], companies are able to achieve a better negotiating position by following this strategy. Indeed, economists and managers argue that extreme modes of production - namely, those that focus either on internal production or on subcontracting - imply a loss in bargaining power for the company. Multiple supply is a mechanism which seeks to address this problem, since subcontracting promotes the competitiveness of internal production which, in turn, constitutes a reference for the assessment of suppliers' competitiveness [25].

#### **4. The importance of subcontracting in the automotive sector**

Subcontracting will continue to grow, especially in industries where the complexity of products and the supply base allow for the emergence of clusters and flexible networks [26]. In fact, in the last decade, a large number of companies operating in the industry have adopted subcontracting processes, and this is particularly true in the automotive manufacturing sector [27].

Increased competition pressure, as well as the demand for efficiency and higher profits have led car manufacturers and suppliers to re-evaluate their activities and supply chain relations [28]. In order to simplify the supply chain and improve efficiency, car manufacturers have streamlined the supply base, and have defined new supply requirements (including global supply, complete supply of services and design for manufacturing and assembly). They have also started to subcontract activities which are considered to be fundamental [29]. As product lifecycles are short in the automotive sector, investment in new facilities constitutes a risk. Therefore, the capacity provided by companies should be enough to meet supply; at the same time, this cannot be so great that they risk underusing their facilities. Within this framework, subcontracting can constitute a solution to eliminate this uncertainty in production [15].

Most companies in the automotive sector outsource procedures, such as car design, production and assembly, to independent suppliers or full-service vehicle companies [11, 28]. With regard to subcontracting activities - for example vehicle design, which is considered a core activity [15] - there is an alignment with the theory that subcontracting key activities can produce benefits in specific circumstances [30]. Baden-Fuller et al. [30] state that subcontracting an organization's core activities makes sense when it is threatened by one of the following circumstances: the company is lagging behind its competitors; there are changes in the value chains; there are technological changes; and, finally, the issue of emerging markets. European car companies such as BMW, Fiat, Mercedes, Volkswagen, Porsche, and American companies such as Chrysler and Ford, are examples of some companies which subcontract design, production and assembly [11]. Japanese car companies are also examples of the growing trend of successful subcontracting based on a culture of cooperation [16, 31]. It is estimated that only about 40% of the production of value in cars manufactured in North America can be attributed to the USA. The growth of international subcontracting may thus constitute an opportunity for companies in developing countries [32].

In the case of Ford, it maintains its core tasks in internal production, but allows suppliers to perform them too. Currently, about 70% of its vehicles derive from subcontracted parts and services. Mercedes Benz also resorts to subcontracting for its production, more specifically, the R-Class was executed by the producer Humvee AM General, which hired external employees - namely, subcontracted labor - to assist in production [9]. Finally, in the case of BMW, for which the BMW X3 model was developed and manufactured by the company Magna Steyr, this collaboration enabled BMW to enter the SUV niche market. The successful implementation of subcontracting by BMW is a tangible example of outsourcing processes such as product development, engineering and design, which define product architecture and, as such, are generally considered to be core activities [11].

## 5. Case studies

Given its characteristics, subcontracting often occurs in companies' strategic decision-making processes. There are already several studies and practical examples, in which the use of subcontracting was used in the automotive sector.

A study based on comparative cases and information from three European full-service vehicle companies, as well as three European manufacturers of original equipment, concluded that the subcontracting of product development and manufacturing shows that complex products, such as cars, can be developed and produced by external suppliers [11]. In another study conducted at two Skoda facilities in the Czech Republic [29], as well as at a Volkswagen lorry and bus factory in Brazil, relations between manufacturers and suppliers were explored. As a result, two conceptual models were developed. The supplier of the modules has started to set these up on the automotive producer's assembly line, thus enabling manufacturers and suppliers to work side by side [29]. One of the studies investigated how the subcontracting strategy affected the performance of Italian car companies. The analysis pointed to growth, productivity, financial dependence and profitability, and concluded that the relation between subcontracting and performance is not linear. Companies of low integration level tend to experience higher growth, whereas those with a high integration level perform better in aspects such as profitability and debt ratio [27]. Another study was developed at four automotive business organizations in India, where a decision-making framework was implemented to assist managers when making off-shore subcontracting decisions. The conclusions of the study revealed that, among the main facilitators of subcontracting, management and strategy carry the greatest weight, followed by technological and organizational facilitators [33]. In a study aimed at exploring the basis of the success of subcontracting, it was using the interpretative paradigm that the Boeing case was also analyzed in the context of subcontracting, along with that of a large automotive group operating in Malaysia. The results showed that cost reduction and efficiency can be achieved by creating economies of scale, namely using and managing suppliers suitably through the combination of a strategic subcontracting alliance [20]. A study which analyzed the "architecture of industry", as well as the structural changes in the automotive sector from 1997 to 2007, found that original equipment manufacturers led efforts to produce alterations in the architecture of industry, working with suppliers to advocate a new vision based on modularity and subcontracting. This trend in the sector highlights a corporate drive directed at a combined strategy of modularization and subcontracting [34]. Another study highlights two reasons for subcontracting: the cost and focus on the company's core competencies. Research on the subject of current and future trends in subcontracting, un-



dertaken at American, British and Central European companies, considered subcontracting to be a strategic lever. It is expected that, in future subcontracting agreements, horizontal linkages will be required to generate advantages in scale and competency [16]. In a research study related to the effectiveness of quality control at a company which produces plastic components for the automotive industry, non-compliant products were detected at the factory. Once these were identified, the supplier was then requested to implement procedures for Controlled Shipping Level 1 and Controlled Shipping Level 2, both of which were executed through subcontracting. The results indicated a higher effectiveness of activities when subcontracting was involved [35]. Another study analyzed the interaction between modularity and subcontracting in the automotive industry, focusing on vehicle cockpit projects in North America and using data collected from three generations of product architecture. It was found that the direction of influence between product architecture and the boundary varies in individual processes, and in higher levels of modularity and subcontracting. The strength of the factors driving these changes depends on individual processes, for example, cost structure and the weight of external factors, such as the development of technologies [36]. Finally, another study underlines the need for managers to consider subcontracting to ensure that companies will have a competitive edge. According to the author, subcontracting provides access to expertise, technologies, innovative processes and economies of scale. On the other hand, there is some concern regarding the loss of power and control over activities and knowledge. Therefore, managers in the automotive sector must seek to understand the concept and its associated risks if they are to benefit from subcontracting [37].

## 6. Relationship between subcontracting and lean methodology

The nature of the shift to a lean paradigm is not only visible in the trend towards the subcontracting of production. It is also evident in the subcontracting of design solutions, which aims to reduce product complexity and development time [38]. The vertical disintegration of up to 70% of automotive component production, along with an increase in the subcontracting of engineering design, are considered to be significant aspects of the lean paradigm [38, 39]. On the other hand, the authors Swenseth and Olson

[19] claim that the organization's strategic decision to subcontract may be seen as an alternative to lean operations.

Guimarães and Carvalho [40] state that, if all the non-value added activities are carried out internally, then the decision to subcontract these constitutes a lean solution. Subcontracting gathers benefits which are aligned with lean thinking, namely: the reduction of operational costs, expertise, the learning curve for the job at hand, the ability to focus on more profitable and key activities, increased productivity and efficiency, and the elimination of financial costs [41]. When it comes to reducing expenses, in various industries, and especially in higher-cost countries, organizations choose to subcontract rather than produce internally. This trend reflects the objectives of the concepts of subcontracting and lean methodology [26]. When lean procedures are applied, the successes achieved - at the tactical and operational levels of the organization - can be complemented by potential gains, such as the flexibility to take advantage of purchase opportunities at lower costs, which results from subcontracting [19].

Regarding expertise, companies can also benefit from subcontracting by acquiring knowledge through their suppliers. When an organization subcontracts services from another, and in the case where the subcontracted activity constitutes its main business, the company may benefit from fewer errors and, consequently, less rework, waste and customer complaints. A higher level of quality can thus be achieved [42].

In line with lean thinking, another factor involved in subcontracting is that, when activities are outsourced, employees dedicate more time to acquiring a greater knowledge of the remaining skills. As a result of this learning process, the company's productivity increases [41]. Subcontracting provides organizations with the advantage of being able to focus more intensively on fundamental and core business activities. In these cases, companies will be able to achieve a higher flexibility in operations, as well as spreading the risks and improving the reduction of time in all the procedures involved [43]. The subcontracting of activities by companies is seen as a lean practice [44], since it contributes to overall improvements in efficiency [45].

In relation to the elimination of financial costs, Aziz et al. [41] state that, if a company resorts to subcontracting, it will not have to invest in new equipment; this will, in turn, have a direct impact on financial costs. The manufacturing industry is currently required to be increasingly flexible, agile and lean. The attempt to achieve one of these objectives often

poses a contradiction for the others; as such, these requirements cannot be achieved at the same time [17]. The solution may then reside in the subcontracting of activities, which thus emerges as a tool to meet these objectives simultaneously [17, 18].

In rapidly changing environments, an agile supply chain is characterized by the ability to respond rapidly and at a low cost [40, 46]. However, flexible supply chains are driven by the uncertain environment of the company's context, as well as the variability of results [47]. Flexibility is ensured by adaptable systems, which are not optimal in terms of expenses [17]. On the other hand, lean methodology focuses on eliminating waste, reducing costs, improving productivity, enhancing the quality of products and services, as well as customer satisfaction [48]. Thus, lean procedures which concentrate on lower cost systems are achieved by forgoing flexibility, so that there is a conflict of factors when deciding between agile flexible systems and lean methodology. By resorting to the outsourcing of certain segments and products, these contradictory factors will be subcontracted, with the subcontracted products thus being optimized, as parts of other systems. Companies will thus be able to ensure flexible, lean and agile systems [17, 18, 40].

Given the characteristics of lean philosophy, it is often present in decisions made by companies to use subcontracting, with the purpose of obtaining advantages and reconciling the two concepts. Thus, there are some examples of studies, in which the use of subcontracting has been integrated with lean thinking.

A study conducted at Airbus UK sought to identify subcontracting trends in the aerospace industry and explored the extent to which the lean approach was able to conceptualize these. It was concluded that lean procedures explain many of the subcontracting trends and policies at Airbus. The increased subcontracting of suppliers which have a greater capacity to perform specific tasks, the sharing of risks, as well as the reduction of internal and supply chain costs are all aligned with lean concepts [49]. Another study undertaken at a petrochemical company analyzed the characteristics of flexible, agile and lean organizations. This was carried out through factor analysis and showed that subcontracting activities can emerge as a key element when seeking to achieve these objectives simultaneously. The variables for effective subcontracting of the value chain were identified and, through the use of Interpretative Structural Modeling, a relational hierarchy of these factors was established [17]. The aim of another study was to understand which factors are essential for the successful implementation of lean procedures in the subcontracting relationships of

information and technology companies. Sixteen factors were identified, for example: the importance of cooperation when identifying and eliminating waste, the relevance of internal experience in lean, as well as the compatibility of organizational culture. The factors at hand pointed to key areas, which guide the implementation of lean procedures in information and technology subcontracting relationships [50]. A different study focused on a health care unit. Following a strategy of subcontracting, the objective was to gain an insight as to how health organizations strike a balance between the use of internal and external resources. This study showed how a service value chain can opt for subcontracting, favoring the lean principle of "pulling" value on the part of the customer [40]. Finally, the purpose of another study was to analyze the characteristics of flexible, agile and lean supply chains, as well as to show that subcontracting can constitute a means to achieve this goal. The main features of these chains were identified and classified into paradigms, such as: responsiveness, inventory control, cost and waste. It was concluded that subcontracting makes it easier for organizations to be simultaneously flexible, lean and agile [18].

Thus, it is clear that Lean principles can be easily applied to subcontracting procedures, leading to cost savings and allowing shortening the lead time of these processes. Otherwise, subcontracting can easily allow to get a better distribution of the tasks by several providers, saving costs as well due to negotiation processes. Indeed, Lean intends to save resources and eliminate wastes, and subcontracting is an extraordinary way to achieve this goal. Moreover, subcontracting intends to get a better performance of the processes, reducing costs and lead time. Thus, these concepts perfectly match. Hence, the beneficial effect of each other has been discussed in other sectors, being also observed in the AI sector.

## 7. Conclusions

Great relevance is attributed to the strategy of subcontracting in the automotive sector. With a view to obtaining strategic advantages, it is already being used widely this area of production. On the one hand, while some authors argue that it is more advantageous for companies to subcontract secondary activities and maintain in-house production for the activities which are fundamental to their activities, others consider that there are advantages in subcontracting core activities. However, what is clear is that a balance must be established between subcontracting and internal

production if organizations wish to maintain their negotiating power.

There is, undoubtedly, a close relationship between lean methodology and subcontracting. Subcontracting has proved to generate advantages, and supports the fundamentals of the lean concept, just as lean can help to manage subcontracting. Several studies and projects in various areas have been developed to analyse this relationship. The trade-off of the transfer of activities enables organizations to be flexible, lean and agile; they can then focus on their core activities, which generate more value, while the option to subcontract generates a significant reduction in costs by transferring non-core activities. Thus, since lean methodology is also of widespread use in the automotive sector, it is concluded that lean and subcontracting concepts are interrelated, within the context of the automotive industry. That is, lean procedures and subcontracting activities are both used in the automotive sector and, as such, lean methodology provides support for subcontracting while, in turn, subcontracting contributes to the development of lean processes.

As main limitation of this paper it can be referred the number of papers consulted, as well as the databases used to perform the bibliographic research. Moreover, some literature found is not so updated as desired. However, this work can constitute a helpful base of work for further studies related to this issue. In fact. Some future works can be developed relating as well these aspects with green and fair-trade market, extending the study to all the three pillar of sustainability, and introducing concepts of fair-trade market in subcontracting operations [51-54].

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