ISSN 2286-4822
www.euacademic.org

EUROPEAN ACADEMIC RESEARCH
Vol. VIII, Issue 12/ March 2021

Impact Factor: 3.4546 (UIF)
DRJI Value: 5.9 (B+)

Critical Factors and Strategies for Cost Management in the Development and New Products Introduction Process

LETÍCIA ANDRADE DE OLIVEIRA BRILHANTE
Master of Production Egineering | Federal University of Amazonas (UFAM)
Manaus City, State of Amazonas (Brazil)

Abstract

Cost is an essential variable for survival and increase in market share of organizations. This article describes the critical factors and constraints that act on this variable during the process of introducing new products in a mobile phone production industry and how Modularity and Communality strategies are used to mitigate costs, as well as their influence on new product introduction portfolio management, product maturity, launch time, quality, flexibility, production capacity, testing time, set ups, line stops, supply chain management, supplier and inventory management. This qualitative case report addresses lessons learned from challenges experienced with a focus on correlating theory to practice in the context addressed, based on a literary review that substantiates the above topics.

Keywords: Modularity; commonality; costs; new products

INTRODUCTION

Within a mobile phone production plant, cost management in the introduction of new products starts from the first investment activities on new machines, testing equipment, assembly jigs, specific features for the new products or product portfolio. Budgets are also considered for trials and building of prototypes for reliability tests and sample for programming and regulation tests, in addition to investments in tools that will be assigned to suppliers and contractual manufactures to perform outsourced activities. In this scope, the production mix and product pools determined for each assembly line are relevant, as well as balancing actions and equalizing the nominal capacity of the production lines, with determination and optimization of head count, the distribution of the number of components assembled by each machine within the line configuration, test steps, product configuration settings and definition of variants for the subsequent stages of the production process. In parallel to all these constraints, every milestone in the development and ramp up process, alternative parts and suppliers are sought, adjustments and updates to the BOM (Bill of Material) of products with a focus on cost reduction and supply chain optimization, bearing in mind that approximately 60-80% of the variable costs of products are determined by the costs of materials and componentes (Anderson & dekker, 2009; Carr & NG, 1995; Lee & Monden, 1996).

The chain described above brings in its general aspects the concepts of modularity and commonality that will be addressed and will permeate the topics of this production with a focus on cost management tools in the development and introduction of new products, the first of which concerns the combination of elements and modules to create new variants of the same product, new products, processes or systems determining the best multi-use configuration for modules, sub-parts and processes and the latter is configured in the idea of using identical types of components of a product in several others, that resulted in the techniques of clusters (clustering techniques solutions) (Fixson, 2006).

The article is structured as follows: section 2 contains the literature review about the costs included in the process of developing and introducing new products and how they relate to the concepts of modularity and comnuality. Section 3 describes the method of conducting the research. Section 4 reports the case study and its nuances under the strategic background of the concepts covered. It ends with section 5 in which the lessons learned and the conclusions obtained inherent to the case are discussed.

MODULAR DESIGN AND ARCHITECTURE

Cost management

The design (Ramdas, 2003) and modular architecture are incremental strategies to increase variety through product portfolios that optimize time in the development and introduction of new products through flexibility and speed and are mentioned in the literature as elements that bring benefits in cost savings (Ben Mahmoud-Jouini & Lenfle, 2010; Fisher et al., 1999; Krishnan & Gupta, 2001), however they also have an impact on the increase in costs (Labro, 2004).

Customer goods/Final goods companies with high production demands and a variety of new product portfolios need to deal with the constant and growing needs of customers, adapting to diversity efficiently. In order to remain in highly changing and dynamic markets, it is necessary to offer competitive prices as a rule, combined with excellence in quality, so that they can maximize the profitability and business sustainability.

Thus, cost management within organizations is essential for them, since cost targets are not defined internally merely as a strategy for greater gains, but defined mostly by the market in the cost-benefit context of each product.

Therefore, costs targets are determined in an interactive and mutifactorial process between product properties configuration, technical complexity, costs and market prices (Cooper, 1996) and the cost target can be a “strategic weapon” to ensure marketing introcducion (Afonso et al., 2008, p. 565).

In general, costs targets are initially determined by determining an attainable sales price for a given product with its settings specifics. Subtracting the projected profit margin results in limiting costs for product development and production (Cooper & Slagmulder, 1999; Ibusuki & Kaminski, 2007).

Cost targets require prior estimates that are made during product development to ensure that costs do not exceed targets, in which case where the design needs to be adjusted. Within this context, the design of a new product is a progressive process, reviewed and updated in specific milestones verified within a range of specifications that must be achieved. Throughout this period, trials, pre-productions Builds are often carried out to verify results, parameters and adjustments. This preliminary phase is still uncertain and does not have clear cost determinations and its implications (Altavilla et al., 2018; Rodríguez et al., 2019; Savoretti et al., 2017) and must be accurately determined in the course of the process.

Stadtherr & Wouters (2017) mention methods in commonality of components, modular design, product platform and technological group (TG), as strategies considered in the context of organizations. The focus on cost management through the coordination of design decisions within the new product portfolio is also corroborated by ElMaraghy et al., (2013); Johnson and Kirchain, (2009); Jose & Tollenaere, (2005); Ramdas, (2003).

Stadtherr and Wouters (2017) bring the use of modularity as an approach to cost management in order to achieve economies of scale in the stages of development, purchasing and production, aiming at reducing total costs and maximizing total profit in the portfolio of new products.

Modularization methods or others based on it are more comprehensive than cost management strategies aimed at a single product, since they can significantly reach a larger number of products, and therefore modules, components and processes in the same time window and a sequential implementation that would require more time is not necessary. The decision-making process ends up being consolidated in stages with greater scope in terms of volume and activities.

Another positive point is that if a change is made for a portfolio of products, it does not necessarily need to occur for others, which saves time and resources. In this way, changes and updates are accurate. (Davila & Wouters, 2004).

Some studies also demonstrate that modular product architectures have a great initial impact on costs, since it is more difficult and expensive to develop interchangeable modules in numerous product variants, in addition to the limited number of parts and part numbers to be created (Fisher et al., 1999; Krishnan & Gupta, 2001; Labro, 2004).

In this case, an "optimal volume" provides better costs. It is necessary to consider that there are particular specifications for sets that require, on their own, greater financial investments precisely because of their modular condition, such as settings and optimizations of greater technological bases etc., (Fisher et al., 1999; Ramdas, 2003). In this case, the unit price of these parts will be more expensive than dedicated parts, leading to higher costs.

Davila e Wouters (2004) emphasize that the cost management approach such as the modular design and commonality of parts are complementary when time-to-market or technological challenges are critical variables in the process of developing and introducing new

products. This is because the possibility of simultaneous product launches that compete with productive resources and materials in common use must taken into account. Given this, Cooper e Slagmulder (1999) recommend considering a portfolio of products of the company as a whole, starting the process of defining cost targets when the individual profit margins per product have already been set.
Kee and Matherly (2013) show that when products share restricted resources (such as production capacity), isolated cost targets focused on a single product or singular products can lead to less effective decisions.

When it comes to resource constraints, there is a need for coherence between multidisciplinary groups and sectors within companies when using tools related to modularity and commonality.

The portfolio for the introduction and launch of new products must be aligned internally with the strategies for the use and allocation of productive, material and human resources, since in the case of competition between product-oriented and portfolio-oriented approaches (such as those observed here) a coherent agenda should prevail with the objective of mitigating costs and maintaining the orientation towards predefined targets. In this sense, the objectives of the product manager and the other teams of the organization must be aligned (Israelsen & Jørgensen, 2011).

The literature has a greater focus on the variable costs of singular products, however it is clear that there are emerging details when looking at the theme of targets and cost management from the modular design method within a portfolio and not isolated projects.
When the verification is made over a broader spectrum through a portfolio, the interdependencies between the different resources are clearer, as well as the restrictions arising from them (Ahn et al., 2018).

The effects through which product architecture features such as modularity and commonality can reduce costs are typically linked to reducing the complexity of the process, increasing economies of scale, risk pooling (risk of aggregating demand through the use of common parts) and how these effects can vary at the intersection with the various activities (Fixson, 2006a).

The cost of materials

Modular product architectures have a bias in the strategy of commonality with the technique of clusters, development of local suppliers and development of alternative suppliers for specific components. The main objective of commonality is to reduce the complexity of BOMs, increase the production of suppliers in scale and obtain a lower price per unit, thus substantially reducing the cost of materials, making the set up processes, machine and equipment configurations, crash analysis, functionality issues and others flexible. There is a predominant focus of the literature related to the variable costs of production that include costs of materials, labor, or the direct conversion of these costs (Ibusuki & Kaminski, 2007; Lee & Monden, 1996; Zengin & Ada, 2010). For Woods et al (2012), the traditional cost target focuses on seeking cost reductions through changes in the type and supply of materials Carr e Ng (1995) also focus their case study on materials and components, according to which, the latter two represent 80% of the costs that the company had to deal with.

Several studies parameterize the cost targets between the company and the suppliers, focusing on the component price represented as a variable of the manufacturing or production cost in the case of factories or production plants and full cost in the case of suppliers (Cooper, 1996; Cooper & Yoshikawa, 1994). Ellram (2006) compares the theoretical cost target model with practices in the United States and other countries and also focuses on the costs of materials and components.

In their study of modularity and supply chain coordination, Ro et al. (2007) demonstrates that the cost target can present itself as a constraint factor preventing effective cooperation between organizations, but it can also be used as a factor of cooperation between organizations and their suppliers (Cooper & Yoshikawa, 1994).

Other studies bring the interorganizational application of cost targets (Agndal & Nilsson, 2010, 2009; 2008; Caglio & Ditillo, 2012; Cooper & Slagmulder, 2004; Fayard et al., 2012; LI et al., 2012; Petersen et al., 2003). Additionally, integrated cooperation with suppliers from the early stages of product development can contribute more effectively to achieving cost targets (Cooper, 1996).

The companies expect that suppliers integrated with the development of new products from early stages will meet the minimum requirements with a focus on the agreed production volume taking into account relevant selection criteria in addition to price, such as: quality, deadlines, delivery volumes and roles and responsibilities. Technical evaluation is a critical item for the sharing of technologies to allow suppliers to the best solutions and there is a need for the involvement of key people in the purchasing areas and suppliers according to each case (Petersen et al., 2003).

Regarding materials, there is also a relationship between commonality or pooling strategy (aggregation of demand through the use of common parts) that should be considered as a critical factor, since it does not decrease stock levels, instead increases them, and can lead to item obsolescence in cases of changes in BOM due to demand variability sales and product discontinuity (Fixson, 2007).

It adds to the criticality of this the fact that commonality can also be used to develop second or alternative parts, as a backup to restrictions in the case of global manufacturing distributed production plants with different geographical locations and needs of specific consumer markets.

The production mix and mobile manufacturing

In order to be successful in the development and introduction of new products concerning cost metrics based on a limited time window linked to the time to Market (Afonso et al., 2008) it is important to observe what was suggested by Tsai & Wang (1999) regarding the fact that the number of modules affects the costs of manufacturing and assembling parts in opposite directions, being necessary to define the ideal number of modules that bring the balance for these two components. Studies on the effects of commonality or pooling costs on manufacturing often focus on economies of scale.

Typically, the objective is to prorate fixed costs (of tools, machines and features in common use) between large volumes and varieties of products to reduce the unit cost. In this case, the pooling of production lines suitable for families of products or products with similar characteristics and technologies can reduce set up times, mitigate line stops and optimize the use of labor in terms of learning curves. Another advantage would be the plan for predictive and corrective maintenance of machines that would have more effective actions in a larger set of products.

Garud & Kumaraswamy (1996) suggest that modularity in design is associated with learning through study, that modularity in production is associated with learning by doing, and modularity in use with learning by using.

For Fixson (2007), industrial processes are increasingly interconnected in supply chains and production networks, and, consequently, the way to better understand them is to study them in their interconnection; products along with the processes to design, produce, sell, use and recycle; organizations along with their suppliers and customers.

According Rostami, Paydar e Asadi-Gangraj (2020), one of the efficient methods of production planning is cell manufacturing (CM), in which cells contain several machines with different and unequal functionality that can process a group of parts called part families that have the same production and processes.

Cellular manufacturing is a hybrid system that has the benefits of production flexibility and efficient use of machine capacity. In a dynamic production environment, some products may not be in demand in a specific period or have different demand in the planning horizon (Rostami et al., 2020).

For Rostami et al. (2020), dynamic cell manufacturing aims to solve the following problems: the alignment of production capacity versus demand, the optimization of equipment and systems reconfiguration time, meeting demand for outsourcing if necessary, reallocation and transportation of machines, equipment and resources, avoiding production stoppages that result in reduced profitability and increased costs.

In terms of logic and structure, the group of machines will be changed according to product demand or the entry of a new component in the system in different periods of time.

The integration of cellular manufacturing into the supply chain is one of the ways to increase efficiency and productivity and to mitigate logistics, production and distribution costs by optimizing the flow of materials and processes.

Product configuration

The configuration allows to share the alternatives and product variants with customers in a scalable way to facilitate and automate sales and production planning. Configuration is a knowledge-based system that assists the user in creating products by specifying modules, features and / or capabilities. The variety of products and the number of customers are among the main factors of decision and configuration of systems. Configurations can usually be developed from scratch or purchased using solutions already developed. Decisions depend on factors such as cost and technical requirements. The process involves capturing the customer's requirements (evaluating possible solutions that meet the customer's expectations and observing preferences considering the economic and environmental perspectives of the solution), (Medini et al., 2020).

THE METHOD

A systematic review of the literature was carried out to find out which costs are considered in the cost target methods and how they were linked to the concepts of modularity, commonality and pooling, such as their interconnections and implications. We sought for articles that dealt with key concepts according to the primary interest of the study, which were: development and introduction of new products, modularity, modularization, modular design, commonality of components, commonality of parts, commonality of materials, pooling, pooling risk, product platform, product portfolio, cell manufacturing. This approach was used as a background to the description and development of the case.

THE CASE

The New Product Introduction department a mobile phone manufacturing plant located in Manaus – AM had 05 project managers responsible for the portfolio and the introduction of new products for CDMA, TDMA and GSM technologies that established the link between the internal multidisciplinary team from Manaus plant and the product managers of the creative centers located in Beijing, Ulm, Dallas, Copenhagen, Salo and Oulu. In addition to the production plant in Manaus, there were other factories in Guanddong, Komaron, Dallas, Reynosa and Salo.

In order to guarantee the time to market and mitigate the variable costs of production, the product introduction metrics were 09 consecutive days as shown below, with 03 days of conversion or line set up, 03 days of process verification with the objective of ensuring the established quality items in the 3 stages of production (SMT "*Surface Mounting Technology*", Tests and Variant Configuration) called MFR (Minor Failure Rate) composed of the difference between 100 and the yield.

Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9
LC	**LC**	**LC**	**LV**	**LV**	**LV**	**RU**	**RU**	**RU**

Before the introduction process, the breeding centers developed Trials B1, B2, according to product maturity. These preliminary stages included the development of the supply chain carried out by the purchasing area, which included lead times, alternative parts and BOM updating, as well as the development of local suppliers, technical assessments of outsourced sub-sets (UI Module: LCD attached to the plate), plastic parts (A, B Covers and keymat) and packaging items.

The B3 Builds took place in the factories with a focus on the development of the multidisciplinary team of engineers, technicians and specialists in the areas of purchasing, engineering, materials, production and quality. At this stage, operators of the SMT, Tests and Final Assembly that would act as multipliers.

The creative centers in Salo, Oulu, Copenhagen, Ulm and Dallas were responsible for high cost products and the Beijing creative center for low cost cell phones.

Commonality was defined in terms of clusters with suppliers of printed circuit boards mounted on SMT (Suface Mounted Technology) lines or sub-sets of UI Module (LCD coupled to PCI) and plastic parts such as A, B, C, D Covers and rubber like the keymat for slides, folder and flip phones. The assembly of PCIs and sub-assemblies of UI Modules was centralized at the supplier Jabil and the plastic parts at the suppliers Foxconn and Perlos.

The production planning or mix took place according to the pooling occurring as follows: a) Lines 1, 2 and 3 with nominal capacity of about 100,000 products / month considering 03 continuous 8-hour production shifts; b) Lines 4, 5, 6 and 7 with nominal capacity ranging from 60,000 to 80,000 cell phones / month taking into account 03 continuous 8-hour shifts. The high volume and performance lines concentrated on a pool of low cost products and less complex technologies while the others added high technology products with higher added value and profit margin.

The poolings were consolidated from the variants of manufacturing design, technological complexity, family of similar products and product testing and configuration settings. The variant features were related to the main cell phone operators in the Brazilian market: TIM, CLARO, OI, VIVO and other variants destined for Central America and the export market.

According Rostami et al. (2020), dynamic cell manufacturing aims to solve the following problems: the alignment of production capacity versus demand, the optimization of equipment and systems reconfiguration time, meeting demand for outsourcing if necessary, relocation and transportation of machines, equipment and resources, avoiding production stops that result in reduced profitability and increased costs.

Having configured the scenario of the production environment and general characteristics of the products and their variants, it is intended to demonstrate 03 specific cases of Ramp Up of products that corroborate relevant issues reviewed in the literature in preliminary sessions.

N 6111 - Variety and product variants: the restriction of the supplier's capacity due to market demands

The Ramp Up planned for the 6111 model had been strategically designed with an initial volume of 30,000 products to serve the main operators in the national market with a split of 20,000 pieces for the pearl white variant and 10,000 for the pink variant. According to the metrics for the introduction of new products, this volume should be reached after the set up and verification of the line, in the first three days of production, maintaining the regular operation of 09 continuous production shifts in order to prove the line's production capacity and product quality parameters.

The product launch was scheduled for the month of May and soon the pink production variant started to see na increase in sales orders its demand becoming higher than for pearl white, since the operators instantly reached the female audience in campaigns of mothers day and brides month. The factory had an unforeseen problem caused by the increased demand and it had stock and supply orders in the reverse configuration demanded by the market.

When establishing new demands for the supplier, the procurement area found another restriction factor related to the film foil required for the pink variant production which had a high import and clearance lead time and would make it impossible to produce new parts immediately.

In view of this issue, intense negotiations were established with the operators and discontinuity of production due to the time of receipt of the *film foil* by the supplier. This restriction directly impacted the Ramp Up and production costs due to line stops at the factory and at the supplier, leading to reconsiderations and unit price negotiations between the parties, in addition to the increase in the unit cost of the model, which despite having a higher aggregate margin for composing the portfolio of mid-high technology, not only had to incorporate the increase in variable labor costs internally, but also the costs of price renegotiation with the supplier due to the downtime and the need for investment in capacity increase, since they kept the volume previously agreed, however in a much shorter time window.

For Fixson (2007), industrial processes are increasingly interconnected in supply chains and production networks, and, consequently, the way to better understand them is to study them in their interconnection; products along with the processes to design, produce, sell, use and recycle; organizations along with their suppliers and customers.

In the above case, the need for integration between sales projections, production networks and supply chain, as well as the critical observation of the interconnection between such variables, becomes quite striking. There is no effective planning of the procurement area without the volumes agreed with the suppliers covering the time window aligned with the market needs. Thus, for example, taking as a hypothetical and illustrative case: it is not enough that the supplier has the capacity to deliver 30,000 pieces in two weeks or a month, but that he can supply such a quantity in three days, considering production times and distribution of final products.

For Cooper (1996) and Cooper e Yoshikawa (1994), the cost targets between the company and the suppliers are parameterized focusing on the components price represented as a variable of the manufacturing cost in the case of factories and integral cost in the case of suppliers.

Often the purchasing area negotiates prices and mitigates costs by taking the total volumes for a given product as a guideline, however it does not observe the constraints related to delivery time, because to reach price targets and consequently material costs, it takes a window as a reference more comprehensive timeframe focused on restricting suppliers' investments in capacity which would increase the unit price of parts. This decision may, subsequently, result in production stoppages and sales order delays or losses that will also have a significant contribution in targets of costs.

The companies expect that suppliers integrated with the development of new products from early stages will meet the minimum requirements with a focus on the agreed production volume taking into account relevant selection criteria in addition to price, such as: quality, deadlines, delivery volumes and papers and responsibilities (Petersen et al., 2003).

N 6101 - Product performance and quality: The interdependence due to the material storage locations

O Ramp Up 6101 occurred with a volume of 60,000 cell phones, since the product line had a capacity of 100,000 products/month and great demand from operators. The target composed of the three production stages (SMT, Tests and Product Configuration) of MFR (Minor Failore Rate) was initially 5.0% in the first month of production, 4.5% in the subsequent one, consolidating in 3.7% in the full product maturity stage. However, still during the RU phase (Ramp Up), the product had an MFR composed of about 7.0% due to a failure in the tests due to the disconnection of the flat cable with the UI Module that caused the LCD to be turned off when opening the phone which was a folder / flip model.

After extensive failure data collection and defect analysis, it was found that failures occurred when using the AUO supplier's LCD and did not occur when the line was powered by Sony's LCD. After several functional tests, it was found that there were no problems with the functionality of the AUO supplier, however it was noted that it was 1mm larger than Sony. Because it is larger, it was compressed on the UI Module and ended up forcing the flat cable to be disconnected, cutting off the LCD power and turning it off each time the phone was opened and closed.

With the precise diagnosis, the purchasing area was activated to check the purchase planning of the item and information was obtained that the AUO was the alternative item and was being directed to the Manaus plant, while the main item of the BOM was being directed to Guangdong due to higher demand and production volume. Clearly, the issue of global allocation had been taken at a strategic level, without the impact on functionality and product quality indexes being known.

When analyzing the stock, it was detected that there would be a need to consume about 100,000 pieces in stock for new purchase orders for the main item to start feeding the production line. As a corrective measure, instructions were given to the supplier to reprogram the assembly of components of the SMD line (Surface Mounted Device) of the UI Module set plate by 1 mm in order to exhaust the quantity of the alternative item in stock.

Baldwin e Clark (2000), Gershenson et al. (2003, 2004), Stadtherr & Wouters (2017) discuss the interdependence between items that involves cost management during the development of new products. In this case, the interdependence of items generated a decision that restricted an item due to the global allocation of materials, however this change brought reflexes in the functionality and quality of the product with an increase in costs due to the increase in the number of failures and consequent decrease output, the need for overtime and the allocation of more technicians for repair.

Kee and Matherly (2013) show that when products share restricted resources (such as production capacity), isolated cost targets focused on a single product or singular products can lead to less effective decisions.

N 6131 –Product Design: the suplier technical assessment issue

In the case of model 6131, during the introduction of the product, the plastic parts showed burrs in the castles, making it impossible to correctly tighten them during assembly, causing RF leakage and failures during the production process. After diagnosing the cause of the failure that caused restrictions on the output and quality of the product, the supplier was called in to repair the process, however as a corrective measure he sent labor to the product's production line so that the parts could be reworked, before assembling the final product, thus avoiding defects and rework.

In their study of modularity and supply chain coordination, Ro et al. (2007) demonstrates that the cost target can present itself as a restriction factor preventing effective cooperation between organizations, but it can also be used as a factor of cooperation between organizations and their suppliers (Cooper & Yoshikawa, 1994). In this case it is observed that even when restrictions occur in the design and modular architecture, it is important that the corrective action is carried out in four hands, in an integrated work between manufacturer and supplier. In the same hand, integrated cooperation with suppliers from the early stages of the product development can contribute more effectively to achieving cost targets (Cooper, 1996).

DISCUSSION AND CONCLUSION

When studying cost management in the development and introduction of new products in the light of the strategies of commonality, modularity, pooling and cellular manufacturing, it was found that these can have positive effects in reducing costs, but can also present themselves as restrictions to the process, acting directly in the increase of variable costs arising from line stops, overtime, material rework, increased head count, investment in production capacity, tests etc. The integration of suppliers from the initial stages of product development and technical assessments are essential to improve parts design and quality in order to achieve cost, quality and delivery targets.

In general, cell manufacturing (Cell Manufacturing) is one of the efficient methods of production planning due to its flexibility and suitability to dynamic environments, solving the balance of production capacity according to demand variability, the optimization of reconfiguration time of equipment and systems, the relocation and transportation of machines, equipment and resources, mitigating production stops that imply reduced profitability and increased costs.

Materials commonality actions require attention to issues such as: item interdependence and inventory management, which can lead to constraints on the supply of primary BOM items due to global allocations and consequently increase inventories of alternative items or non-functional or obsolete second parts.

In the extensive reviwed literature, it was noticed that much has been researched about the cost target inherent to materials, design, configuration and cellular manufacturing, however, it is important to emphasize that the deepening in practical cases and the impact of such strategies in the manufacturing process, as in the costs of line stops, rework, scrap, it is always extremely valuable and importante for organizations in general.

In preliminary studies Garud & Kumaraswamy (1996) said that modularity in design is linked to learning through study and that modularity in production is associated with learning by doing. Taking this suggestion as a true premise, it appears that theoretical knowledge is validated in practice in real events that give rise to the empiricism applied to the specific case, as this way not only exists the possibility of proving the theory, but also optimizing it, including atypical or previously outlined situations. Practical examples make articles (papers) more educated, providing greater ease and access to knowledge.

Thus, it is expected that it fulfills its role in terms of sharing knowledge and good practices and that it will contribute to the development of new research and cases with the same objective.

REFERENCES

1. Afonso, P., nunes, M., Paisana, A., Braga, a., 2008. The influence of time-to-market and target costing in the new product development success. Int. J. Prod. Econ. 115, 559–568. https://doi.org/10.1016/j.ijpe.2008.07.003.
2. Agndal, H., Nilsson, U., 2008. Supply chain decision-making supported by an open books policy. Int. J. Prod. Econ. 116, 154–167. https://doi.org/10.1016/j.ijpe.2008.08.038.
3. Agndal, H., Nilsson, U., 2009. Interorganizational cost management in the exchange process. Manag. Account. Res. 20, 85–101. https://doi.org/10.1016/j.mar.2008.07.001.
4. Agndal, H., Nilsson, U., 2010. Different open book accounting practices for different purchasing strategies. Manag. Account. Res. 21, 147–166. https://doi.org/10.1016/j.mar.2010.04.001.
5. Ahn, H., Clermont, M., Schwetschke, S., 2018. Research on target costing: past, present and future. Manag. Rev. Q. 68, 321–354. https://doi.org/10.1007/s11301-018-014-y.

6. Altavilla, S., Montagna, F., Cantamessa, M., 2018. A multilayer taxonomy of cost estimation techniques, looking at the whole product lifecycle. J. Manuf. Sci. Eng. 140 https://doi.org/10.1115/1.4037763.
7. Anderson, S.W., Dekker, H. C., 2009. Strategic cost management in supply chains, Part 1: structural cost management. Account. Horiz. 23, 201–220. https://doi.org/10.2308/acch.2009.23.2.201.
8. Baldwin, C. Y., & Clark, K. B. 2000. Design Rules. Volume 1: The Power of Modularity. Cambridge, Massachusetts: MIT Press.
9. Ben Mahmoud-Jouini, S., Lenfle, S., 2010. Platform re-use lessons from the automotive industry. Int. J. Oper. Prod. Manag. 30, 98–124. https://doi.org/10.1108/01443571011012398.
10. Caglio, A., Ditillo, A., 2012. Opening the black box of management accounting information exchanges in buyer–supplier relationships. Manag. Account. Res. 23, 61–78. https://doi.org/10.1016/j.mar.2012.03.001.
11. Carr, C., NG, J., 1995. Total cost control: nissan and its U.K. supplier partnerships. Manag. Account. Res. 6, 347–365. https://doi.org/10.1006/mare.1995.1025.
12. Cooper, R., 1996. Costing techniques to support corporate strategy: evidence from Japan. Manag. Account. Res. 7, 219–246. https://doi.org/10.1006/mare.1996.0013.
13. Cooper, R., Slagmulder, R., 2004. Interorganizational cost management and relational context. Account. Org. Soc. 29, 1–26. https://doi.org/10.1016/S0361-3682(03)00020-5.
14. Cooper, R., Slagmulder, R., 1999. Develop profitable new products with target costing. Sloan Manag. Rev. 40, 23–33 (https://doi.org/Article).
15. Cooper, R., Yoshikawa, T., 1994. Inter-organizational cost management systems: the case of the Tokyo - yokohama - Kamakura supplier chain. Int. J. Prod. Econ. 37, 51. https://doi.org/10.1016/0925-5273(94)90007-8.
16. Davila, A., Wouters, M., 2004. Designing cost-competitive technology products through cost management. Account. Horizons 18, 13–26. https://doi.org/10.2308/acch.2004.18.1.13.
17. Elmaraghy, H., Schuh, G., Elmaraghy, W., Piller, F., Sch¨onsleben, P., Tseng, M., Bernard, A., 2013. Product variety management. CIRP Ann 62, 629–652. https://doi.org/10.1016/j.cirp.2013.05.007.
18. Ellram, L.M., 2006. The implementation of target costing in the United States: theory versus practice. J. Supply Chain Manag. 42, 13–26. https://doi.org/10.1111/j.1745-493X.2006.04201003.x.
19. Fayard, D., Lee, L.S., Leitch, R.A., Kettinger, W.J., 2012. Effect of internal cost management, information systems integration, and absorptive capacity on inter-organizational cost management in supply chains. Account. Org. Soc. 37, 168–187. https://doi.org/10.1016/j.aos.2012.02.001.
20. Fisher, M., Ramdas, K., Ulrich, K., 1999. Component sharing in the management of product variety: a study of automotive braking systems. Manag. Sci. 45, 297–315. https://doi.org/10.1287/mnsc.45.3.297.
21. Fixson, S.K., 2007. Modularity and commonality research: past developments and future opportunities. Concurr. Eng. 15, 85–111. https://doi.org/10.1177/1063293X07078935.

22. Fixson, S. K. 2006a. A Roadmap for Product Architecture Costing. In T. W. Simpson, Z.Siddique, & R. J. Jiao (Eds.), Product Platform and Product Family Design: Methods and Applications: 305-333. New York: Springer.
23. Fixson, S.K., 2005. Product architecture assessment: a tool to link product, process, and supply chain design decisions. J. Oper. Manag. 23, 345–369. https://doi.org/10.1016/j.jom.2004.08.006.
24. Garud, R., & Kumaraswamy, A. 1996. Technological designs for retention and reuse. International Journal of Technology Management, 11(Special Issue, 7/8): 883-891.
25. Gershenson, J. K., Prasad, G. J., & ZHANG, Y. 2003. Product modularity: definitions and benefits. Journal of Engineering Design, 14(3): 295-313.
26. Gershenson, J. K., Prasad, G. J., & ZHANG, Y. 2004. Product modularity: measures and design methods. Journal of Engineering Design, 15(1): 33-51.
27. Israelsen, P., Jørgensen, B., 2011. Decentralizing decision making in modularization strategies: overcoming barriers from dysfunctional accounting systems. Int. J. Prod. Econ. 131, 453–462. https://doi.org/10.1016/j.ijpe.2010.12.020.
28. Ibusuki, U., Kaminski, P.C., 2007. Product development process with focus on value engineering and target-costing: a case study in an automotive company. Int. J. Prod. Econ. 105, 459–474. https://doi.org/10.1016/j.ijpe.2005.08.009.
29. Johnson, M.D., Kirchain, R.E., 2009. Quantifying the effects of product family decisions on material selection: a process-based costing approach. Int. J. Prod. Econ. 120, 653–668. https://doi.org/10.1016/j.ijpe.2009.04.014.
30. Jose, A., Tollenaere, M., 2005. Modular and platform methods for product family design: literature analysis. J. Intell. Manuf. 16, 371–390. https://doi.org/10.1007/s10845-005-7030-7.
31. Kee, R., Matherly, M., 2013. Target costing in the presence of product and production interdependencies. In: Advances in Management Accounting, pp. 135–158. https://doi.org/10.1108/S1474-7871(2013)0000022011.
32. Krishnan, V., Gupta, S., 2001. Appropriateness and impact of platform-based product development. Manag. Sci. 47, 52–68. https://doi.org/10.1287/mnsc.47.1.52.10665.
33. Labro, E., 2004. The cost effects of component commonality: a literature review through a management-accounting lens. Manuf. Serv. Oper. Manag. 6, 358–367. https://doi.org/10.1287/msom.1040.0047.
34. Lee, J.Y., Monden, Y., 1996. An international comparison of manufacturing-friendly cost management systems. Int. J. Account. 31, 197–212. https://doi.org/10.1016/S0020-7063(96)90004-7.
35. Li, H., Wang, Y., Yin, R., Kull, T.J., Choi, T.Y., 2012. Target pricing: demand-side versus supply-side approaches. Int. J. Prod. Econ. 136, 172–184. https://doi.org/10.1016/j.ijpe.2011.10.002.
36. Medini, Khaled et al. Integrating Sustainability Considerations into Product Variety and Portfolio Management. Procedia CIRP, v. 93, p. 605-609, 2020.
37. Petersen, K. J., Handfield, R.B., Ragatz, G.L., 2003. A model of supplier integration into new product development. J. Prod. Innovat. Manag. 20, 284–299. https://doi.org/10.1111/1540-5885.00028.

38. Ramdas, K., Fisher, M., Ulrich, K., 2003. Managing variety for assembled products: modeling component systems sharing. Manuf. Serv. Oper. Manag. 5, 142–156. https://doi.org/10.1287/msom.5.2.142.16073.
39. Ro, Y. K., Liker, J. K., Fixson, S.K., 2007. Modularity as a strategy for supply chain coordination: the case of U.S. Auto. IEEE Trans. Eng. Manag. 54, 172–189. https:// doi.org/10.1109/TEM.2006.889075.
40. Rodríguez, A. E., Pezzotta, G., Pinto, R., Romero, D., 2019. A comprehensive description of the Product-Service Systems' cost estimation process: an integrative review. Int. J. Prod. Econ. 107481. https://doi.org/10.1016/j.ijpe.2019.09.002.
41. Rostami, A., Paydar, Mohammad M., Asadi-Gangraj, E. A Hybrid Genetic Algorithm for Integrating Virtual Cellular Manufacturing with Supply Chain Management Considering New Product Development. Computers & Industrial Engineering, p. 106565, 2020.
42. Savoretti, A., Mandolini, M., Raffaeli, R., Germani, M., 2017. Analysis of the requirements of an early life-cycle cost estimation tool: an industrial survey. Procedia Manuf 11, 1675–1683. https://doi.org/10.1016/j.promfg.2017.07.291.
43. Stadtherr, F., Wouters, M., 2017. Cost management and modular product design strategies. In: Harris, E. (Ed.), The Routledge Companion to Performance Management and Control. Routledge, pp. 54–86. https://doi.org/10.4324/9781315691374.
44. Tsai, Y. T., & Wang, K.-S. 1999. The development of modular-based design in considering technology complexity. European Journal of Operational Research, 119: 692-703.
45. Woods, M., Taylor, L., Fang, G.C.G., 2012. Electronics: a case study of economic value added in target costing. Manag. Account. Res. 23, 261–277. https://doi.org/ 10.1016/j.mar.2012.09.002.
46. Zengin, Y., Ada, E., 2010. Cost management through product design: target costing approach. Int. J. Prod. Res. 48, 5593–5611. https://doi.org/10.1080/00207540903130876.