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Introducing the Electronic Knowledge Framework into the Traditional Automotive Suppliers' Industry: From Mechanical Engineering to Mechatronics

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Abstract: The automotive sector is undergoing radical changes. New trends such as electrification, autonomous driving, connectivity, and car-sharing—to name a few—are disturbing the carmakers, which must satisfy their clients while meeting the increasingly strict environmental regulations. This pressure also falls on automotive parts suppliers, which now are asked to manufacture high-added-value integral systems, while struggling to keep a very adjusted price. As traditional automotive components evolve into electronic systems, suppliers must gain digital mastery to remain competitive. This paper presents different ways of introducing e-skills in a company and illustrates this with some examples from the Basque automotive industry. The aim is to encourage corporations to take the step towards digitalization, providing different options for them to choose the one that best suits their current scenario. For this study we have analyzed the literature and the press releases of the component manufacturers and interviewed staff from some of them. This research seeks to provide solutions so that the automotive sector remains competitive, as it is a strategic sector for the economy and employment.

Keywords: innovation management; automotive suppliers; industrial reengineering

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1. Introduction

The automotive sector is going through a disruptive era because electronics have transformed cars into computers on wheels [1]. This not only affects automakers, but also automotive parts manufacturers (tier 1) and the entire supply chain [2]. Environmental regulations are putting an expiration date on the internal combustion engine (ICE) and paving the way to electrification [3]. The COVID-19 pandemic caused the collapse of the automotive sector in 2020, stopping production and causing plummeting sales [4], and has not recovered yet in 2022 [5]. This situation also provoked a semiconductor crisis [5–7]: chip shortages are holding back vehicle production and challenging the "just-in-time" management philosophy [8]. New competitors are entering the sector: China is an emerging market and is leading electric vehicle (EV) adoption [9], to the point where there are so many players that the Chinese government has vowed to consolidate them in larger brands through mergers [10]. The big techs are also taking an important role in autonomous car development, as well as new ways of urban mobility.

Since the first electronic control unit (ECU) in 1978, the adoption of these systems has been on the rise. A modern car may have 100 ECUs [11], which means that the value of the electronics is 40% of the total cost of the vehicle [12]. Despite this fact, electronic design and software development is not the core business of traditional tier 1 suppliers. In a future in which the electric vehicle will reduce drastically the number of moving parts [13], the big techs will develop automotive degree systems and advanced driver assistance systems (ADAS) [1] based on computer vision and artificial intelligence (AI)

and the Chinese market will not only sell commodities, but high-quality products with added value at a very competitive price. This means traditional suppliers must reengineer their businesses. They have the mechanical know-how but lack electronic mastery. Those that want to maintain their competitive edge must address these problems and acquire the ability to complete electronic developments. This is not an easy task.

In addition, automotive electronic developments imply further constraints to be taken into consideration. To begin with, all electronic components used will have to be automotive grade [14], with more demanding reliability requirements. Further developments will have to consider functional safety, by analyzing the potential risks for driver, passengers, and road users. The standard that applies in this respect is ISO 26262 [15–17] and it will mark the lifecycle of the whole project. This can be combined with Automotive SPICE [17], an assessment model that some car manufacturers request from suppliers. In 2021, ISO/SAE 21434 [17,18], which deals with cybersecurity, was released, and some OEMs are also asking about its compliance. Finally, automotive electronics can be affected by electromagnetism [19,20], extreme temperatures, and corrosive fluids exposition, so will also need to be certified in this area [21]. In short, complying with all this is difficult, and even more so when there is no prior experience.

This research aims to identify the changes traditional automotive suppliers can make to go through the disruptions successfully. There are enough reasons to foresee that electronic demand will continue to grow at the expense of pure mechanical parts, which will not satisfy the original equipment manufacturers' (OEMs) expectations. It seems obvious tier 1 suppliers must acquire knowledge in the electronic engineering field, but what is not easy to understand is how to introduce electronics in a corporation which has never done electronic development before, and whose expertise belongs exclusively to mechanical engineering. Some companies have already accomplished this transition in several ways. This investigation intends to determine the keys to succeed.

There is literature concerning industrial reengineering and innovation management. Nevertheless, there is a gap when it is focused on a special industry such as automotive. In this sector, suppliers used to be dependent upon a few automotive OEM customers, and they have had very limited bargaining power [22]: the most competitive factor is cost/price with the threat of new entrants from the software industry and emerging markets; this internal rivalry makes it a very challenging environment for all the participants [22]. These reasons make it an exceptional case which requires its own solutions.

The automotive industry has a very strategic relevance in Europe and is crucial for its prosperity. This sector provides direct and indirect jobs to 13.8 million Europeans, representing 6.1% of total EU employment: 2.6 million people work in direct manufacturing of motor vehicles, representing 8.5 % of EU employment in manufacturing [23]. Globalization has prompted a need for international standardization in production processes and quality standards at different levels of the supply chain [24]. Therefore, local suppliers face the challenge of meeting these standards and, at the same time, they must identify how to fund the tooling, technology, and innovation required to gain business and remain competitive. This is a difficult task, especially for small and medium enterprises (SMEs). Although these times may bring many opportunities for suppliers, they are also disruptive and pose a great risk for those who fail to adapt.

This paper sets out the reasons why a framework could be useful for traditional automotive suppliers. The hypothesis is that a general guide could be adopted and implemented by those enterprises at risk, helping them to develop a long-term solution and to integrate electronic development into their core business successfully. To illustrate this path, this document will address some examples from the Basque automotive industry. Most of the analyzed companies have identified their problems and are aware of their electronic needs. Some of them are mature corporations which have implemented multiple strategies throughout their lifetime but are now struggling to include more electronic products in their portfolio.

2. Sources and Methods

The present research has its roots in a previous work, in which the current situation of the automotive sector was analyzed with a strong focus on tier 1 suppliers. It was observed that car manufacturers were introducing and demanding more and more electronic systems and, while traditional suppliers have their expertise in mechanical engineering, they lack sufficient knowledge of electronics and software engineering. That investigation consisted of a review of the state of the art.

The methodology used in this article was a qualitative approach. In a first stage, an in-depth analysis of the automotive sector was performed. To this end, not only scientific literature was reviewed, but also the reports developed by prestigious consultancies and technological companies, the specialized media and the press releases from manufacturers, associations, governmental institutions, and regulatory commissions. The conclusion of this work was that traditional automotive suppliers' business model was at risk, and they must innovate their products, electronics being one of the stronger trends. The second phase of this research intends to go further, and to provide a set of solutions that companies facing difficulties can apply to introduce electronic know-how into their businesses.

Tekniker has been a key player in this investigation, as it is a technology center with an automotive research line and in contact with the industry. Tekniker's relationship with its customers through the key account managers (KAMs) has allowed it direct contact with some companies and to know first-hand their concerns and needs. When possible, interviews between researchers and suppliers have been conducted. We have also relied on the work of the KAMs, who also know the particular needs of each customer through iterative consultations. Their labor has served to corroborate and complement the information. When this has not been possible, we have resorted to the analysis of press releases and catalogues that the suppliers themselves openly publish.

It is worth noting the importance of BATZ in the research. This company allowed us to visit its facilities and told us about its expansion into the global market and the problems it is facing in a changing environment. It also showed us some of the prototypes it is working on in its advanced engineering department, which is dedicated to R&D.

3. Literature Review

3.1. A Focus on the Automotive Suppliers' Problems

Tier 1 suppliers are going through difficulties. OEMs tend to delegate to them while putting pressure on them in terms of price, quality, and services, and demanding the best quality at the lowest price. Now, OEMs are increasing the number of parts, components, and systems to be outsourced too [25]. This could be a growth opportunity for suppliers, but the downside is that not all of them are prepared to take advantage of this scenario, while new competitors may emerge to fill the gap.

The automotive industry is highly competitive, and if the traditional players want to stay in business, they must apply some strategies, such as investing and researching in advanced materials, cutting down costs in their production chain, or ensuring the added value of their products. For example, if a supplier works with plastics, its options could be to research harder and lighter materials, improve its internal business processes to reduce manufacturing costs, or introduce new features to create added value, such as conductive plastics [26] or electronic systems to provide motion to those parts that used to be fixed.

These strategies are not easy to follow. Research into new materials and surfaces requires large investments and even cooperation with other companies or technology centres. Business process modification demands a thorough understanding of them [27] and the willingness of employees to accept change [28]. Additionally, introduction of new features needs to come from an innovative culture within the company's core [22].

OEMs are now relying too on the ability to integrate parts into comprehensive systems for tier 1 suppliers [29]. For automakers this strategy seeks to reduce the number of suppliers in the chain, but also to obtain other benefits, such as more efficient work and

lower costs. From suppliers' perspective, this will allow them to design, develop, and test their own systems, retaining a larger share of the added value of the final product.

This is a change of paradigm for suppliers: in the past they used to manufacture individual components and parts, now they are asked for integral systems. This is a threat, and some tier 1 suppliers may be relegated to tier 2 commodities manufacturers or even lose their business and close down. However, it can also be an opportunity to grow, which will allow suppliers to be closer to the OEMs and achieve the ultimate know-how. This will require new knowledge and specialization, above all in the field of automotive electronics. SMEs will be the most affected, since they are very focused on mechanics and will have more difficulties building electronics into the company's DNA.

3.2. Proposed Solutions to Create a Competitive Edge

The previous section has presented the changing situation in the automotive industry. In the following sections, different ways of coping with the new disturbances and challenges are shown. These options can even be combined if necessary. In this section, three different strategies are discussed.

3.2.1. Mergers and Acquisitions

A way to gain access to new resources and markets is through mergers and acquisitions (M&A). In a merger, two companies are combined and in an acquisition a corporation takes over another one [30]. Both are different but share the same principle, which states that two companies together create more value than being stand-alone [31]. M&A is an expansion and competitiveness-enhancing strategy. It helps a company move more quickly into a new market or product space or pursue a strategy that would otherwise be too costly, risky, or technologically advanced to achieve on its own. The aim of this manoeuver is to increase revenues, reduce costs, and make the firms globally competitive [31,32].

Before joining forces through M&A, it is essential to know the company's strategy and objectives. Valuing aspects such as the target's worth, the premium price to pay, or the transaction structure are not relevant without a business strategy. Acquisitors must investigate the potential partner's talent, organizational makeup, and behavioral and cultural factors [33]. Likewise, reasons to merge or acquire a company must be analyzed, and it must be completed only if there is a strategic force to do so. A narrow focus should be avoided and replaced by a clear picture of how both companies will be integrated and if both partners are compatible. In addition, experience counts too: companies that make more acquisitions are likely to identify the right targets more often [34].

There are multiple examples of automotive suppliers that have completed an M&A process. For example, the mega-supplier ZF Group acquired TRW which, among other products, was an expert in radar and computer vision technology and advanced electronic control units (ECUs) [35]. BorgWarner purchased Remy International, which had expertise in advanced electronics for turbocharged engines [35]. Yet another example is Harman, which acquired two software companies [35], due to OEMs' demand for connected infotainment systems, and was subsequently acquired by Samsung.

Carrying out an M&A is a complex process. Firstly, knowing the market and what other companies are working on is not always easy. Moreover, even when knowing the competitors there is a risk of targeting the wrong corporation, or that there is no interesting company to acquire, and even if there is the perfect company for M&A, there are more problems to consider. The culture of both companies should be similar or at least aligned with the same goals [36,37], and even in that scenario employees may fear change, which is the so-called merger syndrome. A failure example can be found in the Daimler-Chrysler merger, a story of betrayed expectations, culture clashes, and inability to retain top talent [38]. Figure 1 depicts what an ideal procurement should be like [39], but as explained above, in practice the process can be much more difficult.

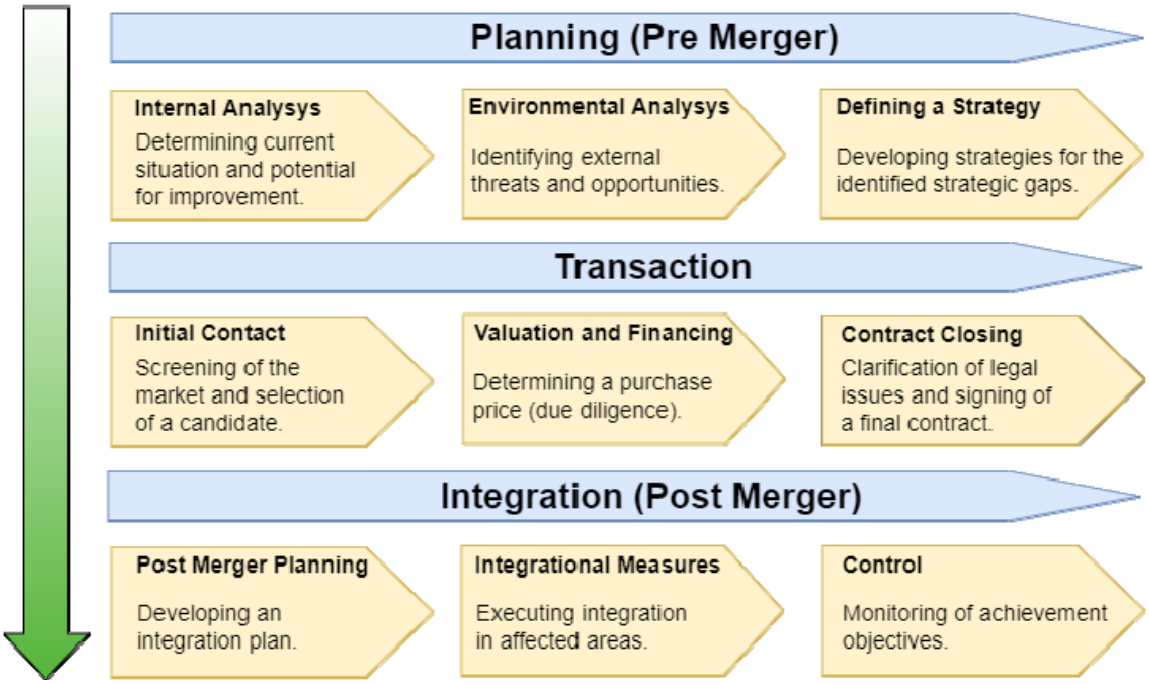

Figure 1. Transaction process: the three ideal phases of a takeover.

3.2.2. Outsourcing Management

The general definition of outsourcing is the act of transferring activities, traditionally done within a firm, to a third party. In this article, the general term will be used when this activity is developed within the country or nearby countries which share a similar culture. When outsourcing takes place in distant foreign countries, with a different culture and lower wages, the term *offshoring* will be used instead.

Corporations expect to gain a competitive advantage from outsourcing. While cost reduction is the main reason for outsourcing [40], the second reason is to access skills not found in-house [41]. Many corporations rely on an external provider to maximize operational efficiency by focusing on those activities that are the main source of a company's profits and success [40], also known as its "core business".

Identifying the core competencies is a difficult task [42]. The corporation must note those factors which make it different from the competitors, picking out the fields in which it excels. If the company cannot perform this task, it may mean it has nothing special to offer compared to other corporations, which puts it in a weak and easily attackable market position. In this case, the corporation must determine which gap it can fill and how to develop unique skills to specialize in and create added value.

Companies tends to outsource those activities which are not their core business [40]. The reason for this is that the core activities should be protected and remain secret. This mitigates the risk of them being leaked or imitated by competitors. As an example, multinational companies are offshoring contact centers, data entry, finance and accounting, human resource services, and everything else that involves little attention and management involvement [40]. All of them are non-core activities, and companies are looking to bring their cost down, but offshoring might have other inconvenient outcomes such as a poorer customer care or lower quality of service.

Addressing this topic from the automotive supplier point of view, a tier 1 supplier can outsource in three different ways:

- Outsource some parts to other manufacturers. When a tier 1 supplier is working on an integrated system, there are parts or components that can be outsourced, which is the case of Magna with active aerodynamic solutions. Its core business is plastics, so the corporation outsources the actuators from an external partner.

- Outsource to technology centers for electronic development. In some situations, tier 1 suppliers may lack knowledge in some areas and is difficult for them to research in-house. These institutions focus their activity on the generation, transfer, and diffusion of technological innovation [43]. Even giants like Bosch or Continental work with R&D centers on projects such as software development, ADAS, and braking systems [43].
- Outsource to other regions (offshore outsourcing). This may have multiple reasons. The tier 1 suppliers are interested in being close to the factories of the OEMs they work with. This reduces costs in the supply chain and if there is any problem with a product, clients can visit the plant and discuss it. Furthermore, is an expansive policy. Another reason is that labor might be cheaper in other countries. Global suppliers usually have manufacturers close to the OEM's plants. For example, when Hyundai opened an assembly plant in Alabama it attracted a lot of suppliers. Lear was one of them, which built a "state-of-the-art" seating factory to supply seat sets exclusively for the South Korean manufacturer, located just minutes away by truck [44].

Outsourcing electronic development could be a temporary solution, but not a permanent one. Nowadays, suppliers are asked for parts with electronic functions, so they must integrate electronics into their core business. Outsourcing can be done when it is cheaper to acquire some parts from other suppliers or when the company lacks the expertise to design and produce electronic products. For traditional manufacturers, it can be an intermediate step in the transition to mechatronics, but they must be aware that implementing this strategy means that the tier 1 supplier is dependent on third parties for the development of its products. Figure 2 shows what the outsourcing life cycle typically looks like [45].

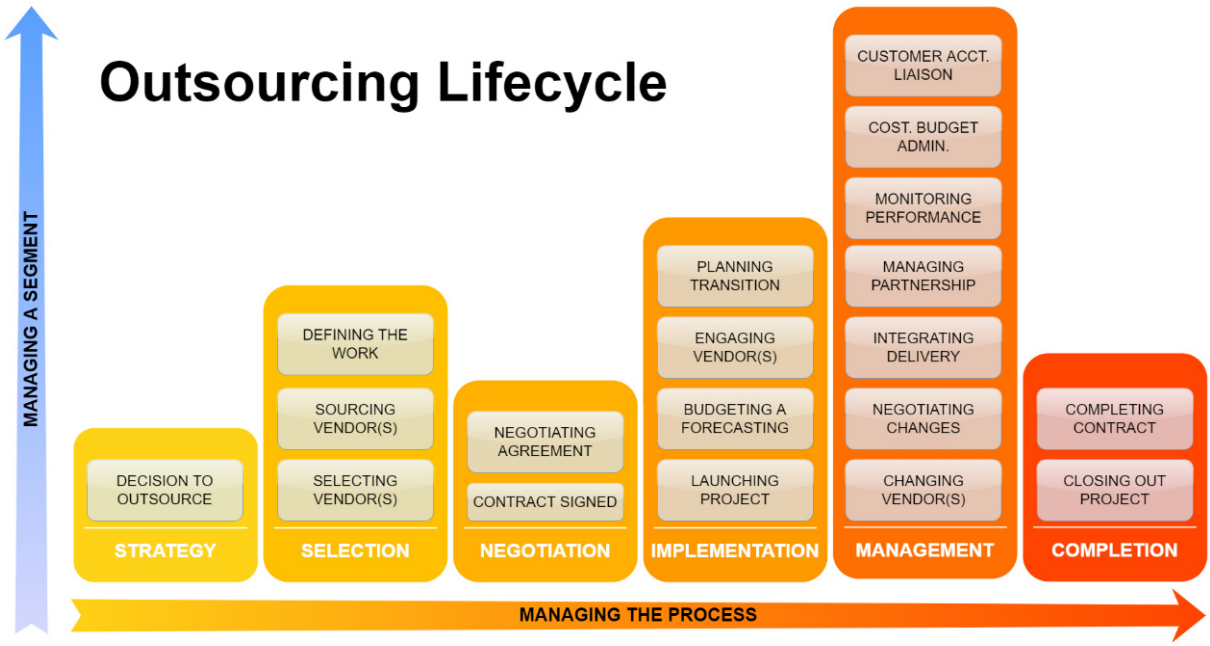

Figure 2. Outsourcing lifecycle: the exposed framework consists of six different phases and helps to identify gaps or missing processes.

3.2.3. Organic Growth

M&A and outsourcing are forms of inorganic growth, both relying on available resources and capital. On the other side, organic growth consists of using the available resources in the organization, such as knowledge, experience, and partnerships to expand the business.

One of the advantages of organic growth is the enterprise develops new knowledge and abilities. In this case, traditional suppliers which used to make mechanical parts for OEMs have to include electronics in their products. Learning new skills in-house makes the corporation self-reliant, so it does not depend so much on third parties for the electronic nor

software development. On the other hand, workers fear change, and organic growth brings with it a reengineering process. Employees will have to develop new skills, work with new environments, and learn the mandatory regulations for automotive systems. Business processes also could be modified to be more efficient. All this requires time and training. It is a long process, but in the end it is fruitful.

On the other side, organic growth also has its drawbacks. The results of this strategy take longer to be seen, as it is a lineal growth [31]. This could be dangerous and create serious problems if the corporation falls behind and loses market share while competitors grow rapidly. Poor planning can also lead to insufficient resources to achieve the objectives set.

Organic growth is a very broad concept, applicable to any area of the corporation. Every part of the organization can be improved from within. If it is of concern to the internal processes, they can be reformulated or even abolished. Manufacturing techniques can be improved too, by simplifying the production chain or optimizing resources' utilization. Marketing is also important: a good catalogue focused on the target customers can increase sales and even allow the corporation to enter new markets. This is also possible through innovation and new product development, which can increase the market share too. Keeping a good relationship with customers enhances the experience and can lead to a long-term relationship. Although most OEMs tend to look for the best deal, others seek mutually beneficial relationships, in which both cooperate to reach the same goals. Finally, the warehousing and delivery chain often have high costs that can be improved too. Lean manufacturing is one strategy to make these processes more efficient.

Systematic research leads to new knowledge that can be the foundation for organic growth [46], and universities and technology centers can act as catalysts for this purpose. These kinds of institutions develop research or projects the corporation cannot complete due to a lack of expertise, and they frequently are open to outsourcing and generating and transferring knowledge to the corporations, creating a thriving industrial ecosystem. Their role is also to stimulate the economic growth of surrounding companies, thus creating a strong and competitive industrial fabric. Governments, public and private bodies, and foundations in countries around the world also fund knowledge creation, especially in science, in an effort to fuel the economy [46].

To grow, it is important to analyze the company's past performance, to identify those actions that worked and brought good results for the corporation. There is a strategy called *repeatability* [47], which emphasizes three pillars: focus on the core business, share a common culture and values from top management to frontline employees, and have continuous improvement processes and measurement systems. This strategy holds that the development of a repeatable model in the company will increase the level of innovation and bring organic growth. In the automotive sector, a good example of repeatability is Toyota [47]. It not only developed its own production system but also pioneered lean production system [48]. When this worked for Toyota, it repeated the same for all its factories. In its repeatable model, it also learned from mistakes. For example, in 2011 there was an earthquake in eastern Japan that affected the semiconductor supply chain, and due to just-in-time policies the automaker's production fell by 78% [49]. In 2021 there was also a shortage of semiconductors, and while other vehicle manufacturers were facing this situation, Toyota had several mechanisms to overcome the crisis [50] such as stockpiling chips, reviewing its semiconductor supply, and alternative products, (which makes shifting to a new product easier when needed) or collaborating with suppliers to find a solution to the problems.

Scania also has a repetitive model based on continuous improvement [47]. Like Toyota, it replicated the same model with all its manufactures. If someone in one of the factories finds a better way of doing something, they communicate it, and it is then applied to the other plants.

Some suppliers have completed this step successfully, following a strategy in which they focused on the development of high-added-value complex systems. This is a major change, since most suppliers have been working on products that did not require any

system engineering. Now, they must build a real system culture inside the corporation. The Figure 3 pretends to represent how working on organic growth can differentiate a company from its competitors, bringing prosperity to the corporation.

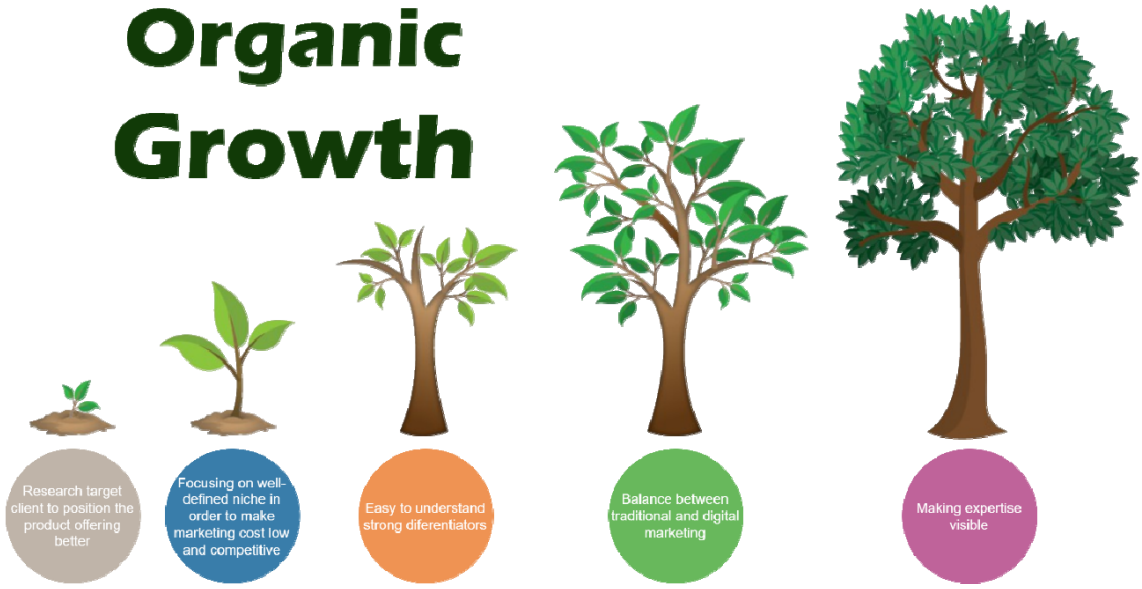

Figure 3. Driving process for organic growth: the evolutionary path.

3.3. Examples from the Basque Industry

The automotive sector is strong in Basque country (Northern Spain), with more than 300 corporations in the business. Many of them face the problems outlined in this article: lack of knowledge in the field of electronics and uncertainty about the future of the automotive industry.

3.3.1. BATZ Case

BATZ is a world-class products and services supplier for the automotive sector. It is headquartered in Igorre and is part of Mondragon Corporation, the largest cooperative industrial group worldwide. This company has a long history. It began in 1963 in the stamping dies market, designing, manufacturing, trying out, and maintaining automotive tooling. Two decades later, BATZ Automotive Systems started its activity oriented to serial products manufacturing, offering competitive solutions to the global market, starting the development from customers' concept designs. This company has also entered in the aerospace market, diversifying its activity from the automotive sector, but taking advantage of expertise in its core capabilities, such as weight reduction through advanced materials and hot forming.

To stay close to the OEMs and create new opportunities in foreign markets, BATZ has also accomplished a successful internationalization project. The Basque firm has expanded globally, building new plants through commercial agreements in strategic geographical locations.

The first overseas plant was located in Kunshan (China), where there is an automotive cluster and plants of Geely, SAIC Volkswagen (a joint venture of both manufacturers) and Stellantis, the latter situated in the vicinity, to name a few. In addition, some OEMs have also established R&D and design centers aiming to develop specific models for the Chinese market [51]. This is not the only market in which BATZ has opened a factory; it has done the same in countries such as Mexico and the Czech Republic.

Joint ventures have been another strategy of BATZ. This is how it entered the Turkish and Korean markets, co-operating with local companies from the respective countries. Both are strategic places. In the case of Turkey, the chosen location was Bursa, where the plants of manufactures such as Renault, FIAT, PSA, and Hyundai are located, and it is close to the largest automotive cluster in the country. In Korea, the nearby manufacturers

are General Motors and SsangYong. Being close to the OEMs reduces transport costs and avoids shortages.

BATZ also knows when it makes sense to acquire a business. FPK was a company established in 1993. It offered lightweight and safe systems to the global automotive market and had a long history of co-operation with BATZ. In 2010, it was acquired by BATZ, and rebranded in 2017 as BATZ Zamudio. This move was intended to add new capabilities and expertise to the corporation, especially in the use of new materials and technologies to reduce the CO_2 emissions through vehicle weight reduction.

As can be appreciated, throughout BATZ's history, change and growth have been intrinsic to its DNA. It has successfully experienced internationalization, joint ventures, acquisitions, and organic growth. Now, BATZ must take the plunge once again. In the current situation the automotive sector is going through, suppliers need electronic know-how and to offer mechatronics in their catalogues. This corporation is well aware of this challenge and has already begun to take care of it.

The chosen strategy this time is organic growth. To achieve it, BATZ has set up an electronic department within the company and hired new employees. At the same time, it is co-operating with technological institutes and universities, in order to research and apply its know-how to the corporation. This has led it to participate in national programmes that promote innovation and technological development, helping and supporting R&D projects of Spanish companies with the aim of contributing to the improvement of the technological level. Through this participation it has developed the project NG-PED (Next Generation Pedal) [52]. It is its first fully functional prototype of a brake-by-wire system, totally electronic, without mechanical attachments to the vehicle's brakes. This project has generated interest among some OEMs.

This is not the first time BATZ has pursued an organic growth strategy. In the past it has carried out other projects to cut down costs and optimise the company's processes. Just to enumerate a couple of them: BATZ implemented the Kanban methodology in its automotive systems plant [53]; through this optimization it achieved a better control over the production chain, a reduction of the space and time needed to store a part in the warehouse. In addition, it also achieved a better management of fluctuations in product demand. BATZ also focuses on the optimization of its existing manufacturing processes, one of its internal projects being the reduction of fluid coolant (*taladrina*) consumption, a very toxic and contaminating residue used in metalworking processes, such as machining and stamping.

BATZ is under the umbrella of the Mondragon Corporation, whose internal cooperative structure is unique in the world. It has its own universities and research institutes, which work closely together to support the conglomerate of companies. In the same vein, the culture of innovation is also closely linked to the Basque country, where there is a large network of research and innovation centers geared towards promoting business competitiveness, with the aim of consolidating a modern and wealthy economy.

3.3.2. Additional Examples

OEMs seek differentiation in all aspects of their vehicles. A current example is plastic trim and interior decoration. In the past, tier 1 suppliers needed only plastics expertise, but now this is not enough. Car manufacturers are asking for details such as backlighting on the badges of their cars [54,55], and customizable colored lighting in the vehicle interior [56] or intelligent surfaces. One Basque company facing these challenges is Maier, which has opened its fabrication laboratory (fab lab) to innovate components for the cars of the future [57,58].

This corporation has been providing plastic solutions for car manufacturers since 1975. Throughout its history, it has established more plants and research centers in Spain. In 2000, it began its European expansion, opening new plants in the UK, Czech Republic, and Italy. In the past decade, Maier has established a manufacturing and a technological center in India and China, and a factory in Mexico. It is now a global corporation. Its new fab lab

will allow it to research and innovate in technologies applied to optical-electronic solutions, sensorization and active systems, and will employ 50 highly qualified professionals [57]. Maier is advocating for organic growth to generate in-house knowledge and face the upcoming challenges. Maier has also participated in regional programs for R&I. A project it led was LIT-SENS [59], which aimed to develop revolutionary new functional and esthetic products through research into novel lighting and sensing technologies to meet current and future market needs. The following images in Figure 4a,b from Mercedes-Benz [54] and Renault [60] online press rooms' illustrates the future of decorative lightning.

(**a**) (**b**)

Figure 4. This figure shows how decorations are being upgraded with electronic components, such as LED illumination: (**a**) illuminated badge on a 2016 Mercedes-Benz GLE (W166); (**b**) illuminated rear badge on the next Renault 5.

Continuing with esthetic features, some OEMs are requesting projections on their headlamps. This can be achieved by using matrix LED technology [61]. However, this feature can also be used to project warning symbols and light markings on the road to warn drivers of dangerous situations [62], an example can be seen on Figure 5 [63]. Replacing traditional bulbs with LED light requires new knowledge, and when it comes to adding new functionalities, even more. There are some experts, such as Hella or Osram, that have developed a successful system, although the resolution of the images is still quite low [64]. In the Basque industry, Alkar is a lighting expert. This corporation has introduced LED lighting in its catalogue, but LED matrix innovation is not yet part of its expertise.

New market trends and future forecasts contribute to the emergence of new developments in an ecosystem as innovative as the Basque one. EVs bring more changes than just to the powertrain; the braking system is one of them. EVs use regenerative braking to improve efficiency, and unlike combustion cars, traditional braking is only used 20% of the time. In these circumstances there are two problems, corrosion and weight. Fagor Ederlan has proposed and developed an aluminum drum brake to solve these problems [65]. The drum brake is less exposed to moisture and other corrosive elements, and aluminum is a lightweight metal that contributes to reducing the overall weight of the vehicle [66]. It is not uncommon to see drum brakes in an electric vehicle, one example being the Volkswagen ID.3. On the other hand, the autonomous vehicle is also a challenge for the industry. Oribay is a Basque company that specializes in windshields and is taking care of these issues. In the past there was only one element on the windshield, the mirror, but nowadays there are more and more devices mounted on this part of the car, such as rain sensors and ADAS. The company is researching and developing new products, such as flexible circuits, anti-fog and anti-ice heating, camera integration, and even power electronics. Both companies are currently pursuing a policy of organic growth, trying to generate internal knowledge in new areas and sometimes turning to local technology centers.

Figure 5. Car projecting a symbol onto the road. The LED matrix makes trailblazing driving assistance possible.

4. Findings

Inventions and technological change are the major driving forces of economic and industrial growth [67]. The automobile industry is going through another era of revolutionary change, which is being driven by the penetration of information technology (IT) in the vehicle sector [68]. Traditional assemblers and manufacturers in the vehicle supply chain face potentially severe competition from industry-leading IT hardware and software companies.

In this research we have identified electronics as the main trend in automotive technological change. Possibilities are immense, any system can be modified to include electronics, from something as simple as the sun visor [69] or the tyres [70] to more complex systems such as the engine control or advanced driving assistance systems (ADAS). With vehicle electrification and new mandatory safety systems in Europe [71], the number of electronic systems will increase. In fact, in 2030, it is forecasted that on average, electronic systems will account for half of the total price of a new car [12].

We have also noticed that companies are suffering from the same problems and share the same concerns, regardless of their market niche. Whether the organization manufactures pedals, suspension systems, plastics or headlamps, the market demands innovative products in their catalogues, with new features and added value, and they face the same problems because they are asked to provide a product with features in which they have no previous experience. In the Basque ecosystem, it has been observed that there is an important link between companies and technology centers, but these corporations are aware that they cannot always depend on a third party and that they must be able to generate knowledge themselves and integrate it into the company's know-how.

Under these threats traditional tier 1 companies must make a choice. Our proposal in this article consists of applying organic growth, as we consider it is an effective and long-lasting solution. Some of the analyzed companies are already adopting this discipline.

Organic growth is not immediate but requires going through several phases. In the first place, the corporation needs to have a global vision of itself. It needs a clear definition of what it is, where it is, which are its problems, and how it intends to solve them. In this

scenario, the enterprise can ask its partners and customers, conducting research to gain insights into what it is doing well and what needs to be improved.

Once the company has gained this knowledge, the second phase is to focus on the market. After the research, the enterprise should perceive which are its strengths and weaknesses and the market demand. It may be even a good idea to focus on a well-defined niche. In the automotive industry OEMs are looking for price and quality, and there is stiff competition among suppliers worldwide. Becoming an expert in a small field and manufacturing high-value-added goods can differentiate the product from commodities, avoiding a price war with cheaper competitors.

To generate added value, mastery is a must. The corporation needs a capable, qualified, and skilled workforce. In the end it is the people who can bring change and prosperity to a corporation, otherwise it would be impossible to apply organic growth. Talent acquisition is essential too, but the corporation must create a good environment in which employees can gain experience and grow personally and professionally, feeling engaged and valued.

Introducing Industry 4.0 (I4.0) in the organization may ensure a strategic role in maintaining competitiveness [72]. It offers relevant improvements in terms of productivity, efficiency, flexibility, and product quality [72,73]. During the investigation, it has been observed that some companies are already using new technologies such as 3D printing for prototyping and digital twins. In addition, the exchange of real-time information related to demand, inventory, quality, and production schedules strengthens coordination between partners and reduces supply chain costs [73,74]. It also impacts advanced manufacturing, leveraging technologies such as cyber-physical systems (CPS), internet of things (IoT), robotics, big data, and cloud computing [75]. While this is not strictly necessary, it is the future. Large companies have a wider application of these technologies [72], which puts them in an advantageous position and helps them to make better decisions than SMEs. Meanwhile, smaller companies also have the handicap of limited human resources and lack of specific technological skills [76]. Successful adoption of I4.0 requires a proactive approach to innovation, the development of long-term partnerships with technology providers, and the early involvement of workers in technological change [72].

Manufacturing innovative quality products and being a market expert is not enough if the message does not reach potential customers. Marketing and relationships are important, and the company must develop strategies to advertise and sell its products. On the other hand, expertise is a differentiator, but is intangible; making it visible is a challenge. This can be done through a carefully targeted and constructed campaign of blogging and article writing, speaking engagements, social media conversations, and search engine optimization (SEO). Organizations should pay attention to this, as it has been found that not all the companies analyzed have a good marketing campaign. Some of them have the potential to carry out outstanding internal projects but fail at showing this capability to their target audience.

To keep on generating revenue, organic growth must carry on. One way to sustain it is to reinvest in the company, as it will allow for more opportunities, including hiring new employees or acquiring new equipment. Having a solid next generation reinvestment plan is important for business of all types.

As the automotive industry is undergoing a period of market turbulence and rapid technological change, the hypothesis presented in this paper is that organic growth may be the best solution. Nevertheless, organic growth is a set of strategies to maximize the business performance, and each corporation must choose which of the available strategies fits best. In the case of the automotive industry, there are many suppliers facing the same problem, a lack of electronic know-how in the company. The proposal is to develop a unitary framework that simplifies the transition of suppliers from mechanical engineering to mechatronics.

5. Discussion

This research has explained how electronics is a growing trend. Currently, more than 90% of vehicle innovations are electronic [77]. This has meant that companies that were not previously in the automotive sector have found new business and traditional parts suppliers feel threatened by their arrival.

Vehicle components have evolved, and even the most basic vehicle components now have advanced functionalities thanks to the integration of electronics. This leap means that many companies, which manufacture very different products, have a common problem.

The analysis has shown that many of these companies, faced with a lack of electronic knowledge, have sought help and advice from technology centers. Some have recognized their shortcomings and are trying to solve them through organic growth.

Analyzing these findings, it is believed that, although these companies have not been pioneers in the integration of electronics in their products, this does not mean that it is too late to make the leap to mechatronics. Although some of them have a deep-rooted perception that they are lagging behind, there is still time to seize this opportunity and acquire this knowledge.

Achieving this goal is important not only for these companies, but for the economy. The automotive sector is strategic in many places, both regionally and nationally. Close to the parts manufacturers there is an auxiliary industry that supplies these factories. In the same way, the whole of this industry generates employment in the region and its surroundings, enriching the area. Furthermore, the automotive sector accounts for a significant percentage of the gross domestic product (GDP) in those countries that have this industry. It is important for economic development that these companies adopt technology and remain competitive.

This article looks at organic growth as a way of creating new knowledge and skills in a company facing the problems mentioned above. The analysis shows how some companies have already chosen this option.

The general idea is that companies start to build up their own electronics department, and that by working together they manage to integrate electronic developments into mechanical components.

This is not an easy task, as functional safety is of the utmost importance in the automotive industry. However, it has been observed that some companies have made use of industrial technology development programs offered by various public institutions at regional, national, and European level. Through subsidized projects, companies can take on innovative developments with very low risks and gain valuable knowledge.

Participating in subsidized projects is useful to learn and obtain a strategic positioning that can lead to customers offers or requests. It has been observed that it is not always possible to make OEMs aware of the capabilities of tier 1 companies. One of the learning objectives must be to gain communication skills that allow them to get closer to the customer.

6. Conclusions and Future Work

In the previous research, disruptions in the automotive sector have been identified. OEMs and suppliers are coping with different issues and actors, and they must embrace the changes and challenges and reinvent themselves. This time they must incorporate electronic skills into their business to remain competitive. To do so, three options have been proposed: M&A, outsourcing management, and organic growth. This sector is special and has its own particularities; tier 1 suppliers are demanded to manufacture cheap, competitive, reliable, and differentiated parts. This paper aims to fill the gap in business management by focusing on automotive suppliers and hypothesizes that a unified framework for implementing organic growth in these corporations will help them introduce electronic mastery while complying with different standards and regulations.

To illustrate the three strategies identified, some cases of companies that have implemented them have been mentioned. Some of them were successful, others were not. In the

research, we identified mergers and acquisitions as the most risky and difficult, as they require an interesting corporation to merge with or acquire and both to be aligned. Despite the drawbacks, it is often the fastest way to grow business. On the other hand, outsourcing can be a good decision, but in the end the company still has the same problem; it lacks electronic expertise and relies on third parties to develop its projects. However, it can be seen as an intermediate step. In the end, we highlight the organic growth strategy as the most appropriate. If done correctly, it will allow the company to gain experience in a new field and become self-reliant. It will have a better long-term impact.

The research emphasizes the difficulties that an automotive company must go through in order to make the leap from mechanical engineering to electronics. Therefore, it highlights the need for an application framework that provides guidelines for implementing this change in the company. This paper also presents the BATZ Group case. This company, which has successfully applied M&A and outsourcing in the past, is now in the process of implementing organic growth to continue to offer innovative products in a changing and challenging market. The same path has been followed by other companies that were also included among the examples analyzed.

Through this study and the responses obtained from some suppliers, it has been observed that there is a common problem that they are unable to deal with. They need to introduce electronics, but not only in their products, but also in the company. They are facing totally new and different developments from what they were used to, and in addition, the OEMs are asking them to comply with standards they are not familiar with. If they do not make the move to mechatronics, they could be relegated to commodity manufacturers or even disappear, with significant economic consequences in the near environment.

This study aims to fill a gap in industrial re-engineering and innovation management regarding the automotive sector. This is an exceptional case, as it faces major changes in a very short time and is economically strategic. The analysis carried out contributes to disseminating the problems suffered by parts suppliers, with a focus on the Basque industry. It also provides solutions that could be adopted by these companies to acquire digital knowledge and implement it in their core business, although additional work is required.

The study advocates for organic growth, but each company will have to decide which model best suits its situation. It should be borne in mind that the introduction of automotive electronics must be accompanied by very strict functional safety requirements. This work has not covered this aspect in depth, but it leaves open a future line of research to study the standards and processes that affect tier 1 suppliers, and to provide a solution to unify them to the extent possible.

The future research will focus on and take BATZ as a reference example. A framework will be designed and implemented in this company, with the aim that it can be used by any automotive supplier that is going through the same problem. The aim is to successfully introduce electronic engineering skills into the company's core business, so that it can develop in-house electronic projects, designing the hardware and developing the software itself.

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