
Technological Quality of Suppliers in the Automotive Industry: A Case Study

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Abstract:

Purpose: Hence, the research problem of the work is to identify the issues of the directions of changes and trends in the automotive industry in the long term by suppliers in the field of the development of new technologies. In turn, the aim of the work is to present the results of own research on the applied solutions in the field of new technologies development by a direct supplier of level 05 (System integrator MAHLE group – herd case) to companies producing vehicles in the automotive industry.

Methodology: The research was carried out using the monographic method and the method of examining documents using the technique of examining documents, participant observation and expert interview.

Findings: The directions of changes and trends in the automotive industry in the perspective of 2030 discussed in this paper are the beginning of changes in the technological quality of suppliers.

Practical Implications: You can observe a growing trend related to the departure from the traditional reactive quality strategy to proactive, which uses new generation automation, communication and collaboration technologies based on the functions of various software and their modules, e.g., in the field of quality management software (EQMS).

Originality/value: The current relationships between vehicle manufacturers and suppliers in the automotive industry have changed significantly, mainly due to new technologies related to the development of vehicles powered by alternative power sources.

Keywords: Technological quality, automotive industry suppliers.

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1. Introduction

Today's environment of the automotive industry is characterized by high volatility, complexity and uncertainty, and its elements interpenetrate and affect the industry. Currently, vehicle manufacturers and their suppliers must cope with global changes in the environment, respond to changing customer needs and create, in particular, conditions for introducing changes in the long-term perspective (industrialization and urbanization in the economies of emerging markets, regulations and sustainable development policy, changing data demographic and new technologies). To this day, the industry is struggling not only with the reduction of global demand, but also with the issue of continuity of supplies after the COVID-19 pandemic, which may further lead to a recession or increased activity in the field of mergers and acquisitions.

The changes in the automotive industry companies so far result not only from technological development and innovations (diversified mobility, autonomous driving, electrification, and connectivity), but also from shortening the product life cycle, reducing production costs and shorter delivery times. The industry's tendencies to search for effective production methods are also important for suppliers (Ambroziak, 2017; Berret *et al.*, 2018; Łuczak and Matuszak-Flejszman, 2007; Naukaibiznes, 2020). The constantly growing competition within the industry prompts car manufacturers and their suppliers to intensively search for more and more effective methods and tools to support management processes. This is to be achieved, *inter alia*, by the development of ERP (Enterprise Resource Planning) information and information systems, the purpose of which is to integrate all processes taking place in the organization (Gruszka, 2020).

The research problem of the thesis is the recognition of the problems of the directions of changes and trends in the automotive industry in the long term by suppliers in the field of the development of new technologies.

The aim of the work is to present the results of research on applied solutions in the field of the development of new technologies by a direct supplier of level 05 (System integrator, MAHLE group - herd case) to companies producing vehicles in the automotive industry. The research was carried out using the monographic method and the method of examining documents using the technique of examining documents, participant observation and expert interview. The research primarily included information in a qualitative and descriptive form, which was aimed at exploring the distinguished features and elements of the strategic orientation of the MAHLE group, which carries out the subject of tasks resulting from the impact of mega-technological trends on the automotive industry (Gruszka, 2020; Mahle International GmbH, 2019).

2. Directions of Changes and Trends in the Automotive Industry

2.1 Factors of Change

The results of global studies conducted by the companies: Deloitte (2019; 2020), KPMG's (2013; 2017; 2018; 2019), McKinsey Company (2016), PZPM (2017; 2018; 2019) and studies by independent companies (Berret *et al.*, 2018; McKinsey Company,

2016) indicate that in the long term in 2030, the automotive industry will be influenced by 4 mega trends:

- Industrialization and urbanization in emerging market economies (BRIC Brazil, Russia, India, and China),
- Regulations and sustainable development policy,
- Changing demographics and consumer preferences,
- New technologies (digitization, internet of things, industry 4.0).

The main factors of change in KPMG's report (2013) include:

1. Growth and globalization. In the existing major markets, the global automotive industry will have to make greater use of the opportunities arising from globalization and the development of emerging markets in the long term. Representatives of the global automotive industry agree that the BRIC markets (Brazil, Russia, India, China) have the best long-term prospects for car sales growth.
2. Environmental challenges – this is an increasing emphasis on environmental protection, further optimization of internal combustion engines and the development of electric drives. The focus will be on hybrid technologies (a car equipped with an internal combustion engine and one or several electric motors), especially plug-in (Plug-in Hybrid Electro Vehicle). Battery Electric Vehicle (BEV) will be more popular than Fuel Cell Electric Vehicles (FCEV) solutions.
3. Changing consumer behavior – consumers are looking for economic solutions, innovation in terms of safety, ergonomic solutions, comfort, and the use of environmentally friendly technologies. They also require additional services related to internet connectivity and electromobility (Figure 1). The key issues are ease of loading the vehicle and its range and durability, optimal purchase options, in particular for crediting the purchase (e.g., leasing or long-term rental)

Figure 1. Breakthrough technological trends in the automotive industry in the perspective of 2030



Source: Ebrahim et al., 2019.

3. Urbanization – the progressive urbanization and development of mega-cities will require new solutions, both in the field of city car design and new models of mobility solutions, for example on demand (Mobility-as-a-Service – MaaS). Most industry representatives believe MaaS will become a viable alternative to owning a car in the city in the future. The car will become more part of the entire mobility system than a means of transport.

2.2 Development of Markets for Vehicles Powered by Alternative Power Sources

According to forecasts, in the coming years the main type of propulsion used in cars will still be gasoline and diesel engines, but their share will be systematically decreasing. The reduction in the number of vehicles running on these types of fuels will be replaced by an increase in the number of vehicles powered by alternative energy sources (also known as green vehicles).

These are vehicles of the following type, PHEV (Plug-in Hybrid Electro Vehicle), equipped with an electric and internal combustion engine that work in parallel, BEV (Battery Electric Vehicle) – a vehicle equipped only with an electric motor and powered by batteries, FCEV (Fuel Cell Electric Vehicles) – an electric vehicle powered by a hydrogen fuel cell (PZPM, 2019; KPMG International, 2013; 2017; 2018; 2019). Currently, hybrid drives are in the lead. Hybrid drive, despite the existing growth potential, must be treated as a temporary solution, until the technology and infrastructure allow the use of electric cars in everyday use.

2.3 Main Trends

The main trends that will affect the changes in the automotive industry by 2030 (KPMG International, 2013; PZPM, 2019; Łuczak and Małys, 2016) include:

- New business models – the automotive revenue pool will increase significantly and diversify into on-demand mobility and data-driven services.
- The emergence of the car-sharing and mobility-matching market - changing consumer preferences, tightening regulations and technological breakthroughs are all contributing to a fundamental change in individual mobility behavior.
- Some cities will replace "country or region" as the most appropriate segmentation dimension that determines mobility behavior – understanding what future business opportunities are requires a detailed look at mobility markets: by city type based mainly on population density, economic development, and prosperity. For example, in mega-cities such as London, car ownership is a burden for many consumers due to additional fees, lack of parking and traffic jams, while in rural areas, the private car will remain the preferred means of transport.
- Sale of new fully autonomous cars - the first technological and regulatory issues have been resolved.
- Advanced Driver Assistance System (ADAS).

2.4 Strategic Importance of Relationships with Suppliers in the Development of New Technologies

The level of cooperation between vehicle manufacturers and suppliers has increased significantly over the last two decades. Technologies are advancing rapidly, vehicle suppliers and manufacturers work directly together, from the concept stage, to set cost targets and share product development (e.g., electric, and autonomous vehicle designs). Currently, it is estimated that almost half of the suppliers are involved in the design of system solutions for assemblies, sub-assemblies, or parts.

Hence, a new tier of suppliers appears as system integrators in the traditional supplier pyramid (Figures 2, 3a). The system integrator deals with the development and integration of many modules and systems. thanks to specialized solutions for vehicle manufacturers. System integrators manage projects and programs with vehicle manufacturers and other suppliers. These companies have many research centers, and they also owe their success to their supply chain management strategies. A well-known system integrator is for example Continental.

Relations between vehicle manufacturers and suppliers are gaining strategic importance, primarily in the following areas:

- Strengthen regional integration within global value chains by shifting vehicle production to lower-cost countries (Western Europe - Central and Eastern Europe and Spain, North America - Mexico and Central America, East Asian countries – Southeast Asian countries); and Consolidation of vehicle manufacturers (OEM) is progressing, Toyota's leadership is shifting to VW, which, inter alia, took control of the MAN concern, Scania.

Figure 2. Diagram of changes in the pyramid of suppliers to vehicle manufacturers in relation to this with the entry of new technologies



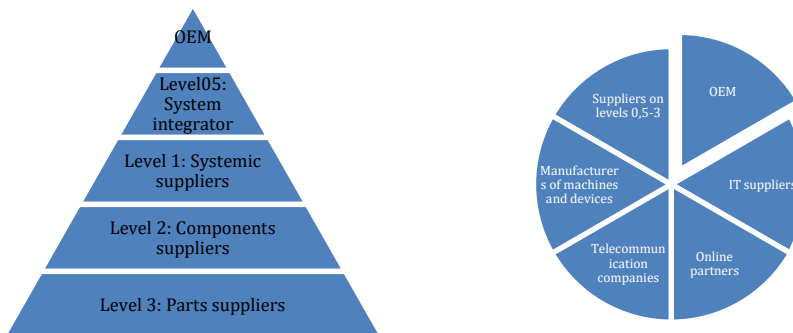
Source: Arthur D. Little, 2019.

- Concentration of direct suppliers around vehicle manufacturers, mainly due to the reduction of the costs of trade, which is usually duty-free within individual regional blocks (e.g., Central European countries – Hungary, Poland, and the Czech Republic, strongly integrated with the German automotive industry).
- Progressive standardization of car production as a response to ever shorter product life cycles. The essence of this solution is the share of the same components in many types of car models. For example, the VW concern uses:
 - MQB (Modularen Querbaukasten - models Audi A1, A3, TT, Seat, Skoda...) for assembly in their factories. Vehicle manufacturers are strengthening their position in the electric vehicle segment with new modular platforms specially designed for electric cars. VW uses a free-standing MEB platform (Modular Electric Drive Kit). Similar directions of changes are used, for example, by BMW, Jaguar Land Rover and PSA Group in the field of flexible platforms (KPMG International, 2013; Łuczak and Małys, 2016).
 - The start of production of hybrid and electric or plug-in vehicles has led to the creation of a new supply chain to produce this type of vehicle. The role of suppliers and their position in the supplier pyramid are changing, which is illustrated in Figure 3b (Arthur D. Little, 2019; Brandes *et al.*, 2013; Muzyczka, 2011).

In the future, the traditional supplier pyramid is likely to turn into a hub-spoke network structure (Model Hub and Spoke – Figure 3b). Model assuming the existence of a transport node (hub) and the radial transport lines (spokes) that supply it. Transport within this system takes place first to the transport node, and then from the node to the selected destination. The hub transport model is often used in air transport (airports, Atlanta-Hartsfield-Jackson, Dubai, Heathrow, and Hong Kong) and in rail transport (e.g., in France, Paris plays the role of a TGV junction).

The development of new technologies is becoming a source of new entrants to the automotive market, including technology companies providing connectivity solutions for car-sharing, ride-sharing platforms, and providers of other transport services.

Figure 3. Model of the supply chain change strategy from the form of a traditional pyramid (a) to a network structure (b) based on the "hub and spokes" model (Model Hub and Spok)



Source: Own elaboration based on KPMG International data (KPMG International, 2013).

3. Methodology and Research Results

3.1 Methodology

The adopted research methodology and technique consisted in a detailed study of an individual case (MAHLE group - herd case) in the field of solutions for future mobility, which is a direct supplier of level 05 (System integrator) to companies producing vehicles in the automotive industry. The research was carried out using the monographic method and the method of examining documents using the technique of examining documents, participant observation and expert interview.

The research primarily included information in a qualitative and descriptive form, which was aimed at exploring the distinguished features and elements of the business structure, management system and the quality of technological processes. The result of the research is this article referring to a specific case (case study).

3.2 Research Results

The MAHLE Group is a leading international supplier of products to the automotive industry and a pioneer in mobility for the future. It implements the dual strategy of today and tomorrow, which includes strengthening the current market position and building the future in the changing world of mobility (Figure 4).

Figure 4. Twofold strategy of MAHLE



Source: Mahle International GmbH, 2019.

Thanks to the strategic orientation of its scope of activity, the MAHLE group implements the subject of tasks resulting from the influence of mega-technological trends on the automotive industry, mainly in the following areas of solutions for future mobility:

- development of highly efficient drive systems (replacement of hydraulic and pneumatic actuators with electric actuators, intelligent accessories for electric motors operating independently of engine speed and pressure, and powered by energy obtained during braking),
- power electronics for electric drive systems,
- Contribution to the development of urban mobility (48-volt two-axle drive with a modular design that can be used in a wide range of platforms),
- developing solutions for the overall heat management of electric vehicles, including both the temperature of the car interior and the heat management of technical drive components,
- the ability of the battery to quickly charge in terms of control electronics, software, and temperature management by dissipating the accumulated heat through active cooling systems,
- Fuel cell monitoring by controlling key input variables (gas or air supply) and discharging the voltage in the fuel cell stack through a semiconductor module, if necessary,
- Low / high voltage electric drives for auxiliary components increasing efficiency, comfort, safety, and ecology as well as energy efficiency for each application.

The strategy to strengthen the current market position includes maintaining the leading position in the global automotive market in the following business segments:

- engine systems and components
- filtration (cabin filters) and engine accessories (pump systems and oil coolers for applications in engines and transmissions),
- heat management for both the batteries and the entire electric drive system
- electronic and mechatronic components used in propulsion systems and the development of e-mobility
- aftermarket (standard engine parts, filters, turbochargers
- and mechatronic components and products for temperature management, vehicle diagnostics, exhaust gas analysers and service equipment for the maintenance of HVAC systems and automatic transmissions).

The strategy of strengthening the current market position includes maintaining the leading position in the global automotive market also through profit centers in the field of:

- engineering services (development of drive systems), motorsport (for the entire motorsport industry for engine components) and the use of special engine components for commercial and off-road vehicles,
- large and small engine components with respect to the piston-crank system
- industrial heat management in the field of cooling and air-conditioning systems and comprehensive thermal management solutions,
- vehicle air conditioning control units.

In terms of direct cooperation between vehicle manufacturers and the MAHLE manufacturing group, their relationship has also acquired strategic importance. You can observe a growing trend related to the departure from the traditional reactive quality strategy to proactive, which uses new generation automation, communication and collaboration technologies based on the functions of various software and their modules, e.g., in the field of quality management software (EQMS).

The use of EQMS capabilities for data management (e.g., statistical process control, risk scorecards) and cooperation between vehicle manufacturers and their suppliers (cloud-based portals, non-compliance management processes, audit documents or training modules) turns out to be a driver of quality improvement, risk and compliance - not only upwards, but also throughout the value chain. The principle of "early quality management" may be the direction of development for enterprises, not only automotive.

4. Summary

The automotive industry is currently struggling not only with the reduction of global demand, but also with the issue of maintaining continuity of supplies after the Covid-19 pandemic. Vehicle manufacturers and suppliers develop breakthrough technologies in the field of mobility, autonomous driving, vehicle electrification and connectivity in their research and development centers. Relations between OEMs and suppliers at the level of 0.5, the so-called system integrators who specialize in the analysis, design and creation of modern systems related to the electrification of vehicles and their connectivity, vehicle mobility with the use of autonomous vehicles.

An example of such solutions is the surveyed MAHLE group, which specializes in system solutions for future mobility.

To sum up, it can be stated that the directions of changes and trends in the automotive industry in the perspective of 2030 discussed in this paper are the beginning of changes in the technological quality of suppliers.

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