PERFORMANCE ANALYSIS IN THE AUTOMOTIVE INDUSTRY

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Foreword

The PhD thesis was elaborated throughout my research activity at the Faculty of Management in Production and Transportation from the Politehnica University of Timişoara and the Faculty of Applied Sciences of Béthune within the University of Artois, France.

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Thank you !

Timişoara, November 2015 ing. Attila Turi

Turi, Attila

Performance analysis in the automotive industry

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automotive industry, production philosophies, systemic model of work organization concepts, conceptual model of sustainable economic development, X90 model, strategic management decision-making framework for relocation, KPIs, forecasting method, performance analysis tool, CSR

Rezumat:
The goal of the thesis was to enable a thorough insight into the automotive industry and its most important challenges and design a practical, relevant and user-friendly performance analysis tool that examines a car manufacturer's compliance towards reference performance targets within the automotive industry.
The thesis summarizes the main characteristics and challenges of the car industry, provides a definition of the automotive industry and its economic contribution and relevance. The manufacturing philosophies that have revolutionized car making throughout the world, Fordism and Toyotism, their distinctive features and characteristics are emphasized on a case study of the Romanian car brand Dacia. The Lean management production philosophy is explained with its component work organization concepts as well as the importance of their interrelated connections and effects on productivity improvement. The role of road infrastructure and the synergic effect of car industry and motorway network enlargement for supporting a sustainable long-term development is also highlighted.
The French manufacturer Renault and the Romanian carmaker Dacia are presented along with their manufacturing sites within the international car market context. Case studies on two current topics in the automotive world are also presented: the low-cost segment created by Renault in 2004 with the Dacia Logan and the more strategic issue of relocation in automotive industry towards more cost-competitive countries with the example of the newly built Dacia plant in Tanger, Morocco.
An extensive review of the specific research literature provides an in-depth analysis on performance assessment issues in the automotive industry which mainly focus on production, management, supplier-buyer collaboration and supply chain development.
The performance analysis tool includes 81 relevant key performance indicators (KPIs) which are applied on a case study on the Renault plant in Douai, France and the Dacia factory in Mioveni, Romania. The case study provides a comparative analysis on logistic, management and internal performance on strategic, tactical and operational level as well as judging their impact on short-, medium- and long-term. The global CSR indicator overviews the degree of economic, social and environmental performance.

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1.1.1. Definition of the automotive industry

The term automotive was created from the Greek "autos" (meaning "self") and the Latin "motivus" (meaning "motion") and represents any form of self-powered vehicle. This term was proposed by SAE member Elmer Sperry. SAE, the Society of Automotive Engineers, is a U.S.-based, globally active professional association and standards organization for engineering professionals in the aerospace, automotive and commercial-vehicle industries and its core competencies are life-long learning and voluntary consensus standards development [106].

The automotive industry is a complex term which usually designates a wide and in-depth range of companies and business entities as well as some specific organizations that are in a certain form involved in the main phases of building a self-powered vehicles as are design, development, manufacture, marketing and selling of motor vehicles as shown in figure 1.1. It is one of the world's most important economic sectors by revenue. The automotive industry does not include the industries dedicated to the maintenance of automobiles following delivery to the end-user, such as car repair shops or even fuel filling stations as they are part of the horizontal industry which also encompasses car washes, parking or other adjacent businesses [33].

Another view on automotive industry provided by Encyclopedia Britannica is that it refers to all companies and associated activities involved in the manufacture of motor vehicles, including most of its components, such as engines or car bodies, but excluding tires, batteries and fuel. The reference also states that the industry's main products are passenger cars and light trucks, including pickups, vans, and sport utility vehicles. Commercial vehicles (i.e., delivery trucks and large transport trucks, often called semis), though important to the industry, are secondary.

Automobile industry thus refers to the business of producing and selling self-powered vehicles. The industry has constantly gained importance on both economic and social level, allowing its customers to commute long distances for work, shopping and entertainment. The car industry has thus encouraged the development of an extensive road network system, which brought about the development of the communities through the newly created investment opportunities it generated. Car industry is one of the largest purchasers of key industrial products, such as steel, while the large number of people the automotive industry employs makes it a key determinant of economic growth and population well-being.

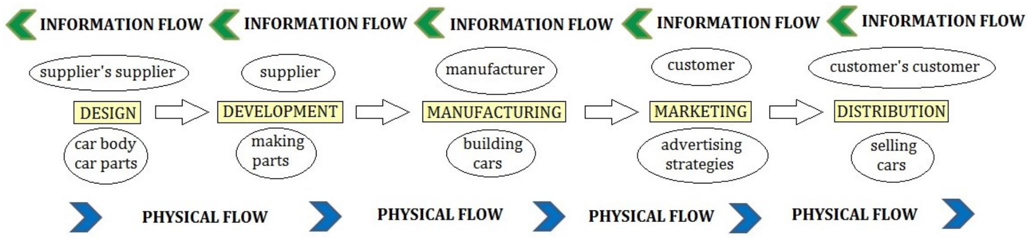


Figure 1.1. The automotive industry

Automotive industry refers to a wide range of companies and their associated activities in the manufacture of self-powered vehicles, both on vertical and horizontal level, as are design, development, manufacture, marketing and distribution towards their worldwide network of customers within a complex and highly competitive supply chain.

1.1.2. The history of the automobile and the automotive industry

Automotive industry began its noticeable rise somewhere between the late nineteenth and the early twentieth century with Europe and the United States leading the way. Among the first prototypes of automobiles to be built were those of Rene Panhard and Emile Levassor. The two French woodworking machinery makers built their first car in 1890 with an engine designed by Gottlieb Daimler and Wilhelm Maybach in Germany. Only one year later French bicycle maker Armand Peugeot, licensed the same engine and sold his first four lightweight cars (1891). He was to be followed next year (1892) by German machinist Carl Benz with his four-wheeled car while in 1893 Charles and Frank Duryea built the first gasoline-powered car in the United States. With 425 "Curved Dash Olds" made in 1901, Ransom Olds is credited as the first mass producer of gasoline-powered automobiles with interchangeable machine-produced parts in the United States. In 1907 Komanosuke Uchiyama built the first gasoline-powered Japanese car, while with the year 1914 Mitsubishi began the mass-production of cars in Japan [149].

Auto sales grew more than 200 times in the United States within 15 years from 4,100 vehicles in 1900 to 895,900 in 1915 and more than 4 times in the next decade (3.7 million in 1925). However, sales dropped to only 1.1 million in 1932 whilst during the Second World War, the car manufacturing facilities were converted to wartime production. After the end of the war in 1945, sales once again took off and managed to increase more than 6 times by 1950 (to 6.7 million units) and by more than 50% within the following 15 years (9.3 million in 1965). The United States automotive industry initially dominated the global market with a massive 83% of all sales, but as Europe and Japan slowly but surely rebuilt their economies, so did their auto industries as they grew to the extent where the market share of the USA dropped to only about 25%. This would also be enabled and rendered possible after the OPEC oil embargo in 1973, as the smaller and more fuel-efficient imports increased their share of the U.S. market to 26% by 1980. In the early 1980s, U.S. auto makers cut costs with massive layoffs, while throughout the next decade car imports, mainly from Japan, took an increasing share of the U.S. market in the 1990s and confirm the competitiveness of the Japanese car industry once again[44].

With the rise of the early 1980s, Japanese and, later, German carmakers set up factories in the United States. Within the following 15 years, these factories were producing around 3 million vehicles per year, more than one third of total U.S. production of 8.7 million vehicles (1999). Since that moment, the figures of U.S. car manufacturers for have slowly decreased to such an extent that they currently make just slightly more than half of all passenger cars sold in America, whilst many of their vehicles contain a significant percentage of foreign manufactured parts. Around $450 billion worth of cars and component parts were produced by manufacturers in the United States and their 902,000 workers in 2007. The 2008 financial crisis brought about significant losses for most automobile manufacturers as recession harshly challenged the automotive sector. The U.S. industry was especially hit hard, as sales figures plummeted, followed by customers shifting more towards energy-efficient cars within the context of fast growing gasoline prices, which lead to automotive companies seeking government financial aid in 2008. The government forced Chrysler and General Motors to declare bankruptcy (2009) and reorganize themselves in an attempt to create viable companies, with the United States and Canadian governments, the Italian carmaker Fiat who purchased a majority stake in Chrysler (in 2014 Fiat would merge with Chrysler and the new company was renamed to Fiat Chrysler Automobiles NV) and the United Auto Workers owned much of the new companies. The increasing role of the car in society would also bring about more delicate issues as were pollution, traffic congestion or safety which would be addressed by the government regulations from the 1970s and imposed car manufacturers to improve their overall fuel efficiency and safety [24].

North America, Europe and Asia (also known as the triad) have brought about significant contributions to the automotive industry throughout the twentieth century in all its stages: product, process and organization. Organizing production inputs from upstream to downstream (such as raw materials, labor and suppliers of components and materials, configuration of distribution channels) has become more and more competitive. The automotive industry is very dynamic and accounts for approximately one in ten jobs in industrialized countries. The high added-value products, innovation and the vast linkages that the auto industry has to other sectors of their economy make it a substantial source for economic growth opportunities.

The automotive industry has its roots in the 1890s when hundreds of manufacturers that pioneered the horseless carriage. For many decades, the United States led the world in total automobile production and was the reference in automotive industry. This was backed up by some supporting facts as in the early 1930s the world had more than 32 million cars in use, with over 90% of them being produced by the automotive industry of the United States. Prior to the Great Depression (1929-1933) the U.S. had one car per 4.87 persons according to an issue of the Popular Science magazine. The United States still produced more than 75 percent of world's auto production after the Second World War. In 1980, the United States was overtaken by Japan who became the world's leading country in car production, a position which it held for almost 15 years, before being again surpassed by the Americans in 1994. After more than 10 years of dominating world production, the United States would once again fall to second place as Japan narrowly took over the leading spot in production figures between 2006 and 2008. After only 3 years however the car production rankings would see a new leader rise, as China took the top spot with 13.8 million units. China produced around 19.3 million units in 2012, which meant almost double the production figures achieved in the United States (10.3 million units), while Japan came in third (9.9 million units). In 1970 there were 140 models available on the market, which would double over the next 30 years as in 1998 the customers' choice had expanded to more than 260 models and after only half the timespan it would again increase by more than double to almost 700 models by the mid-2010s as in 2012 there were 684 models the customers of the U.S. market could choose from. This exponential growth of cars also made room for the more environmentally-friendly hybrid and electric vehicles which currently only have a niche market segment within automotive industry production figures and sales [111, 155].

Throughout the last century car industry has undergone several organizational and structural stages. In the early years of the car industry development craft production (1890-1908) prevailed as there were dozens of small enterprises that eagerly competed to establish a standard product and process. In 1909 in the United States there were a record 272 companies operating in the car manufacturing industry. The 20 years of this kind of production and organization has however left room for plenty of improvement and as the companies would concentrate to build more stable and cost-effective structures, mass production (1908-1973) emerged and would set the trend in auto industry for almost 70 years. Mass production was introduced by Henry Ford who promoted the moving assembly lines, which became the standard operating mechanism of the industry and was to establish a milestone in car manufacturing, completely revolutionizing manufacturing techniques. After a long dominance, mass production would also see its techniques and organizational principles outdated by the Japanese culture of lean production (1973–present), an ongoing manufacturing philosophy initially developed at Toyota under the leadership of Taiichi Ohno during the 1950s, which introduced a revolutionary management process of product-development and production. Lean production would arise after the Toyota Production System (1948-1975) had impressed the automotive world where Ohno and Eiji Toyoda had laid the foundation of the Japanese car manufacturer's success.

Production has also undergone changes over the past century caused by the need to supply faster and at a lower cost. Ford's mass-production system provided standardized cars that allowed the construction of fully automated assembly plants which made use of interchangeable auto parts. In its prime (1908-1920) Ford's assembly process would need just over an hour and a half to produce a car. But the fact that Ford lead in market share had also a downside caused by his complacent mindset that nothing needed changing and that things went as they should have which hindered innovation. In the 1920s General Motors improved on Ford's assembly line process by introducing flexibility into the production system, enabling faster changeovers from one model to the next. Toyota would also respond with the Toyota Production System, followed by lean production a couple of decades later, which significantly improved productivity by replacing the former "Push system" promoted by Ford with a "Pull system" based on immediate and firm customer demand. This allowed and enabled Toyota and the Japanese companies to minimize inventories at suppliers, assemblers, and dealerships, hence throughout the entire supply chain and made the entire network more effective and reliable. The Just-in-time production system would also impose a larger responsibility for product design, quality, and delivery to assembly workers and suppliers than the mass-production system did, thus integrating the principles throughout the entire chain would be a key asset for the system's efficiency. Suppliers were not vertically integrated into auto assembler operations at the time, but partnerships with long-term contracts would dominate the supply chains which experimented the Japanese philosophy. This system generated cost-minimization and improved responsiveness to customer demands and would create a new global current in automotive industry manufacturing. The Japanese model however would also be adapted in order to better serve regional conditions [46].

Product innovation soon emerged and would become an important competitive advantage for all carmakers, thus ending Ford's low-price, monochromatic Model T. This trend would confirm that the ability to vary products was indeed a main strategic asset of auto producers as General Motors were the forerunners of producing different types of vehicles for different product segments. Some important differences arise in market specifics for the triad: carmakers in the United States mainly addressed customers' desires for comfort, speed, and safety and had developed rugged drive trains, stylish chassis and bodies and plush suspensions and interiors. European auto producers on the other hand have focused their attention on performance and agility features of vehicles, such as turbo diesel engines, fuel injection, steel-belted radial tires and disc brakes. The Japanese manufacturers were mainly characterized by the miniaturization culture, therefore the scarcity of fuel, materials, and space largely determine the specifications of their cars [52].

1.1.3. Competitive structure of the automotive industry

Since its early years automotive industry has always been competitive, as rivalry has expanded from national boundaries to a worldwide global competition. Competition has enabled the car market to be dynamic as strategies are almost always based on what the other rivals are doing, therefore the competitive nature of the industry is extremely high, meaning neither car manufacturer knows who will be tomorrow's market leader.

Before establishing industry standards for products and production, hundreds of automakers existed. In the United States, for example, the year 1909 saw the largest number of automakers in operation in a given year—272 companies. Estimates show that within the first 20 years of the industry's existence, in the United States alone, over 500 firms entered the industry. The 1920s saw several auto manufacturers cease activity while many others decided to merge into more profitable companies. At the beginning of the Great Depression (1929-1933) General Motors would become the car market leader, with Ford slipping to second place. This was mainly due to Henry Ford's reluctance to bring on a new model which made the changeover in production from the Model T to the Model A lose sales and market share. Towards the end of the 1930s, the Big Three (General Motors, Ford and Chrysler) had more than 90% of total sales on the U.S. market (General Motors 44.8%, Chrysler 25% and Ford 20.5%), while 25 years later only seven domestic auto producers remained (1960s) [78].

Interestingly Japanese carmakers took over more than a quarter of the U.S. market in the 1990s, and the market share of GM, Ford and Chrysler slipped below 70 percent. In 2014, the Big Three would even fall under the 50% margin, as they collectively captured only around 45.3% of the U.S. market. GM still has the largest share of the American market (17.8%), but Ford (14.9%) and Toyota (14.4%) are catching up, as the Japanese overtook Chrysler (12.6%). Since the mid-1980s market concentration has slowly been declining as the collective market share held by dominant automakers has been slightly weakened by new-entry manufacturers such as Hyundai or Kia [159].

In Europe cars were an important export item as they were high added-value products which helped the European economy recover its war-shattered economy. In the United Kingdom, British automobile output was then shared by the likes of British Leyland, Ford, Vauxhall and Rootes. Rootes would be under Chrysler control from 1967 and later sold to Peugeot-Citroën in 1978, whereas during the same period the government took over British Leyland when it had financial difficulties in the early 1970s. One of the most spectacular automotive features was the revival of the German car industry after the country had faced almost total destruction after the Second World War. Germany managed to rebound with Volkswagen being at the center of the country's automobile rise, although at the end of the war both the Volkswagen factory and the city of Wolfsburg were in ruins. Astonishingly in just over 10 years the city and its factory were restored to production and Volkswagen was producing one-half of West Germany's car output, even securing a strong position in the world market. Fiat, founded in 1899 but without a mass market until the 1950s, dominated Italian automotive production. The French industry was centered on Renault, Peugeot, Citroën and Simca. Renault was nationalized at the end of World War II, but would once again become a public corporation in the year 1996 and was the main manufacturer in the Hexagon. Citroën, who successfully competed with Renault for some good years, was acquired in 1976 by independently owned Peugeot to form PSA Peugeot-Citroën, whereas Simca became a Chrysler property in 1958 but was to be sold to Peugeot in the late 1970s. Northern Europe's Sweden was a relatively small producer, but despite their smaller scale automotive industry, Saab and Volvo, their leading national brands, would make place for their models on the world market during the 1960s and '70s, especially due to their very good reputation of safety. Their car operations would however be acquired in the 1980s and '90s by the first two carmakers of the United States, General Motors and Ford [43].

The Volkswagen group is by far leaders on the European car market with a share of 25.5% in new registrations of passenger cars in 2014, thanks to a milestone year for the German manufacturer. The French groups PSA and Renault follow with 10.7% and 9.5% in the rankings, with the Japanese constructors Toyota and Nissan combined accounting for around 8%. Ford and Opel lag one percent behind, followed by BMW, Fiat and Daimler, each separated by half a percent [1].

The rivalry on the automotive market mainly focuses on product variety and quality as well as price, as the value to the customer is among the most important assets. The pressures are high for carmakers as they seek both short-term profitability for operative reasons as well as long-term viability for future development. Main challenges include attracting and maintaining a solid customer base as well as strengthening the company's brand image. Customer loyalty is of critical importance as high customer satisfaction can significantly increase the possibility of a future repurchase which is essential for the industry's long-term profitability. Product variety in the automotive industry is high, but car manufacturers usually focus on a specific market segment, where they can benefit the most from their core competences. In this sense Mercedes, BMW are renowned German premium brands as are Lexus, Infiniti or Acura and capture a third of the top niche market segment United States. Meanwhile Buick, Ford, Mercury or Toyota are better known for their family-styled traditional cars. Japanese carmakers have usually a reputation of reliability, whereas Ford or Chevrolet promote small or sporty vehicles. The fastest growing market segment in the United States in recent years has been sport utility vehicles (SUVs). SUVs captured roughly 55 percent of vehicle sales in the first decade of the 21st century and due to recent gas prices dropping, sales have picked up as SUV surpassed the 1.5 million mark last year for the first time since the year 2007 (when 2.2 million had been sold) [145].

Car manufacturers have constantly extended their product line in order to cover a large part of customer desires, either on their own or through collaboration with other carmakers. One of the best most representative companies in this sense is General Motors from the United States who offer a very large variety of brands (Chevrolet, Oldsmobile, Pontiac, Buick, GMC, Cadillac and more recently Suzuki and Isuzu subcompacts), Ford who diversified its portfolio by acquiring Volvo and Jaguar, whereas the Japanese carmakers Toyota, Honda and Nissan developed a clever marketing strategy in the 1980s aimed at selling luxury vehicles in the United States by creating luxury brands under the names of Lexus, Acura or Infiniti, even though these cars are built on the same platforms as their other vehicles.

Product quality has always been a decisive and market-driving criteria and a major priority for car manufacturers. Research from the year 1998 showed that European and Japanese brands had fewer vehicle defects than average for cars within their first couple of months of driving on the road, whereas carmakers from the United States or Korean cars had more defects than average. Only 6 years later vehicles from Europe, Japan, the U.S. and Korea were achieving an average defect rate of ten defects per hundred vehicles or even less, which was 10 times better than the previous measurement or the previous improvement scale (defect rate fallen from 176 to 119 defects per hundred vehicles). The Asian carmakers (Japan, South Korea) would rather remarkably outperform the traditional U.S. and European brands in quality [47].

Suppliers within the automotive industry have been gaining an increased importance in the automotive supply chain and within first or second-tier collaboration with carmakers their responsibilities for product development, engineering or even the manufacturing for some critical systems fitted to the car have been significantly enlarged. This is a rather radical change as before a car manufacturer would also make its own parts and also assemble the vehicle within its facilities. This organization would pass towards externalization in order to allow carmakers to focus more on their core competences as during the 20th century the classic vertically integrated structure within assemblers would be replaced by a more network-oriented approach (the current tiering structure). Within this new supply chain scheme and organization the car assemblers coordinate their design and production activities with the help and support of first-tier suppliers. Furthermore, these first-tier suppliers are then in charge of global coordination for subassemblies and production by sub-tier parts manufacturers (second-tier suppliers or other suppliers). The new activity breakdown and responsibility sharing has made first-tier suppliers match automakers in negotiation power as well as in the share of added value to the end product. Although only a small and select part of suppliers have achieved this important level of quality and competence in the production of automotive systems, car industry is expected to shift towards this direction as this will strengthen the links of the supply chain and make it more competitive, reliable and financially stable to assure its long-term development.

As the role of suppliers steadily increased so did their share in employment within the automotive industry. Automotive industry employment in the United States ranged between 700,000 and 1 million workers, with the majority of them working for manufacturing plants until the 1980s. Since then the share of these employees has shifted towards suppliers and starting 1985 suppliers of car assembly facilities employ more than half of all workers in the industry and thus more than the car plants themselves. The share of employment at assembly plants within car industry declined from 44 percent to 36 percent within the following 15 years, whereas the share of workers at automotive suppliers increased from 56 percent to 64 percent. Labor in the United States automotive industry would also be affected by foreign suppliers and assemblers, outsourcing and relocation, marking a turning point within the industry structure [49].

The Worldwide Big Three automakers are Toyota, General Motors and Volkswagen. In 2013 these companies had cumulated one third of the worldwide market with the Hyundai-Kia and Renault-Nissan groups and Ford adding a further quarter, while production shares also closely mirror these numbers. The Asia-Pacific region, with over 42 million units produced in 2014 by China, Japan, South Korea and India is currently the most important region on the automotive industry map, representing almost half of worldwide production. China was the dominant producer, with around 24 million cars, with Japan's output nearing the 10 million milestone, more than South Korea's 4.5 million and India's 4 million cars put together. Western Europe and North America ranked a distant second and third in worldwide production, respectively, producing between 16 and 17 million vehicles in 2014. Germany is the dominant producer in Western Europe with almost 6 million cars produced last year, followed by Spain, with around 2.5 million, France and the UK between 1.5 and 2 million each, while the United States produced almost 12 million vehicles last year, twice as much as Mexico and Canada together, in North America [111].

Since 2008 China is the world leader in car production, overtaking the European Union or the United States and Japan combined. Thus China captured attention as the location for new automotive productive capacity. Beginning with Volkswagen's investment in 1985, all of the major automakers have established productive capacity in China through joint-venture relationships with local automakers. Around the 1970s passenger car production was practically nonexistent in China. 40 years later, sales and profit rates have an impressive development, although capacity utilization and inventories are not as efficient as those of their Japanese, European, and U.S. competitors. By becoming more fully integrated into the global economy, despite modest marketization, its domestic automotive industry has managed to continuously and steadily expand into the industry it is today.

1.1.4. Economic importance and challenges of the automotive industry

The automotive industry is an important sector of the world economy, particularly in industrialized countries where it has an important contribution to economic growth, employment and generating well-being. In the United States for example, the car is second only to a house in purchase value for the average American household. This brings about the fact that the average manufacturing job in the automotive industry is retributed with more than a half more than the average U.S. job (+60%). Industry estimates also show that the industry generates around 10.5 jobs for every worker directly employed in automotive manufacturing in the United States. Across Europe, automobile manufacturers account for 292 vehicle assembly and production plants in 26 countries. Vehicle manufacturing is a strategic industry in the EU, where 17.2 million cars, vans, trucks and buses are manufactured. The automobile industry supports a vast supply chain which enables economic growth, as the turnover generated by the automotive sector represents 6% of EU GDP, where over 12 million people (5.6% of the EU workforce) are employed in the sector. In addition, there are around 2.3 million high-skilled jobs in automotive manufacturing, which represent 7.6% of the EU's manufacturing employment [1].

Motor vehicles are also a major component of international trade and foreign direct investment between countries, as today the share of automotive products in world trade is around 11 percent, keeping a stable growing trend since the last decade. While Western Europe and Asia are net exporters of vehicles, North American imports far outpace exports. In North America, exports have remained relatively flat since the 1980s, whereas imports have significantly increased. North America, Eastern Europe, the Middle East, and Africa are all net importers of automotive products.

Local automotive sectors around the globe have usually been protected by different forms of barriers imposed on imports as North America and Europe applied tariff and non-tariff barriers toward automobile trade. In the 1980s Japan and the U.S. agreed on a fixed number of cars that the Japanese would be allowed to export to the United States through a voluntary export agreement (VER). The VER between the EU and Japan in the 1990s was established as Japanese imports to Europe started increasing considerably. These VERs would then inspire the Japanese auto producers to establish their own manufacturing plants in the United States and Europe and quit exporting towards these destinations. Although jobs and exports are on the upside for the receiving countries, the Japanese also bring along challenging wages and competitive costs that put pressure on the U.S. and European car market [22].

Location of assembly plants and their related suppliers' network is currently determined more and more by production cost. Besides the rigid production costs debate, market opportunity is another main reason to shift production towards more cost-effective countries. In the automotive industry, depending on brand and car segment, material costs usually range somewhere between 22-50%, whereas labor costs usually account for 10-20%. These costs can vary pretty much depending on the region or the car model produced, making manufacturers and suppliers engage in assessments and adjustment processes to implement changes in the configuration and operations of their plants and render them as effective and efficient as possible. The challenges brought about by innovation, the growing importance of environmental concerns, the challenges of flexible manufacturing practices and the globalization of a car manufacturing's operations will further bring adjustments to the industry in the near future.

Overcapacity in the global automotive industry was estimated at 20 million units in 2007, which represents almost a quarter of global annual production. The figure even surpasses the productive capacity of the Western European automakers by around 3 million vehicles, which is worrying. Estimates show that a minimum efficient scale of production at an assembly plant is at around 200,000 vehicles, but there are still lots of factories which are not even close to this output figure. This situation enables the risk that dozens of assembly plants will most likely be closed (see the recent examples of France and Australia) or at least reorganized as carmakers will continue to strive to improve their profitability. In the automotive industry a capacity unitization of about 75% is the break-even point below which automakers will need to enact measures to make activity more efficient and 60% is the margin under which losses are usually inevitable for the concerned factories.

Overcapacity also creates pressures and opens possibilities for company mergers, acquisitions and network alliances in order to help manufacturers operate at more efficient costs. Car manufacturers are also using standardization and modularization to simplify their final assembly processes and are applying several different designs to improve organizational activities or work techniques as part of the restructuring strategy. Vertical and horizontal strategic collaborations among carmakers and suppliers is becoming a trend in order to achieve better productivity and cost-effectiveness as well as a more sound financial stability for the implicated business partners. Benefits mainly associated with these collaborations are the development of new products and concentration of productive capacity to common facilities or plants to reduce operating costs [161].

Nevertheless consolidation also has some more sensitive issues as is does not represent a guarantee that productive capacity of the concerned automakers will be optimized. Mergers typically occur between different types of companies, with different organizational culture and car models. This means that their complementary product lines hinder the possibility to close down certain plants. Moreover any type of effective rationalization will bring about job losses for workers which will create social movements, issues and discontent and may attract political forces to get involved and try to force companies to maintain the domestic jobs. In addition to these industry-sensible issues, other challenges will also arise and be up for debate, such as traffic congestion (especially within big cities), air pollution and highway accidents, which are all associated with the increasingly high role the car plays today in our modern society.

1.2. Evolution of the main production organization systems within the automotive industry

Car manufacturing is the heart of automotive industry as it is the source of continuous development both on technological and social level. Its contribution to the global economies and the scale of its implications has made it one of the most important industries during the last century. The high amount of suppliers which work with car manufacturers all over the world has made automotive industry one of the most important employers and sources of a country's well-being. Nevertheless the industry has also faced a serious amount of challenges and has had to cope with them in order to remain in a competitive position on the global market. Throughout history carmakers have had to overcome contradictory general tendencies in social and institutional structures due to control problems, lack of adequate anticipation or application of new technology in order to adjust to market dynamics [152].

Fordism was the first revolutionary concept of car making, with its innovating mechanisms and integrated supply chain Ford prompted the Model T as a landmark in automobile history. Ford's assembly line managed within the first years to always double production, and after only 5 years the Model T production figures went up over 20 times, as the year 1914 marks a total production of 202,667 cars which meant Ford produced more cars than all other competitors combined. A decade later the Model T would surpass the 2 million boundary, before its production was ceased in 1927 [137]. 50 years later Post-Fordism would emerge, challenging some of the theories which had previously impacted the car industry and mainly brings about a more market-oriented approach or the use of information technologies. In recent years the Toyota Production System and its key pillars have been inspiring the industry and shaping up the organizational culture of companies through Just in Time, Kaizen or Lean management.

Automotive industry is mainly driven by the competitive spirit of carmakers and their general desire to be the best on the market, an ambition which drives the entire industry. As room for consistent growth on traditional markets has slowed down and these have already reached maturity, car manufacturers will try to boost their sales figures by expanding towards emerging markets whilst however facing strong competition. One particular example of the classic shifts in production philosophy from Fordism to Lean management is the case of Romanian brand Dacia, which had a sudden development after being bought by French car manufacturer Renault in 1999. Now, 15 years after moving on to new principles the SUV model with all options of the brand costs just short of 19,000 euros, the price of a luxury car only two decades ago, which shows the remarkable leap in quality achieved by Dacia. However as prices went up, Dacia lost a significant part of its customers and market share on the national market, Renault built a new Dacia factory in Morocco instead of extending the one in Romania and has decided to manufacture most of the brands' models there, so have the changes lead only to positive implications ?

1.2.1. Fordism

Henry Ford is the father of what we today call Fordism, a complex production system, which has become a reference in automotive industry due to its numerous principles which have set about the importance of car manufacturing on a worldwide scale.

Among the most important contributions of Fordism is the development of the assembly line, which implied the division of labor both vertically (by separating the design and execution phase) and horizontally (by separating complex operations into small and simple tasks). The main attribute of the assembly line within Fordism was to standardize the end product. This meant that nothing was to be hand-made by craftsmanship, but rather through machines and molds in order to create standard parts that would be fully interchangeable for a standard output: basically the making of identical cars in large amounts [68]. This was made possible through the use of special-purpose tools and equipment that allowed workers even with low skill levels to operate the assembly lines. The downside was however that each worker did one task over and over and over again, which was a very monotonous and intense activity, as one worker might spend all day every day screwing on doll heads, for example.

One of the most surprising and effective measures implemented by Ford was to double the wages of the workers. This would have a series of positive effects on productivity, as it ceased the massive employee turnover (which could reach even 400% per year) and stabilized the workforce and also was an important incentive to come and work for Ford for other workers. An effect of this decision was that through productivity gains, the cars they produced were getting more affordable and thus they could buy the cars they actually made and helped stimulate the national economy through internal consumption. In this context, productivity gains through economies of scale would render a mass product for the mass market more and more available and affordable [147].

The system used by Ford was what we today call the "Push system" that is a system which provides the market with a product that is designed to be absorbed by the market through large consumption, hence "pushing" it from the manufacturer towards the customer. In order to achieve productivity gains, outputs had to always grow and that could only work within a Just in Case supply, which meant having lots of raw materials, from which lots of end products would be made. This activity is however intense and without a stimulating policy as was Ford's salary increase, it would have had only a scarce chance to prevail. Another important principle involved in the success of Ford's mass production was the fact that he decided to operate a fully integrated supply chain, which meant a huge amount of activities and employees. Ford had perfected mass production techniques and could achieve substantial economies by doing everything himself, but it was mainly due to his belief that a direct supervision of all process stages within his own premises could more efficiently coordinate the flow of raw materials, parts and components through production than in the case of a classic supplier-buyer relationship [19].

1.2.2. Post-Fordism

After more than half a century when Fordism prevailed, shifts and changes in the market had challenged the paradigm and validity of those theories and had set about a new concept in both car making and global economy: Post-Fordism.

Post-Fordism marks the end of an era and the start of a new one, or at least it is characterized by the application of different principles and techniques to achieve desired results. The most important change is related to the emphasis on the different types of consumers in contrast to previous emphasis on social class by the product standardization introduced by Ford. This change in approach led to specialized products and jobs being created, that ultimately required different types of equipment and workforce. Thus more skillful workforce was needed to operate multi-purpose equipment as were certain robots and computer numerical control and flexible specialization had become an important asset within car manufacturing.

This brought about the implementation of the economy of scope principle, which no longer praised cost as a deciding factor, but was keener on competitive advantages through differentiation. In order to do so and respond to market demands more accurately and in good time small-batch production was used. The increased variety of tasks and the different end products lead to new concepts in the industry as was the rise of the service as a complement to the classic end products which would start being offered to the customer and would generally be employed after sale had occurred. Moreover a new type of employee was starting to become noticeable, namely the white-collar worker, which was a person in charge of administrative work usually performed in a separate office and was opposed to the classic blue-collar worker, where manual labor was required and implied, which mainly dominated the car industry. Another novelty was the feminization of the work force, which until that point had exclusively been based on male workers [57].

Compared to Ford's Push system, Post-Fordism uses what we today call a "Pull system", which has an opposite principle as it is a system which responds to a firm order generated by the customer. Thus the impulse is given from the market, hence "pulling" the desired product from the manufacturer towards him, an inverse mechanism of offer and demand to that brought forth by Fordism. The pull system came with a new supply philosophy, that of Just in Time, which matched its mechanism and would only deliver materials if they were needed, thus preventing overproduction and inventory. The system would require however a very sound organizational culture throughout the entire supply chain. The supply chain principle is also different, being another important change brought forward by Post-Fordism as it now encompasses individual specialized firms as suppliers for the car manufacturer. This meant that carmakers would not produce all of the needed components themselves, but rather they would outsource some parts of upstream activities in order to better focus on their core competences. This principle also implied the increasing importance of information sharing and communication as well as the beginning of new information technologies [12].

1.2.3. Toyotism

The Toyota Production System (or Toyotism) marks another era in automotive history. The system was developed by Taiichi Ohno and Eiji Toyoda between 1948 and 1975 and gives great attention to management practices within manufacturing and logistics [110].
Fordism and Post-Fordism both basically emphasize production principles and a specific supply chain design, whereas Toyotism mainly focuses on the aspect of organizational culture and its importance for a car manufacturer's competitiveness as is emphasized by table 1.1. The Toyota production system is not revolutionary, as it rather makes very good use of its resources by applying simple organization techniques and discipline in order to make end products with the best possible efficiency. This is confirmed by sales figures too, as Toyota has been the world number one in car sales for the past 3 years and in 2014 the Japanese company managed to break the 10 million milestone by selling 10.23 vehicles last year. Volkswagen with 10.14 million came in second, whereas General Motors only sold 9.92 million cars in 2014, losing second position to its German competitor.

The production principles introduced by Toyotism were no different than those that already existed, however their implementation was perfected by using simple management techniques: muda, which implied the elimination of any type of waste (transportation, inventory, motion, waiting, over-processing, over-production, defects), the principle of autonomation (jidoka), a combination of autonomy and automation, which was a supervisory function given to a worker who also had the autonomy to stop the machine and the assembly line in the event of some abnormal functioning. Two other important principles referred to production smoothing (production leveling or heijunka, in Japanese) which had the goal to produce intermediate parts or cars at a constant rate (as much as possible) so that further processing may also be carried out at a predictable, smooth and level rate; and to preventing human mistakes (poka-yoke) by designing processes or certain routine operations in a manner that they automatically prevent any obvious mistake a worker might make at his workplace [133].

In order to serve the principle of economy of scope, Toyota also used other management techniques to improve its manufacturing activity as were nemawashi, which meant that mutual content has to be reached prior to any implementation of projects as to gather all opinions an give a sense of implication and importance to all involved members, Genba Kaizen, a combination of Genba Genbutsu, which meant going to see on site what was happening in order to properly understand the functioning of certain activities or the degree of some problems, and Kaizen which refers to an approach of stimulating ideas for continuous improvement, and 5S, a very simple method to organize and standardize one's workplace and to keep it clean through individual discipline. The Pull system and the Just in Time principle were supported by the Kanban method which used labels throughout all workstations to signal the need and the flow for parts, while being at the same time easy to watch over and reliable. Another interesting change within Toyotism was that suppliers were no longer seen as "suppliers", but rather as "partners" which meant a whole new level of confidence, trust and mutual respect emerged between the different links in the supply chain that would also be noticed in the carmakers productivity and in the effectiveness of the supply chain [109].

Table 1.1. Differences in production philosophies

Category/era	FORDISM	POST-FORDISM	TOYOTISM
Production principles	1) standardization of the product 2) special-purpose tools and equipment 3) assembly line 4) division of labor	1) specialized products and jobs 2) multi-purpose equipment 3) flexible specialization 4) new technologies	1) eliminate waste (muda) 2) Autonomation (jidoka) 3) Heijunka 4) Poka-yoke
Organizational culture	1) workers are paid with higher wages 2) economy of scale 3) mass product for mass market	1) service and the white-collar worker 2) economy of scope 3) small-batch production	1) Nemawashi, Genba Kaizen, 5S 2) economy of scope 3) Kanban production principle
Supply chain	1) Push system 2) Just in Case 3) fully integrated supply chain	1) Pull system 2) Just in Time 3) individual specialized firms as suppliers	1) Pull system 2) Just in Time 3) individual specialized firms as partners

1.2.4. Lean management

Although Lean management tends to be mistaken with Toyotism, it is actually one step further than the Toyota Production System. It adds further management techniques like the SMED (Single Minute Exchange or Die) principle to rapidly adjust machines for their changeover, the Ishikawa diagram (or cause-effect diagram) for solving different issues which can occur related to product faults or VSM (Value Stream Mapping) which shows the flows within a value chain. However lean management is different because it does not merely apply these techniques relentlessly, rather it creates a special organizational behavior which stimulates the entire company to think and to act "lean". This means a voluntary commitment of all workers, managers and staff to continuously try to find improvements within current activity, to reduce waste and to focus only on activities which add value to the customer. There is no pressure to make profit or to apply certain tools, it is a more relaxed way to enjoy being committed towards bringing value and ultimately a competitive product for the customer through a common working philosophy. Even though profit making is not emphasized, this approach is supposed to also improve the financial end results through the quality of the workers output [90].

1.2.5. Evolution of production organization systems at Dacia

Since the founding of the Dacia plant in Pitesti in 1966 and the first year of its produced vehicles (1968) the Romanian brand had always enjoyed collaboration with French manufacturer Renault, but it was not until Renault decided to actually buy the factory that this collaboration would start to bring important benefits.

For almost 30 years Dacia produced a standard basic car (Dacia 1300), with scarce technical, technological or design advancements. It's was literally a mass product for the mass market and until 1981 it was the only car produced in the country and had a reputation of breaking down. Spare parts were easily available, but they were also low on quality, as was the overall car which was also short on extras. This very basic vision of Fordism would be challenged by the factory in Craiova where Citroen had collaborated for the Oltcit for 10 years during the 80's years before Daewoo produced a larger range of models between 1994-2005. Dacia managed to design the first car on its own in 1995, the Dacia Nova, which was 33% more expensive than its classic model. Progress overall was however slow and the factory needed investments to be able to overcome its structural issues.

Renault bought the Dacia factory in 1999 and by the year 2001 it already made an impact by fitting the Dacia Nova with a new engine, gearbox and improved interior design and renamed the car to Dacia SupeRNova. Just two year later they would improve the exterior design as well and make some other changes and launch the Solenza model, the first ever Dacia model to have a choice of engines (1.4 petrol and 1.9 diesel) along with the Pick-up. The Post-Fordism era of Dacia would be thus characterized by more specialized products, the emerging of the white-collar workers or the small batch production. This period would not last more than five years as Renault had an idea in mind to replace these models with a new model, more affordable and with an overall better quality and market adaptation.

Dacia enters Toyotism in 2004 as the Logan model is launched, a model with huge success both on national and international markets. The muda principle made the Logan the cheapest new car available with a very good quality-price ratio and would set an example to car manufacturers around the world of efficient production. The economy of scope at Dacia was just beginning, partnerships with suppliers would be on their way, as were the investments of the French manufacturer in the Pitesti plant. After 10 years since launching the Logan, the Dacia plant is a modern car factory, producing a large range of models, even an SUV model, the number of employees has doubled, wages have quadrupled and almost 95% of production is being exported.

Production levels in Romania are at their highest level ever due to the 2.2 billion euro investments by Renault in the factory, with an average level of 92% of maximum capacity within the last six years, while twice being very close to attaining maximum capacity, in 2010 and 2013. Within the last 11 years production levels have increased more than 3.5 times whereas sales have grown by almost 5.5 times as shown in figure 1.2. Due to these growing figures, production of Dacia models in Renault factories around the word is being increased as well.

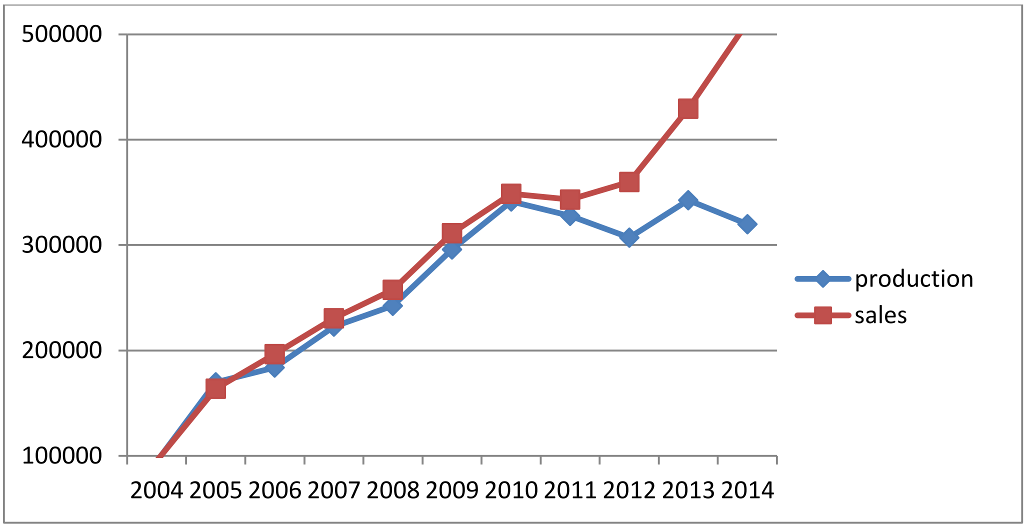


Figure 1.2. Evolution of internal production and worldwide sales at Dacia

Productivity has been one of the key elements in the recent worldwide success of the Romanian brand as the timespan of producing one million vehicles has been reduced from 17 years (1985) to just 3 years (2014), almost six times faster than before and three times quicker than seven years ago (see figure 1.3 below), due to Renault investments and workers efficiency at the Dacia factory. The rise in productivity is also due to the training programs provided by the French manufacturer for the Dacia workers and to the strict conditions required for them to meet at their workplace, as well as several other benefits as free warm meals at the factory. Wages have accordingly been increased and are today twice the national average salary, showing the impressive performance of the car brand.

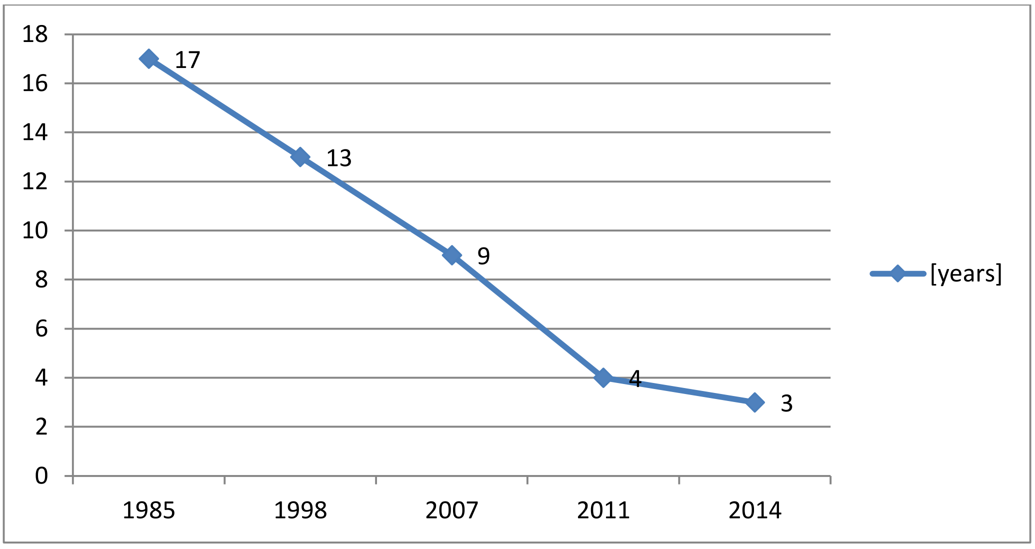


Figure 1.3. Number of years necessary to produce 1 million cars

In Europe no other car brand has had a similar evolution as Dacia within the last decade: even throughout the crisis the Romanian brand continued to make profits and has an average yearly profit of around 70 million euros within the last 10 years. As the brand started being sold in Western Europe, customers have been more and more aware of the models produced by Dacia and demand is rapidly increasing. Since 2012 sales on international markets have increased by more than 40% from 337,674 to 481,840 cars sold last year and if the amount of production exported was only 16% in 2004, today the factory in Pitesti exports around 95% of its production to foreign markets.

A decade ago Dacia sold just over 15,000 cars outside of Romania, today it sells 32 times more, meaning daily exports of 17-18 million euros and a share of almost 10% in national exports. Moreover a car manufacturer usually generates around 6 more jobs within the automotive industry for each own employee, Dacia however surpasses the ratio as around 125,000 people are employed in the car industry in Romania, meaning a ratio of 8 employees for every job at the Pitesti plant. This in turn brought about an increasing contribution toward the country's economic growth, if in 2004 Dacia contributed with less than 1% to the Gross Domestic Product (GDP), in 2010 its contribution surpassed 2%, while in 2013 the car manufacturer came just short of a 3% contribution to Romania's GDP as is shown by figure 1.4.

Dacia also gave special attention to environmental issues and by investing around 25 million euros in technologies the brand managed to reduce the consumption of its vehicles by more than 15%, while at the same time reducing CO_2 emissions by almost 20%. As these two could also be seen in the light of European Directives, the factory managed to reduce overall amount of overhead required to build a vehicle by almost 70% and managed to reuse waste by 96,6% within the last 11 years.

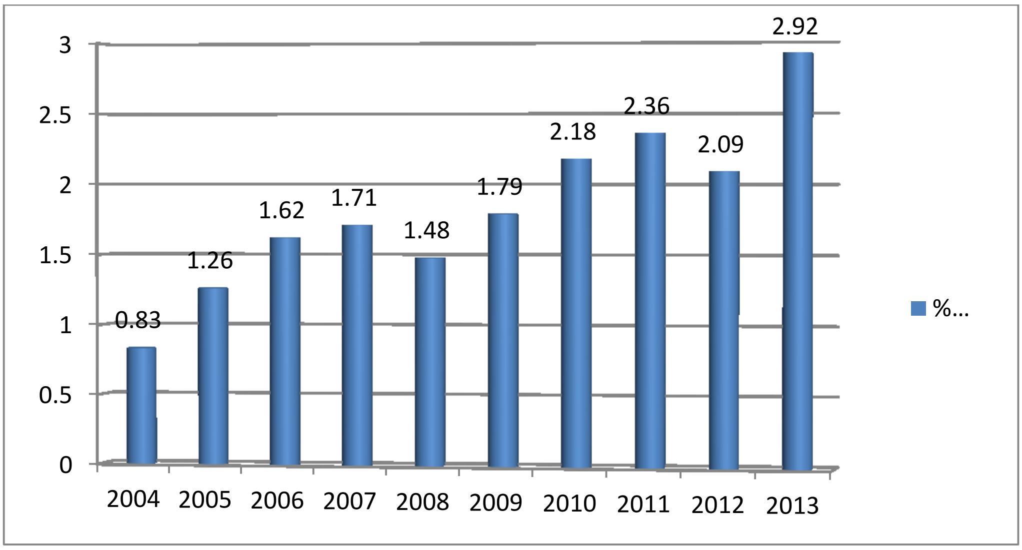


Figure 1.4. Dacia's contribution to Romania's GDP

1.2.6. Conclusions

During the last 15 years Dacia has managed to undergo significant changes and its progress and performance have stunned the automotive industry similar to shifts brought forward from Fordism to Lean management. The Romanian brand has managed to impressively develop on international markets thanks to a "smart buy" opportunity ceased during the recent economic downturn and is today the leading brand on the low-cost market.

The current car market structure in Romania, customer behavior and swift orientation towards second hand imports since a couple of years and a lack in vision and strategic development policies by the government have however contributed to the weakening of the Dacia sales and its overall position on the national market. This lead to a new factory being built in Morocco instead of enlarging the one in Pitesti and currently most of the Dacia models are built in North Africa for a better benefit to cost ratio overall efficiency.

If the Romanian market does not evolve towards better results within the following years, the Dacia brand, although born and made successful by the workers at the Pitesti plant could soon be mainly transferred towards the factory in Tangier and paradoxically Dacia's own success on foreign markets can soon be the cause for continuing expansion and maybe significantly relieving production from Pitesti in the future. As harsh as this may be, currently Dacia's main market is outside its own country where it only sells 5% of its production volume, therefore being "lean" implies getting closer to the main market despite having to cut production or maybe even reduce workforce from the source of this achievement.

Fordism, Post-Fordism, Toyotism and Lean management have all brought about changes in the way car manufacturers lead, organize and carry out their activities which have evolved very much within the last century. Neither of them can however independently improve performance of carmakers as this is only possible when combining the advantages of each of them in order to match the target market's specificities as adequately as possible by providing added value to the customer.

1.3. Importance of work organization concepts within lean management in car manufacturing companies

One of the most important assets of Japanese car manufacturers is the way they conduct their business, their work culture and the attitude towards the every-day activities of workers, supervisors and managers altogether which enable a high productivity.

In the 1980s studies indicated that Japanese firms, particularly Toyota, had achieved the highest levels of manufacturing efficiency in the world automobile industry. Physical productivity of the Japanese companies had been significantly higher than within most of the manufacturing facilities in the United States. This showed the remarkable efficiency of not only generating output, but also the effectiveness of the Japanese in work-in-progress activities and the associated labor, which also translated into higher rates of inventory turnover. The Inventory turnover indicator is aside productivity a very useful measure of efficiency, since it is a reflection how well manufacturers meet market needs and can transform inventory into sales figures. Moreover inventory turnover reflects how effectively the manufacturer is capable of reducing the number of parts and semi-finished goods, which is of considerable importance as these add to operating costs and often cover up inefficient practices or process errors. [28]

Japanese companies have managed to address this challenge so well, that many authors cite the contributions of Japanese workers and Japanese culture and praise their substantial contribution to a company's organizational culture. The performance of Japanese firms in car production does not solely depend on the empowerment of their Japanese workers, as Japanese innovations in technology and management have also provided an important support for enabling higher effectiveness rates.

In order to fully and properly understand the Japanese work philosophy it is necessary to break it down to some simple work organization concepts which are inter-related and which can only bring results when applied together. After being used one by one, today most car manufacturers employ these concepts in a more integrated manner, thus helping them improve productivity and reducing the gap between the European and American carmakers and the Japanese ones in terms of overall efficiency [32].

Some of the most important Japanese terms which have entered automotive industry terminology are:

1) Long-term strategy
2) Just-in-Time (JIT)
3) Kanban (English: Sign, Index Card)
4) Heijunka (English: Production Smoothing)
5) Chaku-Chaku (English: Load-Load)
6) 5S: Seiketsu (English: Sanitizing) – Seiri (English: Organizing) – Seiso (English: Cleaning) – Seiton (English: Straighten, tidying up) – Shitsuke (English: Sustain, discipline)
7) Muda (English: Waste) – Mura (English: Unevenness) – Muri (English: Overburden)
8) Genba (English: The actual place, the place where the real work is done) – Genchi Genbutsu (English: Go and see for yourself)
9) Jidoka (English: Autonomation = automation with human intelligence) – Poka-yoke (English: fail-safing - to avoid (yokeru) inadvertent errors (poka)
10) Kaizen (English: Continuous Improvement)
11) Obeya (English: Large room, war room)
12) Nemawashi (English: Laying the groundwork, building consensus, literally: Going around the roots)
13) Lean philosophy and work culture
14) Hansei (English: Self-reflection)

1) Long-term strategy

Maybe the first important element in the Japanese work philosophy is the word long-term. Why long-term? Because everything which is released by the production floor has to be of such a high quality that it will last in time and will save the company money by avoiding warranty costs, faults or other issues and customer complaints related to product manufacturing.

Depending on the source, the word long-term is defined differently: "lasting, staying, or extending over a long time: long-term prospects" [23], "covering or involving a relatively long period of time” [122] or “being or indicating a relatively great or greater than average duration or passage of time or a duration as specified” [164].

Japanese cars have a worldwide reputation of being reliable and warranties offered by these carmakers can extend to 7 years, which seriously sets the bar high for the other European or American car manufacturers and creates a new industry standard with which it will be tough to keep up with. The main aspect is related to winning the customer’s loyalty over time, by providing a reliable product with which the customer will be satisfied in that extent that he will once again choose the same brand the next time he purchases a car. Every car brand has its own philosophy, but reliability is one of the most important issues which drives carmaker competitiveness.

2) JIT

Just-in-Time (JIT) is a type of operations management approach which originated in Japan in the 1950s. Just in time is a production strategy that strives to improve a business' return on investment by reducing in-process inventory and associated carrying costs. JIT is a very ambitious strategy, which requires very good organization and very reliable links in order to work properly, but when functioning normally it provides savings with inventory and stocks, as well as associated costs and one of its major advantages is that it operated based on a Pull system, which means only the requested amount of products from the customer is being produced and moved along the supply chain. Toyota and other Japanese manufacturing firms adopted the Pull system and achieved excellent results, thus becoming a benchmark of the automotive industry as the system allowed Toyota and other practitioners to significantly raise productivity, mainly due to eliminating waste [14].

JIT is an approach keen on setting up a zero-stock policy, but although in practice this is not realistic, the Japanese approach still helps a company keep its inventory to a minimum level. Nevertheless depending on the complexity of the supply chain and of the various links which it contains, in certain nodes it is important to keep inventory (for example, bottlenecks). Thus, even though one specific firm may not be carrying inventory, this may simply mean that it chose to outsource its input inventory to suppliers, even if those suppliers don't use Just-in-Time. The benefit for the manufacturer is it does not carry inventory and thus avoids the associated risk but in return for their service suppliers in Japan would usually charge their JIT customers an average 5% price premium. This is also due to the very strict policy of Just-In-Time which requires very much of suppliers, who not only have to be very reliable with delivery times and strict quality requirements, but they also have to meet fluctuations in demand, which is always a challenge they have to manage properly. In order to support suppliers they are generally offered longer-term contracts to ensure that they have a better overview on expected volumes and a certain security within the partnership. By reducing inventory, beside operational and financial benefits, the environmental aspect is equally important, as less fuel and energy gets used to transport goods around [107].

The application of the JIT process mainly relies on Kanban (Japanese for “label”) signals between different points, which are involved in the process, which alert the production workshop when it is time to manufacture the next part or product. Kanban are mainly used as simple visual signals to show the status (presence or absence) of a part on a shelf through labels or tickets. Just-in-Time is thus a method to keep inventory levels at a minimum level and ensuring that the right material, in the exact amount, at the right time and place are available for the production workshop without the safety net of inventory. Inventory is seen as a waste, of financial means with materials, of associated labor costs and work hours, and time, which have a negative effect of the entire flow process. JIT relies on continuous improvement to improve quality and efficiency, which are mainly done by improving process flows through a specific work philosophy based on employee involvement and discipline. Effects of implementing the Kanban system are first of all an improved response time towards customer demands and a more efficient internal process flow which provides important overall savings (time, money) by reducing inventory and its associated risks to a minimum [144].

One of the most important aspects is quality, which had to be at a very high standard when using JIT, thus Toyota had to test and train parts suppliers to assure both quality compliance and on-time delivery. The company decided to eliminate several suppliers and only work with those business partners which could provide the high level of service demanded. A key principle also involved having at least two suppliers for a specific reference in order to prevent shortage on the production floor [105].

When a process or parts quality problem surfaces on the production line, the entire production line has to be slowed or even stopped. No inventory means a line cannot operate from in-process inventory while a production problem is being fixed. Many people in Toyota predicted that the initiative would be abandoned for this reason. In the first week, line stops occurred almost hourly. But by the end of the first month, the rate had fallen to a few line stops per day. After six months, line stops had so little economic effect that Toyota installed an overhead pull-line, similar to a bus bell-pull, that let any worker on the line order a line stop for a process or quality problem. Even with this, line stops fell to a few per week. The result was a factory that has been studied worldwide. It has been widely emulated, but not always with the expected results, as many firms fail to adopt the full system [13].

3) KANBAN

The Kanban system is mainly applied in manufacturing, but it was inspired by a technique used in supermarkets, where all products/components were available to be withdrawn by implementing a specific process to replenish after customers retrieved certain items. In order to be able to implement a JIT philosophy and a Kanban system, 3 aspects have to be managed: first there is the process phase, where flows have to be designed, the processes linked to each other and the capacity of the workstation balanced; next here is the quality aspect involved, where training of workers is of utter importance for overall activity, inspection and workers participation to ensure compliance with methods and quality measures; last there is the organizational part, because managing such a complex system requires good management skills and discipline. In this final phase we refer to the following: schedule balancing, reducing lot sizes, preventive maintenance, reducing lead times, reliable deliveries as well as overall improvement measures (standardization of product design, improving process design/layout, reducing setup times, etc.).

JIT is effective only if it works as close as possible to optimum effectiveness. If there are quality issues and products have to be reworked, this may cause the system to malfunction and cause important disruptions within the flow process and the entire supply chain. Therefore quality is a main pillar in the Just-in-Time production philosophy. Within a JIT system everything works well when demand is stable and rather balanced. When shocks in the demand pattern occur causing fluctuations this will unbalance the process flow and put pressure on the factory. A basic tool to manage this weakness of the JIT philosophy is production leveling which tends to level out and remove these variations.

Just-in-time is a means to improving performance of the system, not an end. Very low stock levels means shipments of the same part can come in several times per day. This means Toyota is especially susceptible to flow interruption. For that reason, Toyota uses two suppliers for most assemblies, after having experienced the 1997 Aisin fire, an event which put the entire company at risk. The Aisin factory produced brake fluid proportioning valves, also known as P-valves. These valves help prevent skidding as they control the pressure on the car’s rear brakes and are used in the braking system of all Toyota vehicles. Luckily, Toyota would be saved thanks to one of its business conducting principles, as it always made a point to maintain high quality relations with its entire supplier network. This brought about a remarkable mobilization by several other Toyota’s suppliers, who immediately took up production of the Aisin-built parts by using the existing capability and documentation.

This episode would teach both the Japanese car manufacturer Toyota and its partners some important lessons and they would manage to solve the problems in only 5 days, even though everyone was expecting the factory to cease operations for at least a couple of weeks. Toyota would thereafter repay its suppliers and also grant them with a bonus for helping out and achieving a remarkable comeback [108].

Today almost all value chains are split into a part made-to-forecast and a part make-to-order by using JIT as this allows to better combine both the advantages of economies of scale (Just in Case) and economies of scope (Just in Time). By integrating the JIT philosophy into its supply chain Toyota reaped huge benefits and has since acquired a benchmark position in the auto industry through high-standard organization.

Main benefits of JIT include among others:

1. Reduced setup times or the consistent reduction of inventory for "changeover" time by using SMED (single-minute exchange of dies)
2. Improved flow of goods from warehouse to shelves by using small lot sizes
3. More efficient use of employees with multiple skills enables employees trained to work on different parts of the process to be flexible and move where they are needed
4. Production scheduling synchronized with demand: if there is no demand for a product at the time, it is not made. Instead workers can focus on other work or participate in training programs, saving the company money
5. Increased emphasis on supplier relationships: since the company itself does not carry inventory it has to assure and support its supply system to be working properly and avoid any problem that may cause a part shortage, thus making the relationship with the supplier extremely important
6. Synchronized process flow: supplies come in at regular intervals throughout the production day in accordance with production demand and the optimal amount of inventory is on hand at any time, thus only what is demanded by the customer is being produced and at a steady rate

7. Minimum storage space: as parts and materials move directly from the truck to the point of assembly, the need for storage facilities is significantly reduced, therefore reducing the associated risks with carrying inventory [98]

4) HEIJUNKA

Production leveling, also known as production smoothing (heijunka in Japanese) is a technique for reducing the uneven demand pattern which in turn ultimately reduces waste in several forms. It was vital to the development of production efficiency in the Toyota Production System and lean manufacturing. The goal is to produce intermediate goods at a constant rate so that further processing may also be carried out at a constant and predictable rate.

Fluctuations in performance on the production line increase waste. This is due to the fact that as in any industrial process the installed equipment, the workers, associated activities must be ready to operate at peak production, as a measure of flexibility. Problems also occur when downstream changes in the order specifications generate a hectic fluctuation for upstream operations, putting pressure and testing the capacity of the organization to properly handle these variations. If customer demand was to be constant, production leveling would be easy, but where customer demand fluctuates, certain techniques are used to level out fluctuations in order to smoothing demand.

The final assembly line at Toyota has an interesting operating process. The Japanese facility never assembles the same Toyota model in one batch. The Japanese carmaker prefers to assemble a mix of its brand models in each batch for a good spread of variety and it also sizes these batches as small as possible. Toyota’s approach contrasts with the classic model of mass production promoted by Ford, where the principle of economies of scale dominated the batch formation. When the final assembly batches are small, the other prior associated processes are linked and synchronized (press operations and changeover times) must be aligned as well and are also shorter, which impose a quick changeover of dies. The changeover time has been dramatically reduced within the last half a century as in the beginning they took two to three hours (1940s), then 10 years later they would drop from one hour to 15 minutes (1950s) and now only take a couple of minutes.

Production leveling can be achieved by either leveling the scheduled volume output or by leveling the product mix to assure better flexibility, the two being quite closely related [36].

5) CHAKU-CHAKU

Chaku-Chaku (Japanese for “load load”) is a term from Japanese used to describe a single-piece manufacturing process in which the worker who is in charge of an area of workstations takes the piece from one workstation to the next. The worker does multiple jobs as he is responsible for setting up and operating each of the machines within his work area from beginning to the end of the production cycle as described in figure 1.5. Chaku-Chaku proves to be efficient in production mainly because all the needed machines to manufacture a part are situated in sequential order in close proximity of each other. Each machine is in charge of performing a different stage of production (turning, drilling, cleaning, testing or sandblasting). The operator simply loads a part and moves on to the next operation, where he unloads the part and loads it onto the next operation in a successive manner.

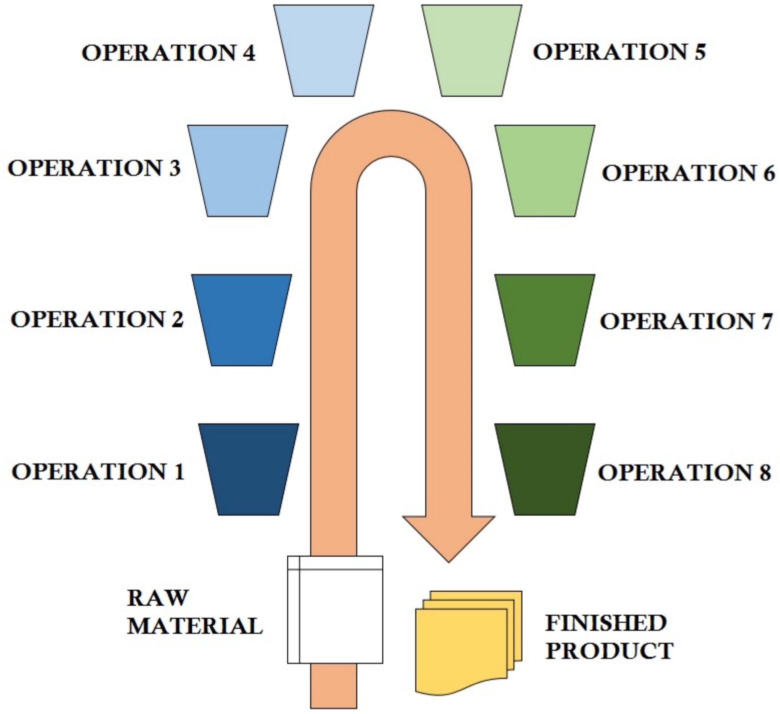


Figure 1.5. Visual representation of the Chaku-Chaku principle [139]

The parts do not wait in front of the machines or between transports from one machine to the other (at most there can be a short buffer time between operations) and are treated rapidly within the designed sequence, making them available very quickly. Another advantage is that the workstation or work area is responsible for the complete manufacturing cycle of the specific part it passes through providing a better follow-up of due deadlines, quality and traceability. The key to the efficient use of Chaku-Chaku is the good synchronization between the operations and the circuit of the worker in order to maximize his occupation and to enable good productivity premises. The most appropriate circuit to be employed in this situation is the U-shaped manufacturing cell.

The process does not need skilled personnel to operate the workstations and one downside is that the work is rather monotonous after some time as operations are done repeatedly. However this allows for system flexibility in accordance to demand volumes and process security is strengthened by both the flexible personnel operating the workstations as well as extra Poka-Yoke measures [139].

6) 5S

5S is the name of a workplace organization method that uses a list of five Japanese words: seiri, seiton, seiso, seiketsu, and shitsuke as a means for productivity improvement. Translated into English, they also start with the letter "S": "sort", "straighten", "shine", "standardize", and "sustain". The 5 principles help better organize a work space and maintain a high efficiency through easy identification and storage of the items used as well as maintaining the area organized. It basically refers on keeping a tidy workplace which will help increase productivity through standardization.

5S is a technique developed in Japan within Just-in-Time manufacturing, but it can easily be applied to other areas as well as practicality and good organization are always part of an effective workplace.

Seiri (Sort) is the first "S" and usually refers to performing the following operations within the work area: removing unnecessary items, eliminating any form of obstacles or unwanted material, preventing the build-up of unnecessary items, assessing the necessary items with regard to certain criteria and removal of all parts not in use.

Seiton (Straighten / Set in Order / Systematic Arrangement) is the second "S" and mainly addresses the following steps: arranging all necessary items in a specific way so they can be easily identified and selected for use, preventing any type of wasteful activity that could lead to loss or waste of time, enabling a system to easily find and pick up needed items, establishing a proper priority system and enabling a smooth workflow.

Seiso (Shine) mainly refers to keeping a proper and clean workplace by first cleaning the workplace completely, inspecting cleanliness, prevent machinery and equipment deterioration and enabling a safe and ergonomic workplace.

Seiketsu (Standardize) is probably the main success factor of the entire 5S method as it is responsible for setting up a standardized workplace through the following activities: standardizing best practices in the specific work area, at all times imposing high housekeeping standards and efficient workplace organization, maintaining everything in their standardized order and in their associated right place and having a standards for each and every process.

Shitsuke (Sustain) is the last "S" but is equally important as the former ones as it implies keeping everything in working order, regularly checking for performance deviations, training to improve the established organization of the work area and the discipline to continuously apply the entire system [62].

Some authors include additional phases to enlarge the 5S methodology (safety, security, and satisfaction), but these do not provide a more comprehensive or more inclusive approach of the traditional method.

7) MUDA

Muda is a term from Japanese which means "futility, uselessness, idleness, superfluity, waste, wastage, wastefulness" [77], and is also part of the benchmark Toyota Production System (TPS) with three different types of concept variation (muda, mura, muri). Waste reduction in one of the measures Toyota promoted to increase its profitability, because it helps processes to increase the share of added value activities and enables the company to provide a service that the customer will pay for. A process will provide value if the amount of used resources and generated waste is as efficient as possible, meaning the ratio between achieved effects and invested effort is as high as possible.

Lean practitioners tend to focus more on muda (waste) than on mura (unevenness) and muri (overburden). This is mainly because muda will most often lead to mura and muri, or in English waste is more likely to generate unevenness and overburden for the factory employees, therefore by carefully analyzing and eliminating the major cause of ineffective performance, overburden and unevenness issues will probably decrease in intensity and only require minor improvement actions. Lean manufacturing and the Toyota Production System promote the principle of separating work processes into added value tasks, non-added value tasks and wasteful tasks. A car manufacturing facility, as any company has to increase the share of its value added activities in its overall activities and try to eliminate all of the wasteful activities it discovers and reducing non added value tasks to a minimum. Lean practitioners use the expression "Learning to see" which describes the critical sense and ability to observe an activity which generates waste where it was initially not perceived as such. Many carmakers have engaged to better understand this ability by attending study visits to Toyota in Japan to see for themselves the differences between their operation system and one that has been under continuous improvement for more than 30 years under the TPS principles or the Lean management philosophy. Toyota's Chief Engineer, Taiichi Ohno identified 7 waste types which emphasize the resources that are wasted during the common production process.

Overproduction occurs when a facility makes more products than is required at a given time and which is not backed up by firm customer demand. Large batches are a common example of this and are also problematic in the sense that if customers demand changes, the amount of produced goods made to stock will be obsolete and will immediately have generated both a waste of time and money. Overproduction is probably the worst kind of muda because it has the capacity to hide and/or generate all the other waste types as well. It also leads to excess inventory, which then further generates the need to assign resources for storage space, activities which do not create added value and which ultimately do not benefit the customer, as he is not willing to pay for them.

Inventory which may refer to an amount of raw materials, work-in-progress (WIP) or finished goods, available on stock at a certain moment is not productive neither for the customer or the manufacturer, although it is important as a safety measure against possible supply issues. Nevertheless if any of the 3 types of inventory do not add value to the product, they are considered waste and should be eliminated or at least reduced to improve effectiveness.

Waiting is very unproductive and is the most classic way to lose time. Whenever goods are not in transport or being processed, they are waiting. These goods are thus either waiting for an upstream process to deliver, for a machine to finish processing, for a supporting function to be completed or even for an interrupted worker to get back to work. In any case waiting is a situation where activity is being put on hold because due to certain reasons transformations on the product are not possible and a buffer time (waiting time) is needed before being able to proceed with operations.

Motion refers to the damage that the production process may inflict on the resources used to actually create the product. This can usually happen over time and generate issues for both the technological equipment used and also for the workers. Issues related to motion could be wear and tear for the technological equipment used in the factory as well as repetitive strain injuries for the manufacturing site’s workers. Other inconveniences may also arise during discrete events as are random accidents that can severely damage used equipment and may also injure workers. The best way to eliminate or reduce this type of waste is to avoid any unnecessary motion of the employees within their workplace.

Transportation is one of the most risky activities that can affect the integrity of the product. This is due to the fact that during transportation (and even when it is just moved about) the product stands the risk of being damaged, lost or delayed, creating inconvenience. Transportation is also an activity which does not make any transformations on the product, thus it does not provide added value and is a source of cost for both the company and the customer. Beside the actual transportation in itself, the transport itself also passes through other risk prone activities as is the handling of the products during loading and unloading, which further increase the risk and chances of damage occurring and is another source of non-added value time.

Defects generate extra costs which account for either reworking the part (when defect is discovered within due time) and rescheduling production or for recalling products after them being launched on the market, which may prove more costly as the brand image will also be affected. This kind of events results in additional labor costs and more time spent by the product in the work-in-progress phase. Another issue is that sometimes defects can even double the cost of one single product, and although it is a source of cost for the manufacturer, it should however not be passed on to the customer, but rather accounted for as a loss.

Over-processing occurs any time more work is done on a piece other than is required by the customer, which translates into higher expenses for the manufacturer without the customer really needing those features. This means the customer will not be willing to pay more for features he did not ask for from the beginning which include using components that are more precise, complex, higher quality or expensive than absolutely required or when inspections are needed rather than a process design which eliminates problems.

Some authors claim there can also be more forms of waste in addition to the 7 classic muda that Toyota promotes, as is non-used employee talent which most often results into unused potential and also may create motivation issues on the long-term. This is mainly because companies employ their staff for specific skills that they need the employees to have in order to perform specific tasks, but those same employees have other skills too and by not enabling them to use their other skills as well the company may lose an important source of creativity.

Other wasteful activities include confusion, mainly due to either missing information or misinformation, confusing goals and metrics which hinder clear and precise understanding of what is to be expected. Waste can also occur due to unsafe or non-ergonomic work conditions which may cause several other problems for workers as are eye fatigue or back problems which affect their physical health and overall motivation and productivity and may be the root for further associated problems [37].

8) GENCHI GENBUTSU

Genchi Genbutsu is another important principle part of the Toyota Production System. The translation of the Japanese term of Genchi Genbutsu means "go and see". The best way to properly understand a situation or issue in-depth within the manufacturing facility is to actually go and see the gemba (Japanese for the “real place”) where the actual work takes place in order to have a clear picture of what is going on and to perceive with one’s own eyes and senses the nature of the problem.

Taiichi Ohno had a very interesting approach to teach this principle to newcomers, as would take new graduates to the shop floor. He would then draw a chalk circle on the floor and ask the graduate to stand there, in the circle. Taiichi Ohno would thus see how well the graduate would overview what was happening and to what extent the graduate would watch and think for himself during that time. The graduate would then provide feedback based on what he observed and wrote down, but if Ohno considered the graduate had not seen enough while he was checking up on him, he would ask him to keep observing. Ohno would thus teach future Toyota engineers that if waste was observed then there would still be non-value added activities to eliminate from the process and that the only way to correctly assess what happens on the shop floor was to go there. This approach is rather obvious as the best decision is usually made when the decision maker has enough data on a problem, and by actually going to see it, time is saved and the chance of making a quality decision increases. Toyota's management would spend a fair amount of time here to increase the share of its value added activities in the overall company processes.

Genchi Genbutsu is sometimes referred to in English as "Getcha boots on", the wordplay implying the actual meaning of the Japanese principle. Going to see the gemba was an important factor at Toyota as it did not merely mean to just wander around and visit the shop floor, it was an approach managers used to immediately observe actual issues and unplanned events and solve them as quickly as possible. This principle had the benefit of managers being aware of what was going on on the shop floor as well as it could help identify issues of which the actual workforce were not aware of as they were used to working within the floor and these may not have been clearly visible to them. [90]

9) JIDOKA

The originators of the Toyota Production System, Taiichi Ohno and Sakichi Toyoda, considered Just-in-Time and jidoka the pillars upon which the Japanese company's effectiveness was based. Jidoka is the process of autonomation promoted by the Japanese manufacturer in its companies which is the combined effect of automation and a worker's autonomy. If automation is rather obvious as it refers to machine and equipment productivity, the worker autonomy is more interesting as workers at Toyota had the authority to stop production whenever they saw a problem on the production line. This rather courageous decision of the Japanese company to empower workers to stop production flow in order to fix problems as they occur rather than pushing them down the line to be addressed later was a large part of the difference between the effectiveness at Toyota and other car manufacturers who unsuccessfully tried to adopt Lean Manufacturing.

Autonomation is an essential part of successful Lean Manufacturing implementations, because the Just-in-Time system has to provide impeccable quality, otherwise the system will backfire and not provide the expected and desired results. For the JIT system to prove its results it is absolutely vital to produce with zero defects otherwise these defects will disrupt the production process and bring about wasteful activities towards the end of the process. This is why Toyota is always obsessed with searching for targets that enable continuous improvement, as the Japanese company rapidly understood that only through important and long-term quality improvements can it compete with its American and European competitors.

Jidoka is also known as "intelligent automation", "humanized automation" or "automation with a human touch" as it involves the automatic detection of errors or defects during production. When a defect is detected stopping production immediately draws attention to the problem and is addressed right away to eliminate it as soon as possible for production to restart. Obviously applying the principle means slowing down production but detecting a quality problem earlier and avoiding it to spread throughout the entire process to only be addressed towards the end of the production phase is considered waste and an example of bad practices as well. Toyota preferred to accept the disadvantage of the principle and prioritize finding and eliminating the causes of problems so they do not continually crop up, therefore adopting a long-term strategy rather than a more convenient operational focus.

Autonomation is a more supervisory function than production function, which helps Toyota promote quality as a principle and not as a technology enabled asset through 4 simple steps: first workers need to detect the abnormality, then they need to stop the line and fix the situation as quickly as they can and then they need to also investigate the root cause of the issue and provide a solution for installing a countermeasure to prevent the problem from reappearing. This helps eliminate overproduction and enable immediately identifying, addressing and correcting possible mistakes that may occur in an industrial process.

Jidoka also has the advantage of the machine alerting the worker, thus it relieves him of the effort to continuously judge whether the operations are running as they should, making work more interesting and less consuming. Besides overproduction, defects are also avoided as applying the jidoka system prevents waiting until the end of production to inspect a finished product. Employing the principle from early stages in the process considerably reduces the amount of work that is added to a defective product at the end and also prevents the associated non added value activities. Self-assessment is thus essential, as workers are encouraged to stop the line when a defect is found either within their work station or from the previous workstation. A designated responsible addresses the problem detected by the machine or worker once the production process has been stopped and after the issues have been addressed Toyota also tries to prevent the same error to occur by inserting a so-called Poka-yoke (Japanese term used to avoid mistakes, from poka – mistake and yokeru – to avoid) device somewhere in the production line [124].

10) KAIZEN

Kaizen is another Japanese term which stands for "good change" or “change for better”. Kaizen thus refers to activities that continually improve all functions of the workplace and is usually performed with a proper involvement of all employees starting from the top management right to the assembly line workers and is mainly applied to processes. The aim of Kaizen is to ultimately eliminate waste by implement measures that improve and standardize a factory’s activities and processes. The concept of continuous improvement within the Toyota Production System is well-known as the jidoka principle is a more specific form of kaizen.

Kaizen is not only a mere daily process which has to be carried out, it is part of the Japanese culture to continuously improve the workplace, but its purpose goes even beyond the goal of productivity improvement. This is because Kaizen is a process that tends to also humanize the workplace, eliminate the stressful overly hard work and also enable employees to learn to identify and eliminate waste in the company’s business processes, which will automatically increase productivity.

Applying Kaizen usually refers to following certain steps, very similar to the Plan-Do-Check-Act (PDCA) cycle. The steps start with standardizing an operation and its associated activities, then measuring it (usually by cycle time and amount of in-process inventory), comparing the measured results with the set targets or standard requirements, increasing productivity through innovative measures and then standardizing the new and improved operation found. This cycle is to be applied continuously in order to achieve productivity gains and improve the share of value added activities [91].

11) OBEYA

Obeya is a Japanese concept which can be translated into English as "big room", "large room" or "war room". This concept of Lean management is mainly employed in the project management of Asian companies. Toyota uses obeya for product development, but the principle also enables the Japanese carmaker to enhance effective and timely communication within its factories. These types of meetings mainly employ highly visual charts and graphs to represent program timing and some key or important milestones and emphasize their progress to date. An obeya can also prove very useful and efficient in providing countermeasures to certain existing technical problems within the manufacturing facility or to some scheduling issues. Project leaders gather in obeya to enable team spirit improvement, find ways to shorten time needed to add value and support project success.

The purpose of an obeya is to gather the people involved in new product development and planning and provide an overview of key information which is visually available. This enables the project team to achieve faster communication and makes the decision making process more effective due to the fact that all the essential information is visually presented on walls usually through charts, graphs and drawings, but also through kanban boards or schedules. Obeya is thus an ideal setting for meetings or discussions, as it removes barriers, empowers teams, updates the project team on progress and schedules and enables the coordination of team members' work activities on problem solving.

In practice obeya is often used by multidisciplinary teams to discuss performance or other related topics such as schedule, design, workflow or any other type of problems that came up the prior to the meeting, which are then prioritized and addressed one-by-one using specific processes. Teams may include representatives from departments such marketing, sales, shipping and receiving or purchasing. The main benefits of obeya are that the principle saves time, brings focus and enables reliable communication. Time savings come from the fact that the team working on a project can gather in a room where all the essential information is ready and visually available for fast understanding. The principle also brings focus as the specific and targeted issues are addressed and allow for quality decision-making within the meetings, which enables efficiency. Finally besides the open communication of all important parties, obeya also gives a quick overview on the status of the project to all the interested departments present within the meeting [157].

12) NEMAWASHI

Nemawashi is a further Japanese principle usually employed within the Toyota Production System. The term nemwashi stands for "going around the roots" or "laying the groundwork" and is basically an informal process of quietly laying the foundation for some proposed change or project, which is usually done by talking to those people who are concerned by the matter and gathering their support and feedback. Nemawashi is an important principle to be respected in Japanese organizational culture especially in any major change, as the Asian culture seeks the consent of all sides before any official approaches are considered.

At Toyota as well as in Japan, managers expect to be let in on new proposals and ideas prior to an official setting or meeting. Finding out about something for the first time during the meeting gives the managers the feeling they have been ignored and not respecting the nemawashi principle can mean dismissing the idea. Approaching the manager individually before the meeting gives the proposer the opportunity to introduce his thoughts and to assess their reaction and significantly increases the chance of the idea to get filtered objectively within the upcoming meeting [82].

13) LEAN

Lean manufacturing, also called lean production or just simply "lean" is a very recent Japanese production principle which provides a systematic approach for all staff to target the elimination of waste ("muda") within the current manufacturing process and promotes focusing primarily on value-added activities which bring value to the customer.

There is lots of literature on this topic, which includes a list of tools used within lean, but what is essential is that lean is not about the tools, it’s about the understanding of the philosophy of lean, which is to involve everyone in the factory to reduce wasteful activities and focus only on value-added activities which ultimately provide value to the customer and benefits for the company. It is a continuous process and requires discipline, motivation and involvement and is one of the pillars within Japanese working culture which made Toyota one of the main players in automotive industry.

Toyota's view on Lean management can be summed up in reducing just three different types of waste, which have already been previously stated, namely muda ("non-value-adding work"), muri ("overburden") and mura ("unevenness"). The goal is to expose problems systematically and continuously try to reduce all non-added value activities, improve effectiveness of all processes and improve the value to the customer.

Lean implementation is focused on achieving a very good and effective work flow through flexibility and the ability to make change whenever they are needed to eliminate or at least reduce waste. What is really important is for the employees to understand, appreciate and embrace the concepts part of lean management, because they will actually build the products as it is their implication in the company’s processes that ultimately deliver the customer value. There is one view on lean management which may seem odd for those who are not familiar with the Japanese culture, namely the fact that the cultural and managerial aspects of lean are in fact more important for achieving the targeted overall improvement than the actual tools or production methods themselves. This has also been supported in practice as there are many cases of carmakers implementing lean without successfully achieving targeted effects which are most often due to a poor understanding of lean and its importance throughout all company processes. Applying lean is similar to optimizing the whole process rather than just individually optimizing its component sub-processes [84].

Lean simplifies the work process to the extent that it is easy to understand, do and manage whereas lean thinking goes way beyond improving business profitability. Toyota industrial sites are well known for their efforts to achieve a sustainable waste reduction policy and the Japanese carmaker is well ahead of the “zero landfill” goal, which implies all waste should be recycled within the factory premises. Practicing lean management and enabling lean thinking offers a radically new way to look at traditional goods and service production and in the light of growing CSR awareness lean can have a much better focused approach on supporting sustained benefits at a much lower overall cost, both on financial and environmental level.

14) HANSEI

Hansei means "self-reflection" and is a central idea in Japanese culture. The principle basically means that people are encouraged to acknowledge their own mistakes and to accept possible improvement which is usually related to an important degree of self-awareness and also of one's capacity to objectively assess their own performance.

Hansei is a constant and consistent approach which emphasizes the problems and issues or other things that went wrong during certain processes and suggests creating clear plans for ensuring that these inconveniences will not reoccur in the future. To understand the principle better one needs to focus on a practical example which comes from the Japanese manufacturer Toyota, where even if someone successfully completes a project, Toyota still organizes a hansei-kai (Japanese for "reflection meeting") where a review in conducted on what went wrong within the project. Should the person in charge of that project claim there were no problems at all with the project, they will be reminded by the members at the meeting that within hansei at Toyota no problem is a problem. What the Japanese carmaker is implying with this principle is that the people in charge with that particular project have not objectively and critically assessed their own project to find possible opportunities for improvement. Toyota considers that the failure to deliver critical aspects regarding one's own work or results indicate a certain lack of motivation to meet (or exceed) one's known and expected capacity.

Japanese companies promote hansei within their organizational culture as managers usually get feedback in this form from his subordinates in case of mistakes. The practice is then that the manager is the one who will publicly take the blame, while the department staff will work on solving the issues. Hansei is a continuous and non-ending process of improvement, where there is always room for yet further improvement as one should never become convinced of their own superiority and also learn to manage success with modesty and humility. Interestingly hansei is also applied in politics where Japanese politicians involved in corruption publicly apologize for the inappropriate conduct, step away from the public area for a couple of years only to resume their career after that culturally accepted period where it is believed they have learned their lesson.

"Hansei is really much deeper than reflection. It is really being honest about your own weaknesses. If you are talking about only your strengths, you are bragging. If you are recognizing your weaknesses with sincerity, it is a high level of strength." [90]

The Japanese work organization concepts presented and applied Toyota achieved remarkable productivity results because the Japanese organizational culture understood not only each and every principle individually, but they also understood the entire production philosophy and by applying these two work concepts in their everyday activity, the Toyota facility became a benchmark manufacturing site. Figure 1.6 presents the mechanism of the Japanese work organization concepts which enabled Toyota's effectiveness and which outperformed any other carmaker's efficiency throughout the past decades. The first important principle is to understand that the Japanese philosophy needs time to settle within the common work environment and is a long-term strategy to improve overall activity and achieve productivity, which cannot be achieved in short- or medium-term timespans. Next, the Just-in-Time principle is based on continuously lowering the level of safety stock to such a level where the flow is continuous, suppliers are reliable in quality and delivery times and the occasional interruptions can be handled without inconveniences for the production cycle. The implementation of the Just-in-Time system is enabled by the Kanban system within the plant, which should be understood by all workers and rigorously applied without compromising the features of the Kanban loop and its labeling rules.

The proper use of Kanban within the factory will also enable the production flow to be leveled out (through heijunka) and better respond to customer demand throughout the year as well as contribute to a better production scheduling throughout the year. Chaku-Chaku is a specific principle which can help improve productivity, as the 5S system can apply to any department and increase its effectiveness. These 3 last principles focus on a more operational level of production, but they need to be coupled with the following to improve the production line’s output. First of all the muda principle needs to be a common objective, as reducing waste will spread benefits to the entire plant, not only to production and through constant efforts it can considerably bring back even more benefits for the production department. If any problems occur managers should also take the time to come and assess the situation personally in order to better judge the corrective measures which are needed to restore a proper working climate. Most important, the jidoka principle needs to be encouraged although at the beginning it will prove quite annoying and will stop production several times before it will enable a continuous uninterrupted flow of faultless products. If heijunka, chaku-chaku, 5S, muda genba and jidoka are a more individual approach to the Toyota Production System, the following 3 principles are more team oriented. Kaizen is oriented towards continuous improvement on all levels of the manufacturing facility and will brng about contributions and benefits for all employees, obeya is a project management principle which enables teams to work out what there is to be done very efficiently and nemawashi is a more human way to help strengthen collaboration within the facility among all involved team members.

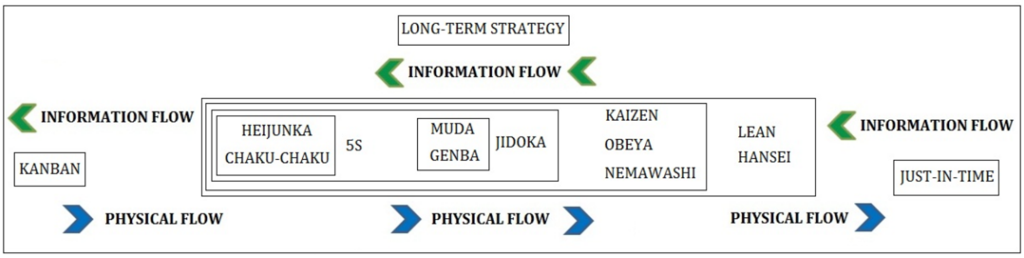


Figure 1.6. Systemic model of Japanese organization concepts

When all personnel is motivated and dedicated towards implementing these changes both on individual level and collective level it is one step away from achieving lean production. The final step is related to self-assessment as hansei will provide the proper guidance for their actions and after these principles properly settle in within the manufacturing facility it will undoubtedly provide impressive changes throughout the factory, help increase productivity and strengthen the company's organizational culture. The main idea is to understand that the successful implementation of the lean management philosophy requires working to improve on several levels, operational, individual, project teams as well as on a collective level with the same motivation and intensity to lay the foundation for achieving benchmark performance on a long-term perspective.

1.4. Role of infrastructure in developing the automotive industry in Romania

One of the hottest debates in recent years in Romania has been the need to prioritize investments in motorways in order to support the national economy, especially local car manufacturer Dacia and the Sibiu-Pitesti motorway [151]. The advantages of a motorway are mainly the higher speeds at which transportation can be performed, the reliability of the time expected to cover routes, better safety and security, less traffic congestions which all imply a decreased risk of accidents and unforeseen events. Romania's road network is mainly made of national roads and highways that are averagely maintained. Problems occur on certain road sectors when traffic congestions become unbearable due to a large amount of passenger cars and trucks, which often lead to accidents or very poor average distance covered by all traffic participants, whether passenger cars, commercial vehicles or trucks. This is mainly caused by the fact that most highways are only two lane-roads which can easily cause traffic congestion when the vehicle flow starts to build up.

Spence & Linneker [138] were amongst the first to argue the benefits of motorway construction in developing the economic system in the UK, while Holl [64] gave the example of Spain, where national policies favored the construction of motorways which lead the country towards one of the most developed European economies. By using European Funds, Spain improved its infrastructure, eliminated traffic congestion, increased inter-community and international relations and overcame recession.

1.4.1. Road and motorway network design

Building motorways needs to focus not only on existing traffic needs but also has to have a more strategic perspective as it should serve and cover the priorities of national and European network interconnectivity. The Trans-European Transport Networks (TEN-T) cross Romania through 3 Pan- European corridors: corridor IV (Arad-Bucharest-Constanta and Arad-Craiova), corridor VII (the Danube) and corridor IX (through Bucharest). Besides the 2 road corridors (IV and IX) the TEN-T core routes include several other main routes through the country which can be financed by the European Union by 85% or even up to 95%. In this sense, Holl [65] outlines the importance of infrastructure projects within economic development, while Stepniak & Rosik [141] emphasize accessibility as a main factor in Poland, where priority was given to motorways within the TEN-T network, where location and international dimension were of utter importance to improve travel times and provided the basis for a market responsive supply chain.

1.4.2. Car industry and economy development through motorways

In addition to the practical advantages for traffic participants and a reconfiguration of route planning opportunities, building motorways is one of the most efficient and synergic investments that can help and support the growth of an economy. Alternative routes will also allow for decongestion of pollution within several cities, as motorways do not pass through them, thus reducing the pollution levels and will thus improve air quality. Furthermore, improved infrastructure, mainly by the construction of new motorways will not only benefit the transportation sector through improved roads, flexibility of route planning and less time spent on roads. They will also provide an important opportunity for Corporate Social Responsibility (CSR) policies and the redesigning of current supply chains into green supply chains.

Building motorways creates a snowball-effect in the economy and helps both the vertical and horizontal industries within the area where it is built. On the short term it creates jobs, creates demand for the industry to produce concrete, steel and other materials needed to complete the motorway, but also small businesses within the area will also benefit, as workers will more likely prefer spending their money within the premises due to convenience, thus creating demand in other businesses as well. Figure 1.7 summarizes the dynamics brought about in the economy by the investments in infrastructure, more generally, and by the construction of motorways, more specifically. This is especially the case for those countries which lack an extensive and well-thought network of connecting infrastructure that enables proper movement of goods and people. As the road sector is the most flexible of all means of transportation and the most widely used one, having a sound road infrastructure is utterly important for the functioning of the economy. Motorways are the best possible investment in roads as they imply higher speed limits, significantly reduced risks of accidents and road blocks due to opposing lane separation and, most important, they provide a much better reliability in transportation times, as time is a critical factor in any economic activity or business.

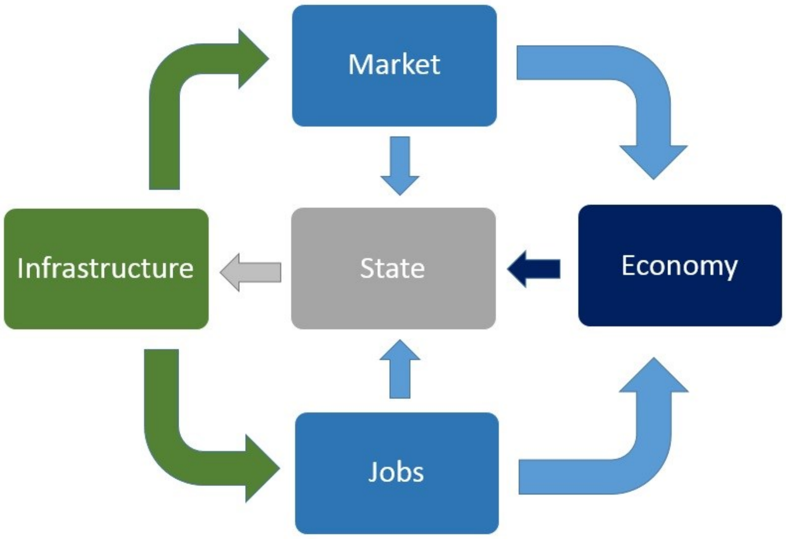


Figure 1.7. Dynamics of economic development generated by investments in infrastructure

By building more motorways, through the creation of jobs, the economy will most likely feel the extra amount of money generated and spent by these investments and the Gross Domestic Product (GDP) will grow accordingly within the same year creating economic growth. This will in turn create new demand and hence the effect will spread towards other industries and businesses as well. As motorway completion usually takes a couple of years, the economy will have time to adjust to changes and its dynamics will further create a noticeable increase in the average national salary. As motorway sectors and even complete motorways will start being finished businesses and companies will reconfigure their routes and make savings through the improved infrastructure. According to Dacia, the Sibiu-Pitesti motorway would help the Romanian carmaker shorten its delivery lead time by a couple of hours within national transport and savings would add up to 14 million euros per year. Savings made through time and cost reduction could thus enable investments which can further develop automotive industry and other businesses and raise salaries for employees and personnel. Within 5 years businesses will grow and the effects of the economic growth will start being felt by car industry as well, as the number of new cars sold towards the population will begin to grow thus further helping national economy. Besides the global effects of motorway construction and their potential to improve a country's level of life, the car industry and more important the automotive industry will feel an increase in demand and in business opportunity. Salaries in the automotive industry are already competitive and easily exceed the national average and more business within the sector will create the premises for carmakers to compete for new customers which will render the sector even more attractive. Automotive industry is an important sector in any economy due to the high added value cars incorporate and due to the extent of the supply chain both on vertical and horizontal level which translate into a high number of jobs.

1.4.3. Relationship between motorways and economic growth

The importance of motorways within a country's economic development can be outlined by comparing data from the most developed European economies, Germany and France, to data from Romania as table 1.2 shows. Germany has seven times, France 12 times more kilometers of roads than Romania, whereas in the former two countries all roads are paved, whilst in Romania less than two thirds are paved. Although just over 2% of the roads in Germany and around 1.15% in France are motorways (only 0.75% of the roads in Romania are motorways), the big difference comes from their extent as they are 20 times (Germany) and 18 times (France) longer than those in Romania. Since 2003 the French have built more than 4,000 kilometers of motorways, the Germany however had built under 1,500 kilometers, as their economies and road infrastructure had already been fairly well developed. Lagging behind, Romania has only built 548 kilometers of motorways in the past 15 years, one of the reasons for the slow and inconsistent economic development.

Germany is one of the most important economies in the world and is the leading European economy with a GDP of 2737.6 billion euros in 2013 and a GDP growth of 0.4%. France is the second ranked European economy with a GDP of 2059.8 billion euros and a GDP growth of 0.3% last year. GDP evolution within the three analyzed countries is provided in figure 1.8.

Table 1.2. Infrastructure data

Data	Roads [km]	Of which paved [%]	Motorways [km]
Germany	644,480	100	12,917
France	1,028,446	100	11,882
Romania	84,887	60.5	644

Although GDP growth in these two countries is not spectacular, the maturity of the economy and the quality of life are so well established that although in percentages the economy does not show significant progress, in absolute figures they represent an extra 6.2 to 11 billion euros. In comparison Romania's unexpected 3.5% growth in 2013 meant only an additional 800 million euros to the economy, 8 times less than in France and 14 times less than in Germany.

Figure 1.8. Economic growth evolution (yearly percentages)

In order to come closer towards a performing economy, Romania needs to give a boost to investments, which is the most important pillar in achieving economic growth, along with exports and consumption. The fact that today Germany's economy is 19 times and the French economy 14 times the size of the Romanian one has also a lot to do with the policies these states applied in order to become solid European economies.

1.4.4. Relationship between average salary and new car sales

An important factor in the potential of a market to become interesting and competitive for carmakers is the average national salary. The higher the salary, the easier it becomes for someone to buy a new car. However if salaries are too low the potential to become an important market for car manufacturers decreases. The average net salary in France and Germany is above 2,000 euros, whereas in Romania it is under 400 euros/month. Being five times as much as the salary in Romania, the German and the French can afford to buy new car a lot easier than their European fellows although their national carmakers are premium (Mercedes, Audi, BMW) or middle-class manufacturers (Renault, Peugeot, Citroen) as opposed to the low-cost Romanian brand Dacia. When comparing Germany with 2.95 million and France with 1.79 million cars sold last year to Romania's mere 57,700 one can observe that the Germans sell more than 50 times while the French sell more than 30 times that same amount within a year.

However the Romanian second hand market sold 225,000 cars last year, nearly 4 times as much as the new cars and mostly more expensive German cars, sometimes more expensive than new middle-class vehicles. It may sound as a paradox, but the Romanian car market mainly prefers German brands: one out of five cars is a Volkswagen, one out of three is a Volkswagen or an Opel while Audi and BMW both account for 15%, thus making it 47% for the 4 brands. Mercedes adds an extra 4%, meaning that German brands have a market share of over 50%, whereas the national car manufacturer Dacia only accounts for 6% of the market. Figure 1.9 shows the evolution of new and second hand car registrations in Romania within the last decade. The economic crisis had a major effect in the plunge of new car sales in the year 2009 when registrations dropped by almost 60%, a severe contraction of the national car market. Since then sales have continued the downward trend and are today at half the level of the year 2009, meaning a further 50% contraction, whereas second hand car registrations continue their growth and easily overcame the crisis.

Figure 1.9. Number of new and second hand car registrations in Romania

1.4.5. Automotive industry key economic indicators

Since Dacia launched the Logan model in 2004, being the first carmaker to enter in the low-cost segment, employees of the Romanian brand have always been over the national average salary. In 2004 net wages at Dacia were 20% higher than the national average and have been constantly growing in accordance with the brand's performances. Last year the net average salary at Dacia was around 714 euros, which meant that wages within the Romanian carmaker had practically doubled the national average within the last decade. This in turn brought about an important development for the horizontal industries where around 100,000 people are employed as well as for its national supply chain network. Figure 1.10 provides a comparison in figures between these three countries by average net salary in car manufacturing, average national salary and cars per capita. Salaries within German and French car manufacturers are up to six times higher, but when comparing them to national average they range from just under 15% more in France to just over 35% more in Germany due to the fact that in these countries the whole economy is well-established and not just one sector. The cars per capita indicator showed a constant growing trend in Germany since 2002 until the crisis, but today is has overcome that downturn and is stable around 550 cars per 1,000 inhabitants. In France shy growth can be noticed throughout the last decade, but today with just under 500 cars per capita, France is 5% above its level from 10 years ago. Romania had a level of 137 cars per 1,000 inhabitants in 2002 which increased by over 50% mainly due to new car registrations and Dacia's impressive development until the year 2009 when the crisis began. Since then the growth of 7% to today's 224 cars per capita has been sustained by second hand imports.

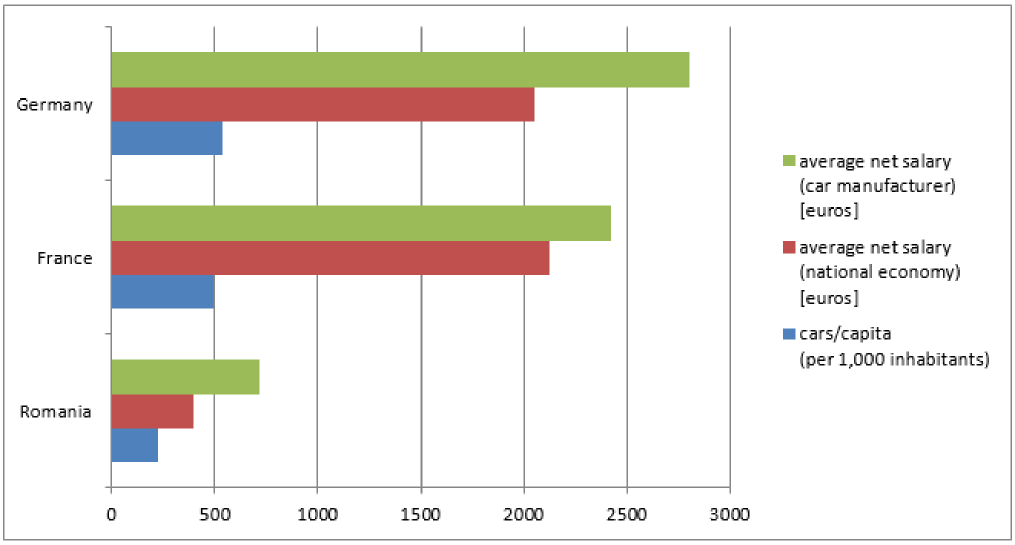


Figure 1.10. Indicators of the level of economic development

The effect of Dacia's development is however marginal, because although it continues to gain market share on foreign markets, it has lost on its home market, which has shifted towards second hand cars rather than new ones. In 2005 Dacia sold 113,246 cars on the local market and since then sales have been following a decreasing tendency. In 2013 Dacia managed a 12% growth in national sales, but with less than 25,000 cars sold is currently sells almost five times fewer cars than eight years ago. Not only that but the entire Romanian market is currently experiencing a downturn as last year 57,700 passenger cars were sold, nearly six times less than in 2007.

The lack of a fairly oriented policy towards supporting the local automotive industry and the economy as well has led to massive imports of second hand cars, mostly premium or German brands which are not productive for national economy and do not contribute towards developing national economy. A more worrying fact is that also very old used cars are imported which are more than 15 or even 20 years old and are sometimes technically out of date or the more recent problem with Romanians registering their cars in Bulgaria and thus eluding national taxation and assurance policies. 2008 was the first year when second hand car imports had overcome new car registrations, while today only 20% of the car market are new cars. The problem with buying a second hand car from abroad is that the money will be introduced in that foreign country's economy (either for buying a new car or for other purposes) and is thus a loss for all car manufacturers who also operate within the national market. As sales drop, investment opportunities and creation of new jobs decrease leading to slow or scarce perspectives for future economic growth and wellbeing for the population.

1.4.6. Conclusions

The strategic importance of motorways in supporting both the automotive industry and the national economy of emerging countries has not been ceased by Romanian authorities to its full extent. The current Transport Master Plan lacks vision and does not take into account the actual needs of companies, transporters or even traffic participants, an issue also outlined by Judge, Werpachowski & Wishardt [72] in Poland, and needs to be reviewed. Consumer needs are constantly shifting as also shown by Wells [158] and thus, besides the companies who are well aware of the challenges they have to meet, authorities have to also keep pace with current developments and provide the needed infrastructure in order to support a well-functioning economy which serves all of these three stakeholders. The International Monetary Fund (IMF) recently suggested that investments in infrastructure would enable and support the revival of national economies on medium term. The document published in the World economic Outlook in October this year suggests that these investments will stimulate the economy and adjust inflation towards right levels and reduce unemployment. The IMF also warns that economic development within emerging countries may be limited if efficiency in infrastructure projects will not be improved and if the selected projects are not viable.

Moreover besides the positive effects of macroeconomic consolidation, infrastructure investments will allow companies within the automotive industry to redesign their transport flows and improve current supply chain responsiveness by reducing traffic congestions, improving lead times and reducing environmental issues within cities. The paper presents a series of indicators within a framework which can serve for further analysis and outlines the capacity of motorway investments to generate overall benefits within the national economy of emerging countries by progressively supporting economic development and increasing the overall quality of life.

2. ANALYZING THE INTRODUCTION AND PROJECT DEVELOPMENT OF THE X90 MODEL AT THE DACIA PLANT IN MIOVENI

2.1. Presentation of the Renault Group and its worldwide network of manufacturing sites

2.1.1. Presentation of the French car manufacturer Renault

Renault was founded in 1899 as Société Renault Frères by Louis Renault and his two brothers, Marcel and Fernand. Louis handled design and production, while his brothers managed the business. The Renault Voiturette 1CV was the first Renault car to be sold and was bought by a friend of Louis' father. By 1903 it started manufacturing its own engines, while two years later Renault would introduce mass-production techniques (1905). In 1908 the company produced 3,575 units, making it the country's largest car manufacturer and also renown for the London and Paris taxis. Renault would also be involved in motor sport as it was seen as a good opportunity of publicity for the brand. Louis Renault became the sole owner of the company in 1909 and would rename it to Société des Automobiles Renault [55].

Shortly after World War I Renault struggled to compete with the more popular small and affordable "people's cars". Renault was surpassed by Citroën for a couple of years as the largest car manufacturer in France. Among other issues, problems with the stock market, the workforce or distribution slowed the company's growth. Renault produced 45,809 cars in 1928, as they ranged from small to very large, with the smaller being more popular. In 1931, Renault introduced diesel engines for its commercial vehicles. Citroën models at the time were more innovative and popular than Renault's. After the Great Depression Renault would regain its position as largest car manufacturer in the Hexagon until the 1980s. The late 1930's would however bring about a series of labor disputes and strikes as an effect of the economic crisis. This caused uncertainty within the workers as unrest spread throughout the French automobile industry. Renault handled the disputes in a particularly intransigent way as eventually around 2,000 people lost their jobs.

After World War II operations at Renault restarted slowly, but in a harsh atmosphere dominated by plotting and political conspiracy. Because Billancourt was a communist stronghold from a political point of view, the French government decided to requisition the Renault factories. In the meantime, the government accused Louis Renault of collaborating with the Germans. He was to be arrested on 23 September 1944, along with other French auto-industry leaders. Due to his harsh handling of the 1936–1938 strikes Louis Renault was left without political allies and was incarcerated at Fresnes prison where he died one month later on 24 October 1944 in unclear circumstances while he was awaiting his trial. In 1945 the company was formally nationalized as Régie Nationale des Usines Renault, making Renault's factories the only ones to be permanently expropriated by the French government. Under Pierre Lefaucheux, the newly appointed administrator of the firm, Renault would experience both a commercial resurgence and labor unrest that would continue until the 1980s. Louis Renault had developed the rear engine 4CV during the war which was launched under Lefacheux in 1946. The car proved to be a capable rival for cars such as the Volkswagen Beetle or the Morris Minor with sales of more than half a million ensuring production until 1961. Then Lefacheux oversaw the Renault Dauphine which sold well in Africa and North America, making the company expand its production and increasing sales.

Renault then launched two successful cars, the Renault 4 (1961–1992) and the Renault 8 (1962-1973). The Renault 4 (also known as R4 or 4L) was a larger, more urban vehicle designed under Chairman Pierre Dreyfus as a practical competitor for the Citroën 2CV. The Renault 10 followed the success of the R8, and was the last rear-engined Renault. The company also achieved good results with the Renault 16 hatchback (1965-1980) and the smaller Renault 6 (1968-1986), making the 1960s a decade of aggressive growth and prosperity for the French manufacturer, despite the workers' strike from 1968 which became a reference in social movements. In 1969, the Renault 12 was launched, a car with a combined engineering philosophy merging the hatchback with the more conservative design. The four-door Renault 12 model fit between the Renault 6 and Renault 16 and was to a real success, being produced until the year 2000. In 1970, shortly after launching the Renault 12, the carmaker made more than one million cars in a single year, building 1,055,803 units, for the first time in its history.

During the 1970s Renault produced the R4, R6, R12, R15, R16 and R17 along with some new models including the compact and economical Renault 5, the Renault 18 and the Renault 20. Throughout the seventies the French carmaker continued to expand globally, including the likes of South East Asia. Renault did not have large or luxury cars in its product line and decided to launch a partnership with Nash Motors Rambler to assemble the Rambler Renault (1962-1967) in its factory in Belgium as an alternative to the Mercedes-Benz "Fintail" cars.

Soon after the company decided to establish subsidiaries in Eastern Europe, most notably Dacia in Romania, and in South America and began technological cooperation with Volvo and Peugeot. However, when Peugeot acquired Citroën and formed PSA, Renault's collaboration with Peugeot was reduced. This did not affect the already established joint production projects which went on as planned. In 1976, Renault decided to reorganize the company into four business areas:

- automobiles (for car and light commercial vehicles or LCVs)
- finance and services
- commercial vehicles (coaches and trucks over 2.5 tons GVW) and
- minor operations under an industrial enterprises division (farm machinery, plastics, foundry, etc.).

In 1980, Renault produced 2,053,677 cars and LCVs. The cars the French car manufacturer made at that time were the Renault 4, 5, 6, 7, 12, 14, 16, 18, 20 and 30. In 1982 Renault become the second European automaker to build cars in the United States, after Volkswagen. However, Renaults quickly became the target of customer complaints for poor product quality and sales plummeted, damaging the image of the brand. The problems with the Renault 14 in the early 1980s had been the most ill-fated for the French carmaker.

Renault was losing a billion francs a month and faced a total loss of 12.5 billion francs in 1984. The French government immediately intervened and appointed Georges Besse as chairman. He set about to restructure the company's activity and started his plan to cut down on costs. First he sold many of Renault's non-core assets, took an important step back from motorsports and laid off many employees. Within two years his plan helped reduce the deficit by 50%, but Besse was murdered in 1986 by a communist terrorist group. Raymond Lévy, who replaced Besse, continued his initiatives and by the end of the year 1987 Renault was once again financially stable.

Renault continued the good spell with its models thanks to the Renault 9 (voted European Car of the Year in 1981), a small four-door family saloon, or the more popular Renault 11 hatchback. Other cars also had good results, as were the Renault 5, which continued to sell well when entering its second generation in 1984 or the Renault 21 which replaced the Renault 18 which added a seven-seat estate to the product range. The top of the range model of the French carmaker in the 1980s was the Renault 25, which was launched at the end of the year 1983. Renault signed an agreement to collaborate with Volvo in 1990 enabling the reduction of vehicle conception costs and purchasing expenses. Volvo would provide expertise in upper market segments and in return Renault provided its designs for low and medium segments. Although intentions to merge existed, Volvo's shareholders rejected the idea in 1994. With an improved marketing effort Renault launched some of its most important models at the beginning of the 1990s. One of today's reference models, the Clio, was even voted European Car of the Year soon after its launch, and was to become one of Europe's best selling cars in that decade. The Twingo in 1992 and the second-generation Espace in 1996 were other successful models for the brand in the 1990s.

Renault was privatized in 1996 because state-owned status was considered a disadvantage. This new status soon led to building a new factory in Brazil and upgrades for its existing infrastructure in Argentina and Turkey. Nevertheless, Renault's financial problems were not all fixed by the privatization. Carlos Ghosn was in charge to handle them and elaborated a plan to cut costs for the period 1998–2000. Among his key points were to reduce the workforce, revising production processes, standardizing vehicle parts and pushing the launch of new models. Meanwhile the French carmaker introduced lean production inspired by the Japanese systems and called it the "Renault Production Way". Renault also searched for a new partner to cope with a consolidating industry and on the 27 March 1999 the agreement with Nissan was signed. The Renault–Nissan Alliance was the first of its kind involving a Japanese and a French company, including cross-ownership. The same year Renault bought a 51% majority stake of the Romanian company Dacia thus, 30 years after the Romanians had started building over 2 million cars that primarily consisted of local versions of the Renaults 8, 12 and 20. In the year 2000, Renault acquired a controlling stake of Samsung Motors, the automotive division of South Korean company Samsung.

In the 2000s Renault impressed with the distinctive styling of the second generation Laguna and the Mégane, which were successful. The French carmaker also had some disappointing models which mere quickly abandoned as the Avantime or the Vel Satis. Besides car design, Renault would also develop a very good reputation with safety with many of its models achieving a 5-star rating by the independent EuroNCAP: Laguna (2001), Mégane and Vel Satis (2002), Espace and Scénic (2003), Mégane Coupé Cabriolet and Modus (2004) or the Clio (2005). Moreover in 2007 the Laguna would receive 36 out of 37 points, with the Mégane securing the full score only one year later (2008). The Renault Grand Scénic would

be the 12th model of the French carmaker to receive the 5-star rating in 2009. Even after recently EuroNCAP made the review process harsher, Renault continues to score 5-star ratings, as is the case with the new Espace (2015).
In more recent years Renault-Nissan launched an alliance with Daimler (2010), finished building a new Dacia factory in Tanger, Morocco (2012) where it makes the Dacia Lodgy and Dacia Dokker, and the second generation Dacia Sandero, a small Renault assembly factory in Oran, Algeria.

2.1.2. Renault innovations

Renault has always been a forerunner in automotive industry and has constantly promoted innovations which have changed car industry throughout the years. Louis Renault began the series with the revolutionary direct drive gear in 1898, which would be followed by the first car with a roof (1899), a starter which could be activated from the driver's seat (1905) and later by the first serial car with four-wheel disc brake system (Renault 8, 1963), turbochargers in Formula One cars (1980), the revolutionary minivan concept of the Renault Espace (1984), Europe's first multi-purpose vehicle, or the innovative and roomy Twingo (1992), the first car to be marketed as a city car MPV.

In 2001 Renault was the first car brand to achieve a 5-star rating at the EuroNCAP crash tests with the Laguna, while in 2004 it started production of the Dacia Logan, the first low-cost model, which has ever since been a great success, even on more conservative markets. Renault has also recently launched the first affordable electric cars, the Kangoo Z.E. and Fluence Z.E.(2011), which are all-electric car concepts, the name "Z.E." stands for zero emissions, followed by the Twizy and Zoe (2012), which made Renault the leader of electric vehicles sales in Europe in 2013.

Four wheel steering would be introduced with the Laguna model (2007), while the Clio would be the first car with an integrated satnav system (2009). At the 2008 Fleet World Honours, Renault received the Environment Award for its impressive range of low-emission vehicles marked eco² and introduced in 2007. These vehicles' CO_2 emissions would not exceed 140g/km, or would be biofuel compatible as an addition to the fact that at least 5% of recycled plastic was used to make these cars the vehicle's materials would have to be reusable to an extent of 95%.

The Technocentre in Guyancourt, near Paris, France is Renault's main research and development facility since 1998. The Technocentre ranges over 150 hectares and joins together all departments involved in product development and industrial processes (as are design, engineering or product planning) and supplier representatives as well. The Technocentre has around 9500 employees which work in one of the eight different areas, gathered in dedicated buildings. There are three main sections:

- L'Avancée, which gathers all the early design stages as are research and development, design and even logistics
- La Ruche, which is the facility dedicated to research and engineering activities for the development process of new vehicles, and
- Le Proto, which is the facility dedicated to building prototypes;

These three main sections are accompanied by five auxiliary technical facilities:

- Le Labo, where research and studies are conducted upon materials and on chemical processes
- Le Diapason, which is the facility dedicated to handling product quality
- Pluton, which is dedicated to computing
- Astéria, where the facility is dedicated to the companies providing engineering services, and
- Le Gradient, which handles all other activities of the Technocentre as are sales, after-sales, etc.

Renault invested around 5.5 billion francs in its research facility, which has 900 meeting rooms, 11,000 computers, 170 servers, 2,000 computer-aided design stations, 4 virtual image walls at a 1:1 scale and 1.5 kilometers of footbridges and covered aisles. The first car fully designed at the Technocentre was the Laguna II, which was then followed by the Espace IV, Mégane III, Scénic II, Modus or the Clio III. Besides the Technocentre in Guyancourt, which is Renault's main engineering facility, the French carmaker also has satellite engineering and design centers, located strategically to match the carmakers' development on its main markets. The engineering center focuses on standardizing processes on a worldwide level: making standards uniform, defining the key functions and harmonizing the technical policies.

Its other engineering centers around the world are Renault Technologie Amérique (with branches in Brazil, Argentina, Mexico, Chile and Colombia), Renault Technologies Roumanie (branches in Romania, Turkey, Russia, Slovenia and Morocco), Renault Technologies Espagne (branches in Spain and Portugal) and the Renault Samsung Technical Center in Giheung, South Korea. In addition to its engineering centers the French car manufacturer also concentrates on a network of four satellite design centers. These centers are virtual tendency observatories, as they draw the designs for cars which will go on new markets. They come forth from the beginning of the projects at the launching phase until the model of the car is finished. The design centers are the Renault Design Central Europe in Bucharest, Romania, the Renault Design America Latina in Sao Paulo, Brazil, the Renault Samsung Design in Giheung, South Korea and the Renault Design India in Mumbai, India. Renault's engineering section has around 7000 employees worldwide, of which a third are engineers and more than 60% are technicians. Overseas engineering is increasing and the teams working in research and development are in charge of adjusting existing vehicles to specific local needs and assigned budgets.

2.1.3. Renault-Nissan Alliance

The Renault–Nissan Alliance is a strategic partnership between the French and Japanese automobile manufacturers Renault, based in Boulogne-Billancourt, France, and Nissan, based in Yokohama, Japan. The agreement between the two companies was signed on the 27 March 1999 by Louis Schweitzer and Yoshikazu Hanawa and Carlos Ghosn was assigned Chairman and CEO of the newly formed alliance. The Renault-Nissan alliance is also the longest-running transnational partnership between two major manufacturers in the automotive industry to date.

Renault–Nissan thus control eight major brands: first of all, Renault and Nissan, as well as six other brands: Dacia, Renault Samsung Motors, Infiniti, Lada, Datsun and Venucia and Lada. The Alliance set up a joint strategic management company in 2002 in Amsterdam, The Netherlands to oversee areas such as corporate governance between Renault and Nissan. The company is equally owned by the two carmakers and provides a neutral location for building strategy, enabling the exchange of ideas and in order to help leverage maximum synergies between the French and Japanese car manufacturer. The car group have around 450,000 employees worldwide and sold 8,470,610 cars in 2014 (a 2.5% increase) behind the top three carmakers Toyota, Volkswagen and General Motors (see figure 2.1). One of the Renault-Nissan Alliances' objectives is to increase sales to 10 million cars by 2016.

The Alliance is also the world's leader in manufacturing plug-in electric vehicles, with global sales surpassing 250,000 electric vehicles by the beginning of summer 2015. The best-selling vehicle of the Renault-Nissan Alliance is the Nissan Leaf all-electric car, with more than 180,000 units sold by mid-2015 and is at the same time the world's top selling motorway-capable plug-in electric car in history. The alliance between Renault and Nissan is however not a merger or an acquisition, but an actual strategic partnership between the French and Japanese carmakers through a cross-shareholding agreement, which maintains individual brand identities and independent corporate cultures. According to the agreement highlighted in figure 2.2 Renault owns a 43.4% stake in Nissan, while Nissan holds a 15% stake in Renault. The agreement between the two car manufacturers ensures that both Renault and Nissan have the same interests and enables the adoption of win-win strategies that are beneficial to both.

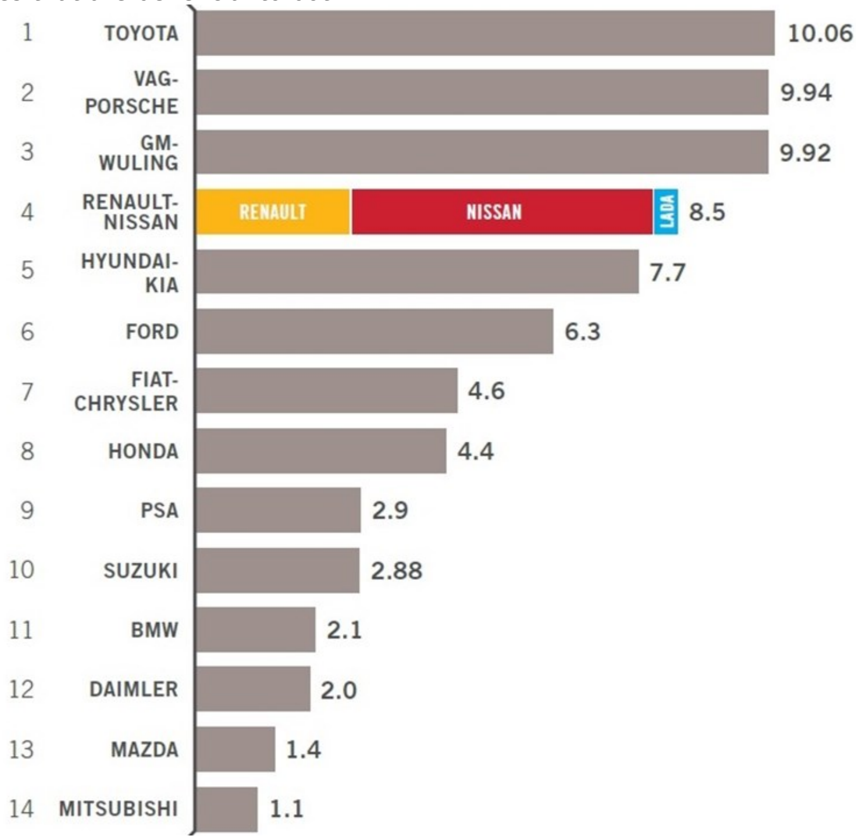


Figure 2.1. Sales results of the Renault-Nissan Alliance in 2014 [54]

Despite the 1990s consolidation trend in automotive industry, the transnational nature of the agreement was however unique and had later served as a model for other carmakers as well (PSA Peugeot Citroën and Mitsubishi, General Motors and PSA or Volkswagen and Suzuki). The Alliance developed and Renault-Nissan formed additional partnerships with other automakers including the likes of Daimler (Germany) in April 2010, Dongfeng Motor (China) or AvtoVAZ (Russia). The Alliance announced a broad strategic co-operation with Germany's Daimler on the 7 April 2010, which joined them by an equity exchange that gives the Renault–Nissan Alliance a 3.1% stake in Daimler and Daimler a 1.55% stake in both Renault and Nissan. Within the agreement with Daimler, among other several projects, Renault would provide Mercedes-Benz with its brand new 1.6 L turbo diesel engine whereas, in turn, Mercedes-Benz would supply the Alliance with a 2.0 L four-cylinder petrol engine.

One of the most important goals of the Alliance is to increase economies of scale for both Renault and Nissan by sharing their infrastructure and local market expertise. Developing engines, batteries, and other key components takes places quicker, is made with reduces costs and has a better chance of being successful on the target market. In this sense Nissan managed to increase its market share in Europe's pretty competitive LCV segment (light commercial vehicles) due to marketing several Renault van models as Nissan brands, such as the Renault Kangoo (marketed also as the Nissan Kubistar), the Renault Master (Nissan Interstar) or the Renault Trafic (Nissan Primastar). Moreover, nearly all diesel engines in Nissan cars sold in Europe are made by Renault, enabling Nissan to increase its sales in Europe, which made Nissan the leading Asian brand in many key markets.

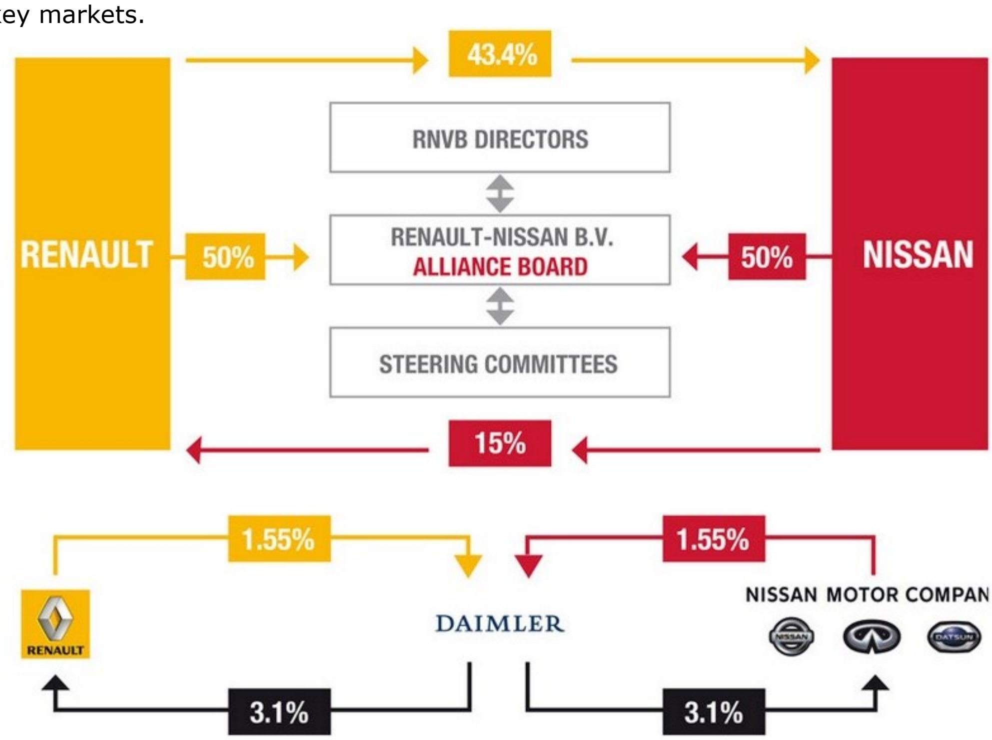


Figure 2.2. The Renault-Nissan Alliance [53]

The Alliance also manages purchasing for both Renault and Nissan, ensuring larger volumes and in turn better pricing with suppliers, as is also the case with its consolidated logistics operations which further reduce costs. Since 2012, the Alliance has benefited from synergies enabled the Common Module Family (CMF). The CMF allows the French-Japanese duo to standardize parts and modules which are invisible to customers, to diversify design and to support flexible manufacturing which in the end provide economies of scale (see figure 2.3).

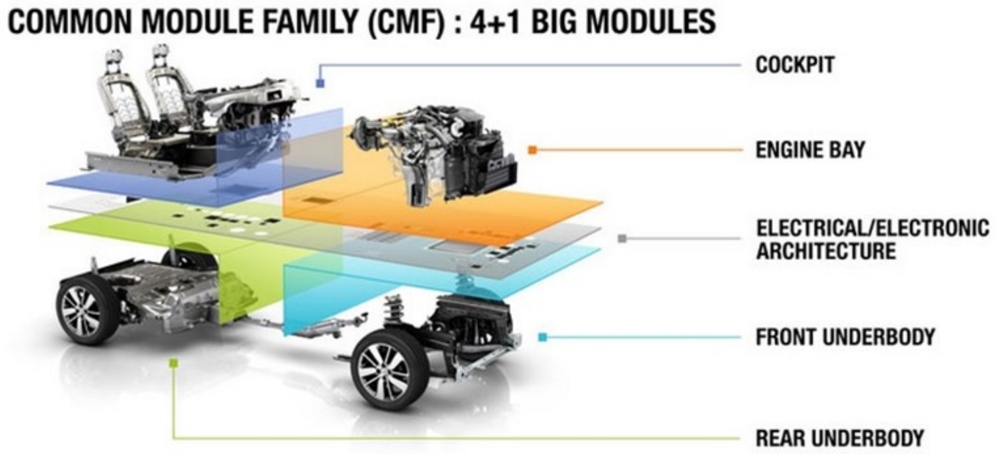


Figure 2.3. Renault-Nissan common module family example [55]

The two companies estimate savings of around 200 million euros per year by sharing warehouses, containers, shipping crates, seagoing vessels and customs-related processing. In 2014, the Renault-Nissan reported synergies of around 3.8 billion euros, with a target level of 4.3 billion by 2016.

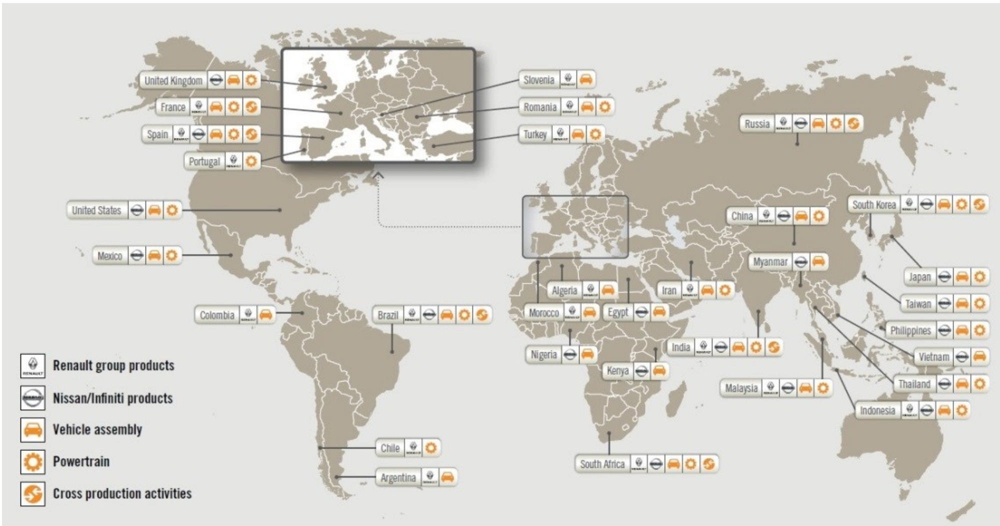


Figure 2.4. Renault-Nissan Alliance manufacturing plants throughout the world [55]

The Alliance also develops and exchanges best practices with one another, by borrowing systems and controls from one company in order to strengthen the other. By applying the "Nissan Production Way" in Renault factories, the French carmaker reported increases in productivity by 15 percent thanks to the new system, which would be adapted to "The Renault Production System". The Alliance also has a very extensive global market coverage, as the plants of the two carmakers are spread throughout every continent and make for a very balanced distribution of manufacturing facilities and associated activities as is shown in figure 2.4.

2.1.4. Renault production sites

Renault has 30 production sites around the world of which 19 are in Europe, 2 in Eurasia, 1 in Asia-Pacific, 4 in Asia-Pacific and 4 in both Africa Middle-East India and South America. Of the 19 production facilities in Europe, Renault has 13 manufacturing subsidiaries inside of France.

These 13 manufacturing sites are located in Batilly, Caudan, Choisy, Cléon, Dieppe, Douai, Douvrin, Flins, Le Mans, Maubeuge, Ruitz, Sandouville and Villeurbanne and are all situated in the more Northern part of France, none of these faciltiies being even close to the Southern part of the country. Some of these facilities are actual Renault factories while others have associated activities towards the manufacturing of Renault vehicles.

RENAULT FRANCE (13)

1) Renault, Batilly
= the factory is called "Société de Véhicules Automobiles de Batilly" (SoVAB) is a subsidiary created in 1980 to operate Renault's LCV (Light Commercial Vehicles) plant located in Batilly, Meurthe-et-Moselle, Lorraine in the northeastern part of France
= the LCVs produced at Batilly by the French carmaker were:
Renault Master I (1980−1997)
Renault Traffic I (1981−2000)
Renault B/Messenger (1982−1999)
Renault Master II/Mascott (1997−2010)
Renault Master III (2010−present)
= there is only a single production line at the Batilly which can reach a maximum of 650 vehicles per day and averages 100,000 LCVs per year with its around 2,400 employees. The 350 different versions of the current Renault Master assembled by the company are sold by Renault (Master), Opel/Vauxhall (Movano) and Nissan (NV400).
= On the 13 June 2013, SoVAB produced its 2,000,000th unit, while last year it made 108,943 Master III units

2) FDB, Caudan
= the "Fonderie de Bretagne" (FDB) is a company created by Renault in 1966 in Caudan, Morbihan, Bretagne under the name of "Société bretonne de fonderie et mécanique" (SBFM)

= the main activity of the FDB is the foundry of ferrous metals such as cast iron and steel in order to make manifolds and parts for the exhaust system for several carmakers
= the factory was a highly specialized foundry with modern technical and industrial equipment and manufactured steel parts and cast iron malleable for cars, trucks, tractors and machine tools, before being sold by Renault to Italian companies in 1998 and 2006
= in 2009 Renault decides to buy back the SBFM and changes its name to "Fonderie de Bretagne" with a plan to renovate the production facilities with an 85 million euro investment
= around 39 million were already spent shorty after Renault bought the facility back from Italian group Zen while a further 35 million will be invested to set up a new production line, which should be ready and operational by the end of 2015 to support the work of the foundry's 560 employees
= in 2014 the FDB produced 26,171 metric tons of aluminum foundry elements

3) Renault, Choisy
= Renault's factory in Choisy-le-Roi, Val-de-Marne, Île-de-France (10 kilometers from the center of Paris), remanufactures and recycles automotive parts such as engines, gearboxes, injection pumps, turbochargers and injector holders and also makes small mechanical parts (springs, gear levers)
= a remanufactured gearbox from Choisy contains, on average, 75% pre-used (but tested) parts, while an engine contains 38% pre-used tested parts, which allows for substantial savings of raw materials; in 2013 a number of 28,200 engines, 20,100 gearboxes and 16,840 injection pumps were renovated, while in 2014 a total number of 179,070 units were renovated (engines, transmissions, injection pumps, turbos and sub-assemblies, short-run machining)
= the factory provides clients with remanufactured parts at very low prices, whilst almost 6,000 tons of metal are recycled in Choisy each year, thus making the factory an active player in the environmental policy of Renault. The site currently employs 325 people.

4) Renault, Cléon
= The Renault factory in Cléon, Seine-Maritime, Haute-Normandie is the main mechanical facility of the French carmaker since 1958 and builds engines (including electric motors) and gearboxes for the Renault-Nissan Alliance
= the factory produces around 700,000 gearboxes and 600,000 engines every year and around 65% of production is exported;
= The plant has 137 production lines while its main departments consist of a foundry, engine machining, engine assembly, a gear shop, assembly of housings, logistics, maintenance and mechanical engineering, where 3,551 employees work
= in 2014 the factory made a total amount of 572,607 engines and 444,665 transmissions and produced a total of 14,537 tons of aluminum foundry elements

5) Renault, Dieppe
= the Renault plant in Dieppe, Seine-Maritime, Haute-Normandie (Société des Automobiles Alpine) is dedicated to the assembly of sports (or other) and motorsports vehicles and the sale of associated spare parts
= the factory has 1 production line and 1 workshop for motorsports vehicles such as the Clio Renault Sport models (Clio Cup, Clio 4 Cup), competition models (Mégane

Trophy, Formule Renault 2.0) or the electric Bolloré Bluecar and currently employs 293 people
= the Renault factory in Dieppe is also the historic site where the legendary Alpine cars were made, like the Berlinette (A110, 1961-1977) and besides manufacturing, there's also a department specializing in spare parts for racetrack and rally cars or single-seaters
= the facility produced a total number of 5,774 units in the year 2014

6) Renault, Douai
= the "Georges Besse" plant in Douai, Nord, Nord-Pas de Calais was founded in 1970 is currently the only Group plant to build Scénic and Grand Scénic along with the Mégane Coupé-Cabriolet. Since 1995, Douai has built most Mégane family models, including Scénic I, which made it the world's first plant to build a compact MPV
= the Renault factory in Douai has 2 production lines and employs 3,835 people where it produced 109,121 vehicles last year (2014)
= in its 45 years, the Douai plant has built over 9.4 million vehicles, of which four million Scénic units, since the launch of the model in 1996. Other models built at the "Georges Besse" factory were the Renault 5 (1974-1984), Renault 4 (1974-1981), Fuego (1980) and Renault 19 (1988-1995)
= Douai will also be the factory which builds Renault's European executive models (the Nouvelle Espace and Talisman) on a platform developed by the Renault-Nissan Alliance, as well as the Scénic IV. A total €420 million have been invested to get the plant ready for these vehicles, mainly new processes and new workshop organization.

7) FM, Douvrin
= the Française de Mécanique (FM) factory founded in 1969 and located in Douvrin, Pas-de-Calais, Nord-Pas-de-Calais is equally owned by Renault and PSA Peugeot Citroën
= the plant has 4 production lines which build 2,810 engines each day with the help of its 2,800 employees, of which 5% are women; Française de Mécanique produces 4 main engine families (3 for PSA Peugeot Citroën and 1 for Renault), as well as its main parts: cylinder blocks, rods, crankshafts, and cylinder heads.
= 611,349 engines were built in Douvrin in 2014 while the factory has manufactured more than 46 million engines since being established

8) Renault, Flins
= founded in 1952 the Renault factory in Flins, Yvelines, Île-de-France (also known as the "Pierre Lefaucheux" plant) is Renault's oldest French bodywork-assembly plant and conducts the pressing, body assembly, paintwork and final assembly of vehicles prior to their distribution across the Renault network
= the factory in Flins has 1 production line and was dedicated to the production of Clio III in recent years, the site also began building the Clio IV and the all-electric city car ZOE in 2012 as well as Clio R.S. bodies and spare parts and employs 2,196 people
= since its establishment the factory has built around 17.5 million vehicles and almost twenty different models, from Juvaquatre to Clio as many of the brand's emblematic models like the 4CV (1952), Dauphine (1956), Renault 4 (1961),

Renault 5 (1972) and the first-generation Twingo (1993) were launched here; last year 119,243 units were produced in the Flins factory

9) ACI, Le Mans
= the ACI (Auto Châssis International) Renault plant was founded in 1920 in Le Mans, Marthe, Pays de la Loire and produces chassis systems (rear axles, front axles, sub frames, cast rotor, lower arms) fitted for Renault vehicles (Clio, ZOE, Kangoo, Master) as well as on Dacia and Nissan brand vehicles (like the Micra) that are built in Europe
= the factory has 88 production lines and 1,732 employees, whereas the activity is organized in three departments: 79 (part pressing, welding, assembly), 81 (welding, rear protection, rear axle assembly) and 8085 (foundry, machining, front axle assembly) and it also has an engineering center.
= ACI Renault Le Mans delivers its products to the Group's bodywork-assembly plants in Europe, as well as in Brazil and Morocco

10) MCA, Maubeuge
= The factory in Maubeuge, Nord, Nord-Pas de Calais was founded by the Société des Usines Chausson (SUC) in 1969 and initially had only two production units (for pressing and body assembly) with the Renault 15 being the first car to be built here
= in 1978, Renault acquired the stake of SUC to found Maubeuge Construction Automobile (MCA). The factory would then go on and build the Renault 18 (1979-1985), Renault Fuego (1979-1985), Renault 21 Nevada (1986-1990), Renault Medallion (for the US market, 1986-1988), Renault 19 Cabriolet (1988-1992) and Renault Express (1989-2000).
= In the 1990s, Renault decided to build the Kangoo LCV solely at Maubeuge, consequently in 2002 the one millionth Kangoo was produced, while in 2006, MCA reached the four million car milestone
= the factory has a capacity of 240,000 vehicles per year and builds the Kangoo II and the Kangoo Z.E. on only 1 production line with the help of 1,821 employees and since 2012 builds the new Mercedes Citan LCV (based on the Kangoo platform) as part of the strategic partnership between the Renault-Nissan Alliance and Daimler
= the plant in Maubeuge manufactured 137,999 vehicles in 2014

11) STA, Ruitz
= the Société des Transmissions Automatiques (STA), which is jointly owned by Renault (80%) and PSA Peugeot Citroën (20%) was founded in 1970 in Ruitz, Pas de Calais, Nord-Pas de Calais specializes in the manufacture of automatic transmissions and produces more than two million in its workshops
= the factory in Ruitz groups manufacture, engineering, service life unit (incident analysis) and standard exchange and is recognized for its technical expertise in specific areas such as cold forging and fine blanking
= the STA also produces gears, planet wheels, sun gears and other transmission components used to make engines or gearboxes with the help of its 547 employees who managed to make 84,225 automatic transmissions

12) Renault, Sandouville
= the Renault plant in Sandouville, Seine-Maritime, Haute-Normandie was opened in 1964 to mark the launching of the Renault 16 and currently builds the Laguna III (hatchback, estate and coupé), the Espace IV and the New Trafic (Trafic III)

= the Sandouville plant has built most of the brand's executive vehicles, including the Renault 15 and 17 (1971-1975), Renault 20 and 30 (1974-1983), Renault 18 (1978-1985), Renault 25 (1983-1992), Renault 21 (1985-1993), Safrane (1992-2000) and Laguna I (1992-2000)
= starting with the year 2000, the Laguna II, Vel Satis and Espace IV, which all shared the same chassis would be built in Sandouville and were followed by the Laguna III (hatchback and estate, 2007) and the Laguna Coupé (2008)
= Renault will supply Fiat with a light commercial vehicle based on the same platform as the New Trafic, which will be manufactured in Sandouville from 2016, based on an agreement between the two carmakers
= the factory was the first Renault group site to receive ISO 14001 certification in 1998 and has significantly reduced its energy and water consumption as well as reducing its waste. It has 2 production lines which build around 65,000 vehicles per year and has 1,751 employees and the plans to extend production figures to 100,000 units per year.
= the Renault plant in Sandouville built a total number of 52,084 cars in 2014

13) ACI, Villeurbanne
= the factory in Villeurbanne, Rhône-Alpes in the metropolitan area of Lyon was founded in 1970 as the "Société Mécanique de Villeurbanne" (SMV) and combines machining and assembly operations. In 1999, the company SMV became part of ACI before becoming a wholly owned subsidiary in 2001
= the site currently produces running gear, primarily for the Renault-Nissan Alliance but also for other manufacturers (Toyota, Volvo) as well as other parts such as front and rear axles, suspension arms, knuckles, hub drums and wheel hubs
= the ACI factory has 23 production lines where 277 people work

Renault has a complete knock-down kit (CKD) factory as well in Grand-Couronne, Seine-Maritime, Haute-Normandie established in 1991 which handles logistics, packaging, shipping, parts delivery to assembly plants outside Europe as completely dismantled vehicles.
The French carmaker also has 2 technical centres in Aubevoye (Eure, Haute-Normandie, founded in 1982) and Lardy (Essonne, Île-de-France, founded in 1951) where Renault conducts the testing of its vehicles (mechanical, bodywork, crash tests) with the help of around 3,000 employees and collaborators (engineers, technicians, pilots).

Moreover, the "losange" brand has an additional facility in Villiers-Saint-Fréderic (Yvelines, Île-de-France), which is a development centre meant to complete the Technocentre as the site is responsible for the design, engineering, industrialization and other projects concerning the commercial vehicle range of Renault (Kangoo, Trafic and Master). An overview of these facilities is provided in figure 2.5 below.

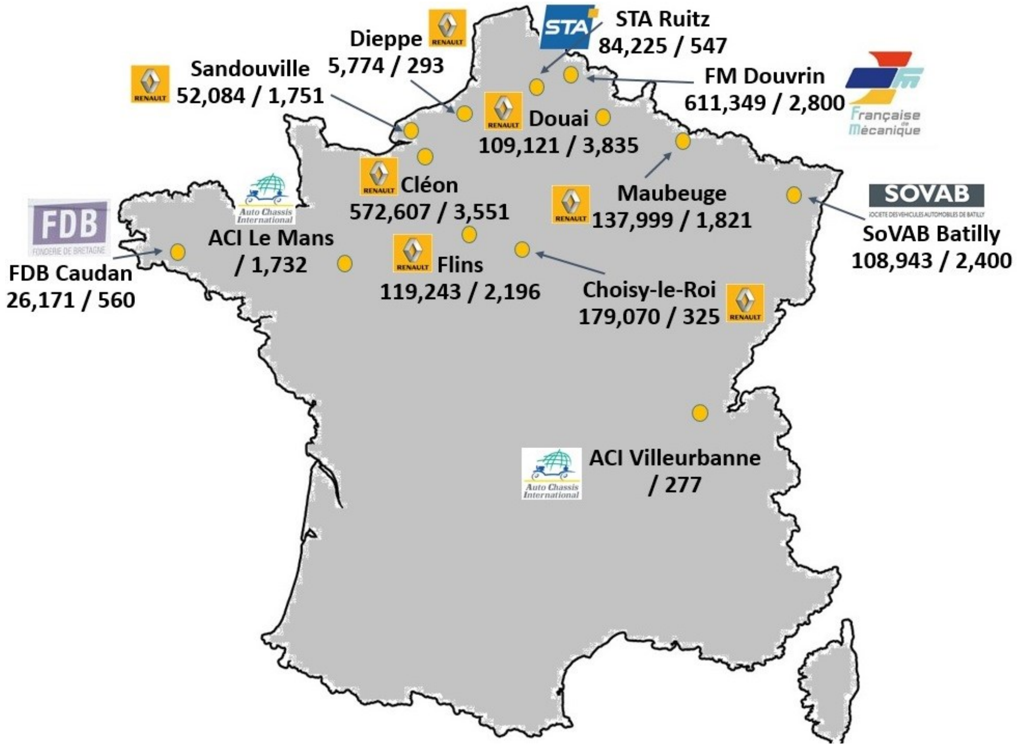


Figure 2.5. Renault production sites in France

Renault has 6 further manufacturing subsidiaries inside Europe, outside France mainly concentrated in Spain.

RENAULT EUROPE (6)

1) Renault España Sociedad Anónima, Valladolid (Spain)
= Renault España Sociedad Anónima, also known by its acronym RESA, which has its headquarters in Valladolid, is one of the largest manufacturing subsidiaries of Renault. The Spain-based company has facilities in Valladolid (bodywork-assembly and engine plants), Palencia (body-work assembly plant) and Sevilla (gearbox plant)

1.1) Renault 1, Valladolid (Spain)
= the Renault factory in Valladolid (the bodywork-assembly site) was the first plant to be built in Spain by Renault and conducts the pressing, body assembly, paintwork and final assembly of vehicles prior to their distribution across the Renault network
= the plant began dedicated bodywork activities in 1964 and assembly in 1972 and has built 17 models including the Renault 4CV, the Renault 8,4, 5 and 12, Super 5, Clio and Modus, making up for a total of more than five million vehicles since its founding in 1953
= the plant currently has 4,898 employees (including the workers from the engine plant) who work on 2 production lines for the Captur and the Twizy and assembled 124,944 cars in 2013 as well as other parts for the Renault group plants, while last year production figures increased to 212,113 units (2014)

1.2) Renault 2, Valladolid (Spain)
= the engine plant in Valladolid was founded in 1970 and is located close to the bodywork-assembly plant
= the factory produces petrol and diesel engines (K9, K4 and H4J in particular) and spare parts (crankcases, cylinder heads, crankshafts, flywheels, camshafts, connecting rods) for the French carmaker and built 1,092,082 engines in 2012, 1,247,579 one year later and 1,457,808 in 2014, an interesting 16.8% increase in activity

1.3) Renault, Palencia (Spain)
= the Renault factory in Palencia was founded in 1978 and currently has built throughout its existence several Renault models, including the Renault 12 (1978-1981), Renault 18 (1978-1982), Renault 9 and 11 (1982-1988), Renault 21 (1986-1991), Renault 19 (1988-1996) and the first two generations of Mégane
= the site is currently dedicated to producing the Mégane III (hatchback, estate, coupé and the Renault Sport version), is one of the largest Mégane manufacturers in the world (58 percent of the model's production in 2011), and conducts the pressing, body assembly, paintwork and final assembly of these vehicles prior to their distribution across the Renault network
= the plant in Palencia has 1 production line and 2,237 employees which built more than 260,000 units in 2011 and over six million vehicles since being established; last year however the facility only made 133,881 vehicles

1.4) Renault, Sevilla (Spain)
= the Reanult site in Sevilla produces gearboxes for the following Renault families: JB (mainly the Twingo), JHQ (Logan, Mégane), TL4 (Scénic, Laguna and Nissan Tiida, Qashqai), JH Base, JE3 and JS3 and powertrain components for other Group plants (Pitesti, Cléon, Aveiro and Bursa, in particular)
= the Sevilla site opened in 1938 initially made spare parts for aircraft, before producing gearboxes for Renault Dauphine (1958) and later being bought by Renault in order to became a specialized in the automotive sector (1965)
= around one million gearboxes are produced here every year (1,011,308 units in 2012 and 938,206 transmissions in 2014) on the 86 production lines by the 1,077 employees, who celebrated the 20 millionth gearbox in 2010

2) Renault, Cacia (Portugal)
= The Renault facility in Cacia, Aveiro also called CACIA (Companhia Aveirense de Componentes para a Industria Automovel) was founded in 1981 and is a Renault subsidiary since 1999
= the factory in Aveiro built both engines and gearboxes before specializing in gearboxes from 2001 (JR and ND models), but the site also manufactures aluminum crankcases, aluminum engine components or oil pumps.
= in 2011 the 1,012 employees produced more than 500,000 gearboxes, which were exported to Renault-Nissan Alliance sites all around the world, while last year 543,963 transmission units were made in the plant

3) Revoz, Novo Mesto (Slovenia)
= the plant in Novo Mesto assembled its first Renault vehicle in 1972 already, the Renault 4, which would become the most-produced Renault model within the

country, but it wasn’t until 1991 that the French carmaker took over the plant when it acquired a 54% majority stake from Revoz. Renault eventually became the full owner in 2004.
= throughout the years the Slovenian factory produced many of the Renault brand models: Renault 12 (1974-1977), Renault 16 (1974-1976), Renault 18 (1980-1987), Renault Supercinq (1989-1996) or the Renault Clio I (1993-1998)
= the Renault facility in Novo Mesto has 1 production line with a capacity of around 200,000 units and currently builds the Clio II and Twingo II city cars (including the Renault Sport version) and the New Twingo/Smart ForFour; the factory also produced the Renault Wind (2010-2014); in 2010 the production output of the Revoz plant was of 212,680 cars
= the 1,992 employees conduct the pressing, body assembly, paintwork and final assembly of vehicles (118,591 units produced in 2014) prior to their distribution across Renault's European network

Renault has a further 11 manufacturing subsidiaries outside France and Europe which range almost all over the world as shown by figure 2.6.

Figure 2.6. Renault manufacturing sites around the world [55]

RENAULT EURASIA (2)

1) Oyak Renault, Bursa (Turkey)
= The Oyak Renault plant opened in 1971, two years after the founding of the company of the same name. In its first year assembled 1,514 vehicles with only 388 employees
= the factory is a joint venture established in 1969 between Renault and Oyak (Turkey's Armed Forces Pension Fund), 51% being owned by Renault and 49% by Oyak

= the factory currently manufactures the following Renault models: Clio III (hatch and estate), Clio IV (hatch and estate), Symbol, Fluence, Fluence Z.E., Mégane III (Génération)
= over the past decades the plant has made some numbered Renaults (12, 9, 11, 21, 19), or the more recent Mégane Sedan and the variants of Clio III. The Bursa factory had the privilege to inaugurate many local 'firsts' over the years, such as the first estate (Renault 12), the first air conditioned vehicle (Renault 12 GTS) and the first diesel engine (Renault 9 GTD)
= the plant has 1 production line for bodywork-assembly and 4 for powertrains (engines and gearboxes) and also builds front and rear axles with the help of its 5,126 employees
= The Oyak Renault plant has a production capacity of 360,000 vehicles a year, making it the largest Renault factory outside Western Europe, and has built more than 4 million vehicles up to date. Production in Bursa provides vehicles for the local market (one-third of output) and for export (two-thirds), as is the case of the Symbol and Fluence sedans as well as the Clio IV city car and also builds one of Renault's electric vehicles, the Fluence Z.E.
= in 2014 the Bursa factory produced 318,198 cars, a number of 239,222 engines, 251,093 transmissions and 636,502 front and rear suspensions and sub frames

2) Renault Russia, Moscow (Russia)
= Avtoframos was founded in 1998 as an automotive joint venture, dedicated to building and marketing Renault group vehicles in Russia, and would in 2014 change its name to Renault Russia, which is 94.1% owned by Renault and 5.9% by Moscow City Hall
= Renault Russia owns a bodywork-assembly plant, with 1 production line and 3,011 employees, where it currently builds five of the Renault Group’s vehicles: Logan, Sandero, Duster, Fluence and Mégane
= the factory’s initial capacity was of 60,000 vehicles/year when it built the Renault Symbol (2002-2004) or when it started building the Logan in 2005 and since 2009, the plant has more than doubled its production capacity to reach an annual output of 160,000 vehicles, which was in line with the production launch of new models in the Logan family
= production figures of the factory in Moscow was 69,000 cars (2007), with an increase to 73,000 units one year later (2008) or to a more impressive 195,112 vehicles in 2013 after investing around 100 million euros starting 2011 to further extend capacity; last year 153,520 vehicles left the factory gates (2014)

The New Logan, fully adapted to suit the local conditions in Russia, was the first Renault model to be manufactured on the joint Renault-Nissan Alliance and AVTOVAZ B0 production line in Togliatti, which at full capacity will can produce 350,000 units a year. Last year the Renault Logan reached a milestone of half a million units sold in Russia. The Lada factory where the Lada Largus, Nissan Almera, the New Logan, Sandero and Stepway are produced will also host the Renault-Nissan Alliance’s largest platform-sharing program.

RENAULT SOUTH AMERICA (4)

1) Renault do Brasil Automoveis, São José dos Pinhais (Brazil)
= the "Ayrton Senna" complex was founded in 1998 and currently manufactures the Dacia models (Logan, Sandero, Duster) as well as the Mégane II and Master III
= the Renault factory in São José dos Pinhais, which is part of the Metropolitan Region of Curitiba, manages pressing, body assembly, paintwork and final assembly of the French carmakers' vehicles prior to their distribution through the Renault network. The Curitiba site has a passenger car plant (bodywork and assembly), an engine plant opened in 1999 (Mecanica Mercosul) and an LCV plant which is run with Nissan as part of the Renault-Nissan Alliance (opened in 2000)
= the Curitiba factory has 2 production lines where 4,439 people work and has built more than one million passenger cars and light commercial vehicles since its opening. Since 2013, the plant will is able to make an additional 100,000 vehicles, which increased its capacity to more than 380,000 units per year
= around 41% of the cars, engines and parts produced in São José dos Pinhais are exported towards Renault subsidiaries in Argentina (22%), Colombia (13%), Romania and Mexico (4%)
= last year the factory in Curitiba made 229,394 cars and 285,609 engines (2014)

2) Renault Argentina, Santa Isabel (Argentina)
= the factory was founded in 1955 and produced the Dauphine, which was followed by the Frégate and the Ondine. In 1967, Renault became the majority shareholder with a 70% stake and after a series of name changes would rename the company to Renault Argentina SA. Over the years, the plant has built a number of brand models: Renault 4 (1963-1997), Renault 6 (1969-1984), the Renault 12, one of its most popular cars in the Argentine market (1970-1994), Renault 18 (1981-1998), Renault Fuego (1982-1995) and Renault 19 (1993-2000).
= at the end of the 1980s Renault's sales in Argentina were hit by the country's economic crisis. Renault Argentina made 70 vehicles per day with an installed capacity of up to 400 and had an aged and overly large workforce. Manuel Antelo bought a stake in the company and reorganized the corporate structure, fired workers and installed facility improvements and managed to bring the level of quality to that of the Renault factories in France. The company then introduced new models on the market (Renault 19, Renault 9) and became one of the leading carmakers.
= In 2010, Renault modernized the Santa Isabel plant, located 10 kilometers away from Córdoba, by replacing the existing installations with a new single-flow production line thanks to an investment of 135 million Argentine pesos. The factory in Santa Isabel currently produces the Clio II, Kangoo & Kangoo Express, Symbol and Fluence with its 1,835 employees who made 80,860 units last year (2014) and produced almost 4,000 tons of aluminum foundry elements

3) SOFASA, Envigado (Colombia)
= located just outside Medellin, the Sociedad de Fabricación de Automotores (SOFASA) factory in Envigado currently builds the Clio II, Logan, Sandero and Duster, all badged by Renault.
= the plant started production in 1970 and initially built the Renault 4 (until 1992), which was followed by other models for the South-American market: Renault 6, Renault 12, Renault 18, Renault 21 and Renault Mégane I.

= the facility in Envigado was the last plant to build first-generation Twingo, after an impressive 18-year career with 99,833 examples built and was also the first company to produce the Renault Logan in the Americas with its 2 flow lines and 644 employees
= in 2014 the Colombian factory produced 69,480 vehicles (Duster, Sandero, Clio II and Logan)

4) Renault Cormecánica, Los Andes (Chile)
= the Renault Cormecánica plant in Los Andes was founded in 1969 and through to 1991 assembled vehicles for local markets like the Renault 4, Renault 12 or the Renault 18
= Renault's factory in Chile is today specialized in gearbox production and assembly and supplies models in the following Renault model families: JB (Clio, Kangoo), JH (Logan, Sandero), JHQ (Fluence) and JR (Duster) and produced almost 350,000 gearboxes in 2011 with its 525 employees
= last year the factory in Los Andes made a total number of 299,515 transmissions (2014)

Renault is also present with a design center in South America, which is based in São Paulo, Brazil and is in charge of adapting the design of the Renault Group vehicles to the reality and requirements of the Latin American market. The center employs 14 experts from different countries, mostly Latin America (Brazil, Argentina, Colombia) and France. The design center in São Paulo is one of the Renault Group's five design centers: the main design center is based in France (Technocentre in Guyancourt, near Paris), and the other four in strategic regions: South Korea (Renault Samsung Design Kihueng near Seoul), India (Renault Design India in Mumbai), Romania (Renault Design Central Europe in Bucharest) and Brazil (Renault Design América Latina in São Paulo).

Within its strategic partnership with Nissan, the French car manufacturer also makes the Renault symbol in the second and newly inaugurated Nissan factory in Aguascalientes, Mexico.

RENAULT AFRICA-MIDDLE EAST INDIA (4)

1) Somaca, Casablanca (Morocco)
= the SOMACA (Société Marocaine de Constructions Automobiles) factory was founded in 1959 by the Moroccan government with technical assistance from Fiat; Fiat ended its production by the end of 2003 and two years later Renault bought the majority stake (54%) of SOMACA from the Italian carmaker (2005) and now owns 80%
= the plant has assembled Kangoo models since 1999, and the more recent Logan model since 2005 and Sandero (including the Stepway version) since 2009
= the plant has a production capacity of almost 80,000 vehicles a year and gives jobs to 1,307 employees who work on 2 production lines which generated a record output of 66,500 units in 2013 (a 14% increase) and 53,334 last year (2014)

2) Renault Algérie, Oran (Algeria)
= The Renault Algérie Production plant in Oran is an ambitious project of Renault and Algeria to develop the automotive industry in Algeria, the second-largest automotive market on the African continent

= the newly inaugurated plant in November 2014 will produce the New Renault Symbol with an annual production capacity of 25,000, which may in the long-term be increased to 75,000; moreover the New Renault Symbol is the first vehicle in Algeria to be equipped with a GPS and will be marketed as Symbol "Extrême", a name clearly distinguishing it as the high-end Symbol model; last year the factory only managed to build 1,093 units (2014)
= the French car manufacturer's industrial project in Oran is the culmination of its presence in the country (more than 90 years), as at the end of the year 2013 the Renault Group had been the unrivalled leader in the Algerian automotive market for 8 years with the Renault and Dacia brands
= after a dynamic recruitment and training policy, close to 350 employees were hired at the plant in Oran, 40% of them being women, while around 500 new jobs were created in subcontracting

3) Renault Pars, Teheran (Iran)
Renault also has a plant in Teheran, Iran which was founded in 2004 as the Renault Pars. Renault Pars is an Iranian joint venture owned by Renault (51%) and Iran's Industrial Development Renovation Organisation (IDRO) with 49%. Renault therefore has a partnership to build the Renault Tondar (actually the Dacia Logan under a different name) with Iran Khodro and Iran Saipa's Pars Khodro, which are the first two Iranian car manufacturers. The Renault Pars joint venture is thus in charge of managing the assembly of CKD Renault cars, which are brought in Iran through the Renault distribution network. Although there are current restrictions applied by the European Union against Iran, the parties are expected to solve these issues by the end of 2015 and production can resume in Teheran. Iran is Renault's 8th international market as of 2012, when the French carmaker sold around 101,000 units on the high-potential Iranian market.

4) Renault India, Oragadam (India)
= the Renault factory in Oragadam, near Chennai, India, opened in 2010, is the first joint Renault-Nissan Alliance plant for global markets and has a production capacity of 400,000 units since 2012 thanks to the opening of a second production line
= the facility represented an investment of 45 billion rupees (around 750 million euros) and employs 1,500 people, who currently see certain Renault models off the production lines as are the Fluence and Koleos (since 2011), the Pulse, Duster and Scala (since 2012) and since 2015 the Lodgy and the Kwid
= the factory near Chennai is the first Renault-Nissan Alliance site to implement a production system based on sharing both companies' knowledge and best practices and allows the plant to produce Renault and Nissan vehicles on the same line thanks to the new manufacturing process
= in 2014 Renault reached a landmark of 100,000 cars sold on Indian roads in less than 3 years of operation in India (around 49,000 vehicles sold in 2014, compared to 64,368 units in 2013)

RENAULT ASIA-PACIFIC (1)

1) Renault Samsung Motors, Busan (South Korea)
= the Renault Samsung Motors plant, owned by Renault (80.1%) and Samsung (19.9%), was founded in 1995 and is located in the south-eastern part of Korea and is part of the Shinho regional industrial complex west of Busan

= the plant mainly builds vehicles in the Renault Samsung Motors range for the local market. These include the SM3 (Fluence), SM3 CE (Scala, Sunny, Almera), SM5 (Latitude) and SM7 (Talisman) sedans and the QM5 (Koleos) crossover, whereas vehicles badged by Renault and Nissan are intended for export
= the facility in Busan has 1 production line and a capacity of around 300,000 vehicles per year, where it conducts pressing, body assembly, paintwork and final assembly of vehicles prior to their distribution across the Renault-Nissan Alliance network
= the Busan site also has an engine production unit and foundry and all in all has 2,179 employees and since September 2014 also builds the Nissan Rogue, after the Alliance invested around 100 million euros to secure an annual production capacity of 80,000 units for the Rogue
= last year a total amount of 153,151 cars and 103,741 engines left the factory gates

The "losange" brand also makes the Sandero model in the Nissan factory in Rosslyn, near Pretoria, South Africa as an agreement within the Renault-Nissan Alliance and has 2 other Dacia facilities in Mioveni, Romania and Tanger, Morocco.

Renault also locally assembles its Duster SUVs in Indonesia due to the partnership with IndoMobil Group. IndoMobil Group is a car and motor vehicle manufacturer founded in 1976 and located in Jakarta, Indonesia. The Dusters made in Jakarta are assembled from semi-knockdown kits imported from India and are sold with a Renault badge outside Europe and Africa.

Dongfeng Renault Automobile Company (DRAC) or short Dongfeng Renault is an equally owned Chinese joint venture based in Wuhan, China between French car manufacturers Renault and Chinese car manufacturer Dongfeng which makes Renault-badged vehicles. The joint venture was founded in 2013 and followed another joint venture (Sanjiang Renault), a previously established partnership between Renault and Sanjiang in 1993. In 1995 Sanjiang Renault began assembling Renault Trafics, but the partnership would be unsuccessful, as the company only built 4,906 units, before it ceased production in 2004. The Dongfeng Renault factory in Wuhan will have an estimated output of up to 150,000 vehicles per year and will start production in 2016 with an initial focus on sport utility vehicles (SUVs) like the Kadjar and the new generation Koleos.

2.2. Presentation of the Dacia plant and its evolution

2.2.1. Presentation of the Romania car manufacturer Dacia

Automobile Dacia was founded in 1966 and is the first Romanian car manufacturer which name comes from the historic region that constitutes much of the area of the current Romania. Romanian authorities wanted to shorten the time necessary to launch a car in the country and decided to start off by building a car under license from a foreign manufacturer and started negotiations with Renault, Peugeot, Fiat, Alfa Romeo and Austin to build a car with a 1 or 1.3 engine and to make around 40,000 to 50,000 units per year. After Charles de Gaulle's historic visit in Romania in May 1968, the Romanian authorities of the time decided to start the collaboration with French carmaker Renault. Only 3 months later, in August 1968 the first car would be finished at the factory in Colibași, a facility built in a record one and a half years. Today Dacia is owned by French car manufacturer Renault (99.4%) and is thus part of the Renault Group brands. Dacia is also the main exporter of the country and accounts for around 8% of Romania's exports whilst its factory in Mioveni is among Europe's biggest car manufacturing facilities in terms of volume produced and one of most productive sites worldwide.

The company was founded as "Uzina de Autoturisme Pitești" (UAP) in the town of Colibași (in 1996 it changed its name and is today called Mioveni), near Pitești. Until the tooling and basic designs for the Renault 12 were ready, the Dacia factory began making the Dacia 1100 in 1968, which was in fact the Renault 8 being built under license. According to the agreement Renault would provide the parts, while the assembly would take place at the plant in Romania. Former dictator of the country, Nicolae Ceaușescu would be the first to drive the Dacia 1100, as the factory would make a number of 37,546 units between 1968 and 1972. Cosmetic changes at the time were very scarce and the Dacia 1100 would only receive a very minor update to its front in early 1970's, while the 1100S would be fitted with twin headlamps and a more powerful engine, but was produced in very limited numbers and would only be used by the police and in motor racing. Figure 2.7 provides an insight to the Dacia plant in its beginnings.

Figure 2.7. The Dacia plant (UAP) in the 1970's [8]

The first Dacia 1300 (a Renault 12 built under license) manufactured by the UAP would be ready in late summer 1969, but just in time for the National holiday parade organized on the 23 August. The Dacia 1300 would also be exhibited during that same year at the Paris and Bucharest shows while Romanians were so delighted and impressed by the car that the waiting lists to buy it were getting pretty lengthy. Although there were other versions of the classic Dacia 1300 being produced, like the 1300L (for Lux) or the 1301 Lux Super, equipped with a heated rear screen, a radio, windscreen mirrors on both sides and a more luxurious trim as opposed to the standard model, they were only available for leading members of the Communist Party. Figures 2.8 and 2.9 provide snapshots of the Dacia 1300 and the model's spare parts catalogue.

Within the following years changes would be prompted by the opening of export markets and new versions appeared as the 1300 Break estate (1973), the 1300F for carrying goods, the 1300S for the ambulance service or the Dacia 1302 pick-up (1975) of which around 2,000 units would be made and sold by 1982. Dacia would in fact develop a large range of passenger cars and vans during 1970 and 1980, as it was the case with a version of the Renault Estafette van (branded as the D6) or the more exclusive Renault 20 by the very early 1980s, branded as the Dacia 2000 on the national market.

Figure 2.8. The Dacia 1300 at the UAP plant [8]

The Dacia 2000 was available only in dark blue or black and due to the model's exclusivity, it was produced in very limited numbers and was of course reserved for the Communist Party elite. By 1978, Dacia would also build a version of the Renault 18. Inspired by the restyling of the Renault 12 in 1975, Dacia would also make some modifications and present the new Dacia 1310, a restyled version of the 1300. The Dacia 1310 had quad lamps at the front, larger lamps at the rear, re-profiled bumpers, a new interior and would be available by the end of 1979 on the Romanian market. It would also be sold in the UK as the Dacia Denem and marketed as an acceptable car, but despite the top of the range model including a five-speed gearbox, alloy wheels and electric windows, the Denem sales were very limited. Although the model was dropped by 1982, the sales of the Shifter, the pick-up version of the same car continued up to 1990, whereas the Aro 10 was also sold as the Dacia Duster, a name which in recent years is making history for the Dacia brand and the Renault Group.

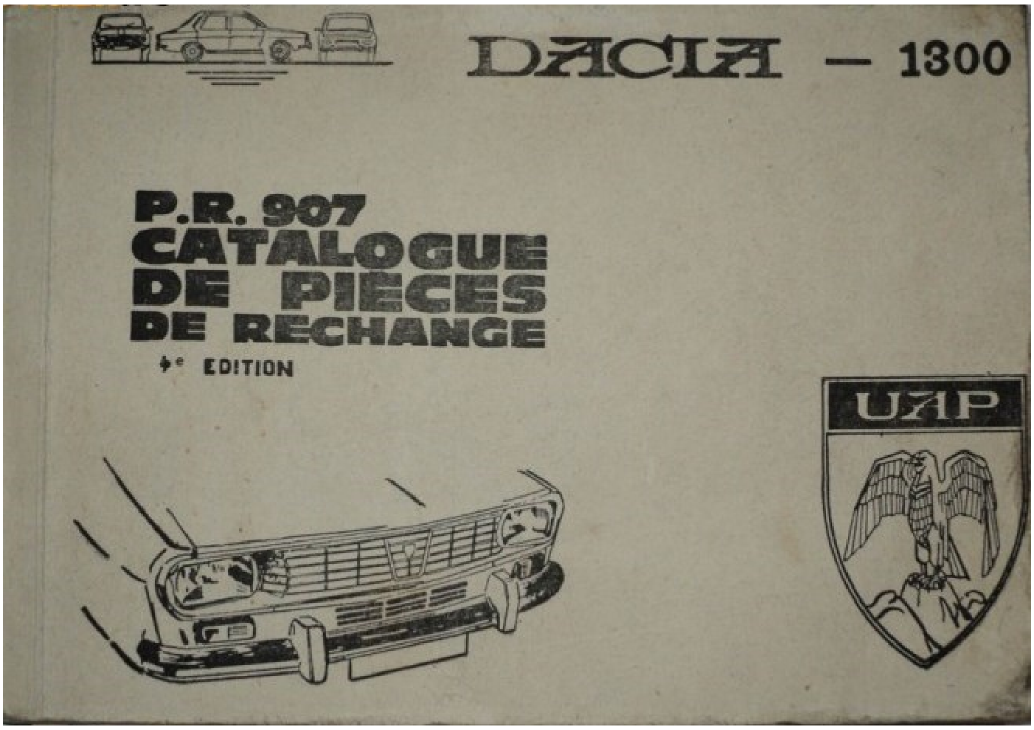


Figure 2.9. The Dacia 1300 spare parts catalogue

In 1978 however the license to make the Renault 12 expired, but the engineers at Dacia autonomously continued production of the model's range and would also implement some changes within the following years. In the early 1980's the Romanian brand would work on the production of a sport version for the younger generation drivers. By 1981 the two-door Dacia 1310 Sport, rebranded as the 1410 Sport only two years later, was on sale. The Sport version would prove very popular for rallies, where drivers had modified the cars as to get the most possible power out of its Renault engine. The designers were still coming up with fresh ideas, but only few of them would actually pass the design stage and would remain only simple designs. Few of them would actually make it into production and today, very few are still in use, but they are eagerly prized by Dacia enthusiasts. The Dacia web forums however are full of evidence about some very rare and odd models produced by the factory throughout the 1980s. After ceasing the production of the 1302 model, Dacia would launch the 1304 Pick-up and 1305 Drop-side models (1982) were introduced, which went on to be a commercial success and remained in production with gradual modifications in line with the rest of the brand range late 2006. The 1410 model would be available starting 1985 with a larger-engine, while the short-lived 1210 economy version would be kept in production until 1992. More slight modifications would arise one year later consisting of a new horizontal rear vent and more chunky rubber mouldings around the front grille. In 1985 Dacia would launch its 500 model, the Lăstun (1985-1991), but due to its unattractive design, bad quality and high price, would only be manufactured for a couple of years. In the meantime Dacia was working on the 1320 CN1 model, a hatchback based on the classic 1310 model. The 1320 CN1 would be distinguishable by a new front end, two larger headlights and a much plusher interior as an indication of owner's status and were mostly owned by high officials of the Communist Party. Despite being the most expensive model in the Dacia range in 1987 when it appeared, the new 1320 would not last long and thereafter be mostly used as taxis until the middle of the 1990s, before getting ready to introduce more modern features in the future model.

After the Revolution in December 1989, production of the quad-lamped models would be stopped, models would receive the front end of the 1320 and the Dacia 1325 Liberta would emerge two years later and would stay in production until the year 1996.

The Dacia Sport would then be dropped due to very poor sales and efforts were made to rejuvenate the model range, as was the case with the new commercial vehicles (the 1307 double-cabbed pick-up or the 1309 estate, which had a tarpaulin instead of a boot and would sell very well on the Chinese market. The cars produced between 1992 and 1994 are pretty particular, because although efforts were made to renew the model range, there were still considerable stylistic hangovers from the quad-lamped models and changes were not applied consistently, which raised questions about the production techniques used at the Dacia factory, which did not seem in line with the more modern expectations. Dacia would nevertheless give its CN model a facelift in 1993 with a reprojected front end that had a horizontal metal line in the grille, new headlamps, front and rear bumpers and a different shape of the front wings. The interior received some modifications too with a new dashboard, while the upper models would have body-colored bumpers, rear head restraints, a radio-cassette, hubcaps, and a black plastic dashboard from the CN1. This model was soon followed by the CN3 which would also be marketed in Europe (1995) and Latin American (1996), although the only differences would be the ones on the trim level and on the radiator grille.

Starting 1994 initiatives to further improve the 1310 range would get even scarcer as Dacia prepared to launch a new model, the Dacia Nova, a hatchback with a pretty rough three-box design. The design of the Dacia Nova was rather outdated, because of the length of its development, as work on its started more than 10 years ago, back in 1983. Although some suggested that the design of the car was in fact a version of the Renault 11 or the Peugeot 309, the Dacia Nova is a 100% Romanian design, which took place after a short end in the involvement of Renault in Dacia. Due to important reliability and rustproofing issues the model did not initially sell well, but after improvements were made to address these problems, the new version from 1996 caught on and would become more present on Romanian roads. The car went on to be sold only for a couple of year before production was ceased, but despite this the Dacia Nova (1995-2000) is however a milestone in Dacia's history, as it would also be the basis on which Renault would come back to increase its involvement in the Dacia factory towards the end of the 1990s.

1998 would be marked as the year when Dacia celebrated 30 years since the first Dacia rolled off the assembly line, when it also produced its 2,000,000th vehicle and when it restyled the 1310 again. This would be known as CN4 and involved a more important restyling of the front end, new door handles, a slightly more restyled rear view mirror and larger tail lights. The load-carrying models followed just one year later (1999) and even if the model was over thirty years old, it still sold exceptionally well which was due to its starting price of only around 4,200 Euros at the time and high availability of parts, but more modern equipping such as a fuel-injection for its engines also helped keep sales volumes high. This was the also the case with the new 1.6 liter engine with mono point injection built by Bosch for the Dacia Nova.

In 2000 Dacia would also launch a special edition for the 1310, called Dacia Dedicaţie, which went into production for the first time as a more luxurious version of the estate. The Dacia Dedicaţie was painted in two-tone silver and had power steering, alloy wheels, body-colored bumpers, electric windows and a far better level of finish, which meant is was also sold at a significantly higher price.
Beginning with the year 2002 the cars would become known as Berlina and Break, with the 1310 lettering being relegated to and made secondary. On the 21 July 2004, the last models of the 1300 series would be produced at the factory in Mioveni, only one month before their 35th anniversary. Nevertheless, the very last saloon version of the Dacia 1310, the one with the number 1,979,730 would be kept at the Dacia Museum which will be finished within a couple of years. Two and a half years later, on the 8 December 2006, the Dacia Pick-Up utility car would suffer the same fate, as the type C 1.6 engine with 68 horsepower would also cease production after having built 2.527.155 units since 1971. Despite many improvements being made (four-wheel drive, a 1.9 diesel engine, Dacia Solenza dashboard, wheels fastened by five studs instead of the classic and archaic three), Romania's entry in the European Union prevented continuing production of old models and the assembly of the Pick-Up had to be ceased.

After thirty-four years of production and more than 2.5 million units of the Dacia 1300/1310 sold, the model was without a doubt the most common car on Romanian roads. During that time, almost everybody owned one or at least learned to drive on it and owners were used to carry out repairs themselves or even do home-made modifications, updates such as newer front ends, which were easy to get, to make them seem more modern or even tuning. Today original early 1300s are quite rare and ones which are well-preserved even more rare. Popular belief would claim that there were two assembly lines during the communist regime, one for those to be sold on the national market and another line producing the same car, but with superior parts and assembled with greater care which would be intended for export. It was also common for Romanians living near the border to purchase their Dacia from neighboring countries, being somewhat convinced of their higher quality level than the ones produced and sold within Romania.

In 1999, Renault bought a 51% stake in Dacia within its strategic approach to make Romania the hub of its automobile development in both Central and Eastern Europe. This meant the factory had to be brought to higher production standards and productivity has to be increased, thus investment was consequently increased and the first objective would be to build a low-cost car for emerging markets within the first 5 years. The first model to have the signature of the French carmaker was launched after only a year, in 2000, with the introduction of the Dacia SupeRNova, an improved version of the Dacia Nova (see figure 2.10). The SupeRNova would be equipped with the Renault engine and transmission from the Clio model and would have a more modern interior styling, as the top-of-the range version had air conditioning, electric windows and a CD player. The top range model cost the equivalent of 5,800 euro at the time, with the basic version being somewhere around 4,500 euro. Sales were surprisingly good, although overall the car concept was still somewhat outdated. Dacia sold around 53,000 vehicles in 2002 and it had a market share of about 50% in Romania at the time.

Three years later Renault would replace the first Dacia model built after the acquisition of the Mioveni plant, the SupeRNova, with a restyled version called Dacia

Solenza, which had a new exterior and interior design, better quality of materials chosen and of finishing touches and the options for an airbag. The Solenza was, however, only an intermediate model built by the Dacia facility before the introduction of the all-important Dacia Logan project of Louis Schweitzer. The model would be made between 2003 and 2005, when its production was ceased and had given the chance to workers to get used to the high demands of manufacturing a model which would be considered acceptable on the more mature Western European markets. In 2003 Renault increased its participation at Dacia from 51% to 99.4%, just one year before launching the Romanian brand's most iconic vehicle within the last couple of decades, the Dacia Logan.

Louis Schweitzer came up with the idea of a cheaper car after a visit to Russia by former French President Jacques Chirac, where he realized that the cheaper Lada, which cost around 6,000 euro, was massively outselling the Renault models, which had a double price tag. He thus relied on technical progress to make a 5,000 euro car, an ambitious project at the time for the French manufacturer. The car would be developed at the Technocentre and is known as the X90 project which also had to meet Schweitzer's three specifications: modern, reliable and affordable with the target price of 5,000 euro.

Figure 2.10. The Dacia SupeRNova model (2000-2003)

After four years of development, the Logan model, with many simplified features to keep costs down, was ready to be launched for emerging markets. The Logan had around 50% fewer parts than a top range Renault model and limited electronic devices, which combined the advantages of producing a car at with fewer costs which at the same time would be easier and cheaper to repair. Moreover, the Logan had much simpler parts than most of its competitors, like symmetrical rear-view mirrors which could be used on either side, a flatter windshield or a single injection-molded dashboard (out of one piece).

The Logan (see figure 2.11) also addressed one of the most important issues, namely the important differences in road and climate conditions within developed and emerging countries. Accordingly the Logan's suspension was soft and strong and the chassis was visibly higher. These features were intended to help the car handle dirt roads and cope better with potholes on ill-maintained roads. The engine of the Logan would also be able to run on lower quality fuels, whereas air conditioning was another important factor, which would be designed to lower the temperature from an average 40 °C or even more, as these were common in the target emerging markets in the Middle East and the Mediterranean Sea. The Dacia Logan is the most successful Dacia model since the original 1300 version, both on national and international markets the different Logan versions have surpassed all expectations and the model is one of the Renault Group's most important assets. The Dacia Logan was launched in August 2004, and despite design-related criticism, it became one of the top-selling cars in Romania, where its sales increased on a month-by-month basis, in Central and Eastern Europe, where its target market was, as well as in Russia. It also received the Car of the Year Award by Autobest in 2005.

Figure 2.11. The Dacia Logan model (2004-2008)

The Logan was not initially intended for Western markets, but the crisis and the great interest in Renault low-cost model made the French carmaker change it initial strategy and today the Logan is sold in a large number of countries, occasionally under the Renault brand in markets where the Renault brand is more important. It only received an average 3 out of 5 stars from the EuroNCAP during crash testing, but it was still by far the best-selling car in Romania, with a market share of 27% in February 2008 and is today a common sight on Romanian roads, similar to the 1300/1310 models before. Renault would also introduce a diesel by 2005 as to prepare for further expansion of the model towards more mature markets. Before it was launched, the Logan was known as the 5000 euro car as this was initially its projected launch price. This was in fact never quite the case, as the basic Logan version had cost 5,900 euro, but still, at that price it was one of the cheapest cars for its size on the market. When the Logan would be sold on Western markets as well, it had a higher starting price, which was due to the fact that the car was better equipped and slightly adapted to those markets than a standard model which would have been sold in an emerging country.

The estate version of the Logan was launched in late 2006 and would be followed by the Logan van (2007), which was basically the estate version with the rear windows filled in and a separate cabin for the driver, which also lead to the cease of production of the Dacia Pick-Up, the classic utility vehicle. Having to cope with such high demand, Renault prepared prior to the launching of the Logan to increase production capacity at the Dacia facility. Thus in 2007 capacity would increase by 50%, from 40 vehicles per hour to 60 vehicles per hour, an equivalent of around 1,300 cars per day and a maximum of 350,000 units a year. The Logan model would also be produced in other Renault factories in Brazil, Russia, Colombia, India, Iran, Morocco and South Africa and sold with the Renault or Nissan badge, Renault Logan (in Brazil, Russia, Ecuador) or Nissan Aprio (in Mexico) or Renault Tondar (in India). Since its launching, the Logan has sold in over 1.5 million units as of 2015 and among its best markets are the French and German market as well. The best markets for the Logan throughout the last 10 years are Romania (513,702 units), Algeria (211,784 units) and France (182,788 units), with Turkey and Germany each coming close with sales of 130,048 and 120,600 vehicles.

The constant growth in activity and productivity for the Dacia factory did not only have its positive side, in March 2008 the workers went on strike and the factory was closed for 3 weeks until the company representatives reached an agreement with the worker union to raise the salaries of the workers with 28% (15% for manager and technicians). The company estimated a 10 million euro loss per day, which added up to around 210 million euro for the 2008 strike. Again in March, this time 5 years later, in 2013 there was a spontaneous strike of the workers which this time lasted only two days, again due to salary negotiations between the union and the company representatives: the union asked for a 25% increase, but the company only offered 5% initially and then 8%, however workers were not satisfied and started the spontaneous strike. The situation was solved during the second day of protests and work was resumed at the end of that same day. The strike of the workers cost the company around 20 million euros and followed after another spontaneous strike which took place 3 months earlier in December, when workers did not agree to 2 days of unpaid holidays and requested an 85% pay during the 3rd and 4th of January. The situation was again quickly solved and work resumed after only 4 hours of strike.

Renault would also set up in 2006 the Renault Technologie Roumanie (RTR) engineering center in Bucharest, Romania, where it currently employing somewhere around 2,500 engineers and a total of 3,000 employees. The main fields of activity of the RTR are the development, testing and design of the new vehicles in the Dacia range, as well as the marketing and technical support. Only one year later, the company set up a styling office as well, Renault Design Central Europe.

Just two years later, in 2008, the Dacia brand would receive two new models: a pick-up model and the new hatchback, called the Dacia Sandero, which also marked the rebranding of the Dacia brand, which adopted a new logo and later the same year launched a facelift of the Logan model.

In 2010, the much awaited first ever crossover SUV built by Dacia after being bought by the French carmaker, the Dacia Duster, was exhibited at the Geneva Motor Show. The Dacia Duster came in both 4x2 and 4x4 versions. Although the Duster was officially revealed in December 2009, it was not available for sale in Europe until March 2010, which would cause an interesting paradox in the carmaker history: as demand was very high for the model, the factory could not keep up with its sales and after the usual 2-3 months of waiting for a new car reached around 6 months for the Duster, the second hand versions already bought had a higher buying price than the new Dusters due to the simple fact that they would be available immediately as opposed to a new car for which the customer had to wait half a year. The Dacia Duster would also receive the Car of the Year Award by Autobest in 2011, six year after the Logan model had received the same prize.

Renault would also inaugurate a testing center in Titu in September 2010 as part of RTR and intended for developing and optimizing new Dacia vehicles. The center in Titu had nine types of tracks with a total length of 32 kilometers and around 100 test benches, used to test the resistance of vehicles and replacement parts to several different conditions, like cold, heat, rain, etc. The year 2012 market the launch of other new models for the Renault Group's most active brand: the Dacia Lodgy, a new compact MPV which would be manufactured at the all-new Renault factory in Tangier, Morocco, as well as the Dokker, a slightly smaller leisure activity vehicle, which would share the same platform as the Lodgy and was available in both passenger and panel van variants. Later that year, in autumn, the second generations of the Logan and Sandero were revealed at the Paris Motor Show, featuring a common front end design, a new engine, improved standard safety features and other new comfort equipment. The Duster would also receive a facelift in 2013 at the Frankfurt Motor Show, the most important being the new turbocharged petrol engine, along with some small modifications to the front and rear ends and the new interior design already available for the Logan II and Sandero II models.

Dacia has only one plant in Romania, which is currently its main facility, located in Mioveni, Romania, together with its headquarters, and has a production capacity of 350,000 vehicles per year. It is divided into several sections, such as bodywork, painting, assembly, mechanical and chassis, foundry etc. Dacia recently opened a new facility in Morocco where it builds its entry models as well as the Lodgy and the Dokker models exclusively. It works in conjunction with the Renault Technologie Roumanie engineering center, located in Bucharest and with the testing center located in Titu. There is also a large logistical center, International Logistic Network, set up near the factory in March 2005, from where complete knock down (CKD) kits are exported to other Renault production sites in Russia, Morocco, Brazil, Argentina, Colombia, India, Iran and South Africa. The logistic center in Mioveni is reported to be not only the biggest logistic center of its kind within the Renault Group, but in the entire world automotive industry, which one can conclude only from its activity in 2012, when the center sent out a total equivalent of CKD kits for 920,646 vehicles worldwide.

Dacia is one of the most dynamic car brand within the last decade, as the Romanian car manufacturer has one of the best productivity figures worldwide. On

the 15 October 2014 Dacia celebrated the production of its 3,000,000th vehicle since 2004, which meant an average of 300,000 cars produced every year within a facility where a maximum of 350,000 vehicles can be produced if work is carried out at maximum efficiency. This means a capacity utilization rate of over 85%, but in reality the plant is capable of making 350,000 vehicles only since 2007, which brings the rate easily between 90-95%, which is remarkable and outstanding for any production site around the world.
Dacia sold a total of 511,465 vehicles in 2014, of which more than 285,000 were exported to Western Europe (55%), the most of them in France (105,893 units) and in Germany (50,704 units). Besides the domestic market, its other key markets are Spain (45,896 units), Italy and Algeria with around 40,000 vehicles and Turkey with just under 35,000 cars sold.

Last year Dacia accounted for vehicles sold in 43 different countries, thus breaking another record and exceeding the 500,000 threshold for the first time in its history and after three consecutive years of an accumulated 49% sales growth, a very impressive development for any car manufacturer.

2.2.2. Presentation of Dacia's production sites

The Romanian carmaker Dacia currently has two plants where it exclusively manufactures the Dacia brand models. The first facility is located in Mioveni, Romania and is the main Dacia factory, whereas the second facility is the 2012 newly built Renault-Nissan plant in Tanger, Morocco (see figure 2.12) [8].

1) Mioveni, Romania
= the Dacia plant in Mioveni started production in 1968 assembled certain Renault models during its first 30 years in operation, the most popular being the Dacia 1100 (Renault 8) and later the Dacia 1300 (Renault 12)
= Renault acquired a 51% stake in Dacia in 1999 which made the Romanian brand part of the Renault group and only one year later the site began building the Dacia SuperNova (2000-2003), the Group's first Franco-Romanian vehicle, which was in fact an improved version of the Dacia Nova. By the end of 2004, the plant decided to stop production of its other models and started building the Logan which turned out to be a milestone model for the Renault Group
= the factory currently builds the Logan, Logan MCV, Sandero, Sandero Stepway, Duster and Renault Symbol on 1 production line where it employs 14,002 people
= the plant produces vehicles and spare parts for Dacia and conducts the pressing, body assembly, paintwork and final assembly of vehicles prior to their distribution across the Renault Group network. Throughout recent years the plant runs close to its maximum capacity of 350,000 vehicles per year, as in 2014 a number of 338,879 left the facility (a highly impressive 96.8% utilization rate)
= besides cars, the facility also produced 332,653 engines, 595,777 transmissions and 1,966,521 front and rear suspensions, axles, sub frames and idler modules
= the plant in Mioveni also manufactures components for Entry range vehicles built in eight other plants around the world (Russia, Brazil, India, Colombia, Iran, South Africa and Morocco) and is a facility of significant importance for the Renault Group as it produces two types of gearbox, two engines and chassis models
= the facility also disposes of a logistics center which ships CKD parts and powertrain components to other vehicle production sites using the M0 platform

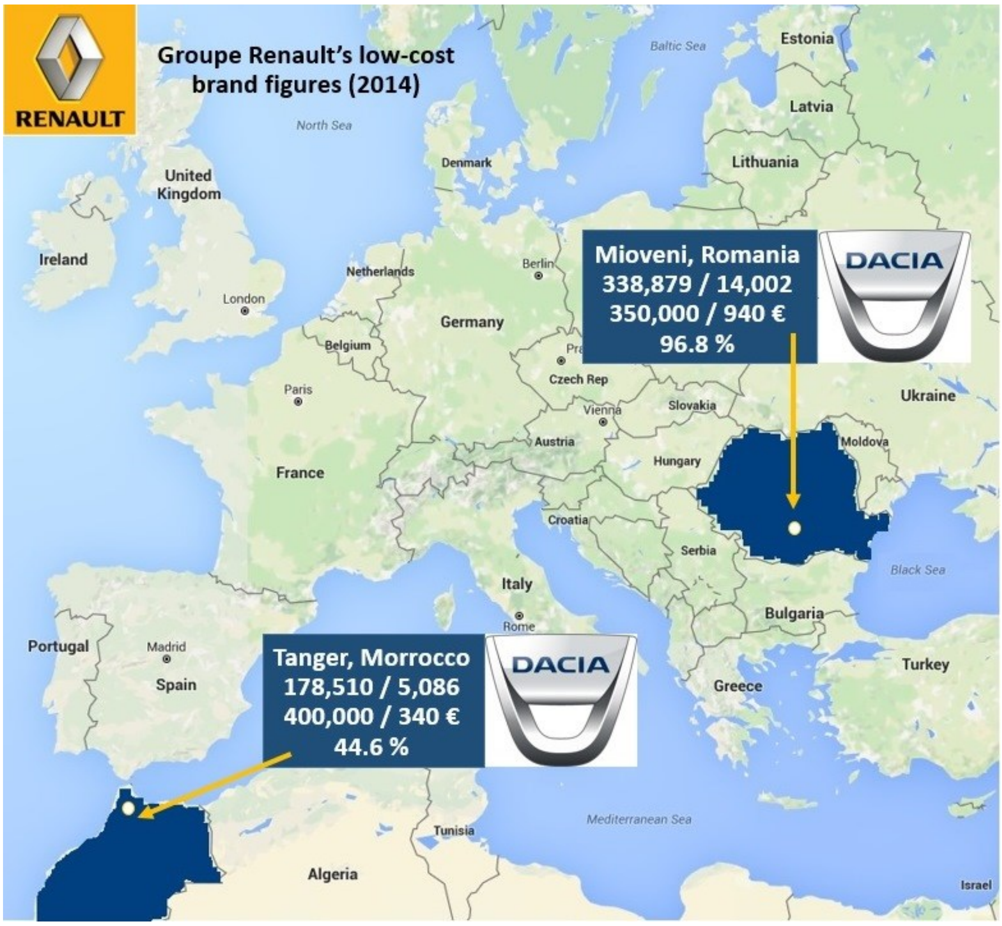


Figure 2.12. Dacia production facilities in Romania and Morocco

The assembly plant ensures both the production of the Dacia range models their respective spare parts and is organized in four main shops: stamping, car body, paint and the assembly. Upon completion of the four stages of the cycle, the cars are sent to the commercial network. Throughout its existence of almost 50 year, the assembly plant has made 8 different models (Dacia 1100, Dacia 1300, Dacia Nova, Dacia SupeRNova, Dacia Solenza, Dacia Logan, Dacia Sandero and Dacia Duster) and over 5 million cars.

The stamping shop has almost 1,500 employees and with the help of 114 manual presses and 1 fully robotized line makes over 350,000 parts per day and uses up around 1,000 tons of steel sheets.

The car body shop has 2,500 employees, 3 assembly flows for the Duster, Logan and Sandero/Stepway/Logan MCV, with the front part being common for all three models which allows for flexibility, as the aluminum parts are made with the help of 900 welding instruments. Although this section has 64 robots, they only do around 5% of welding, mastication and crimping, thus quality manual labor is required to achieve product compliance.

The paint shop uses 8 kg of paint for each vehicle, but although a large range of colors are available, more than 75% of the cars are painted in white, grey or black.

The assembly shop is where all the parts will be fitted to the cars' interior (upholstery, seats, dashboard, windscreen, safety belts and ornaments) and exterior (headlights, the complete engine-gearbox-exhaust system kit and the front and rear axle links). The assembly shop alone employs over 8,000 people.

The facility in Mioveni assembles 1,400 cars daily, which means one car in manufactured every 55 seconds, which is very close to the maximum possible output of 64 cars per hour. In addition the first 3 cylinder engine of the Renault Group (0.9 TCe) is produced at the Dacia plant since 2012 and is a 0.9 liter engine with 90 horsepower. More than 130,000 such engines have been manufactured already as the maximum output rate is of 1,500 engines per day.

The testing center in Titu is subject to an annual 8 million kilometers of driving and the equivalent of 52 years of tests during the 450.000 hours of testing done on the Dacia vehicles. Here the cars simulate driving conditions from all corners of the world, from Russia to the Amazon rainforest, as they simulate driving through rain, wind, saltwater, gravel, sand or ice.

When the cars are ready, they are either sent by train or truck towards their destinations around the world. When delivered by train, the transportation capacity is somewhere between 200-300 vehicles, which are either sent to the port of Constanta to be shipped towards Spain, France or Algeria or towards the city of Valenton in France, a distance of around 2,500 kilometers, which usually takes two and a half days to complete. Every day 3-4 trains leave the Mioveni plant with close to 300 cars each carried by around 20 wagons, whilst another 100-120 trucks carry between 6 and 10 cars depending on the models delivered. The longest time needed for a shipment is 45 days when cars are to be delivered to New Caledonia in the southwest Pacific Ocean.

2) Tanger, Morocco

= the Dacia plant in Melloussa, close to Tanger was founded in 2012 by the Renault-Nissan Alliance and started building the Lodgy and Dokker from pressing to body assembly, paintwork and final assembly to satisfy local and international demand for entry-level models

= the initial investment to build the facility with the necessary infrastructure, offices, workshops (sheet metal and bodywork factory, paint shop, etc.) and the first assembly line added up to 700 million euros while the second assembly line (with a 30 vehicle per hour output, as the first one) required an additional 400 million euros

= after the initial production capacity of 170,000 vehicles per year increased and is getting closer towards its maximum of 400,000 units the factory also recently received the production of the Logan and Sandero models

= the Dacia factory in Tanger has 2 production lines where 5,086 employees work and has won the Production prize in the fifth Sustainable Energy Europe Awards organized by the European Union, for its innovations and ecological performance

= the facility in Melloussa makes the Dacia Lodgy, Dacia Dokker and Dacia Dokker Van on one production line whereas the second production line is dedicated to the assembly of the Sandero and Sandero Stepway models

= after being inaugurated in early 2012 the factory managed to make just under 50,000 vehicles within its first year of being operational (48,870 units in 2012) and doubled its output in 2013 to 100,940 car produced

= production in Melloussa is exported towards 63 different destinations around the world, but mainly France, Spain and Germany import the Dacia "made in Morocco"
= last year the facility in Morocco managed to produce a number of 178,510 vehicles and output is expected to continue growing within the next following years as this year's target is for 250,000 vehicles to leave the factory gates in Tanger (2015)
= the all new Renault-Nissan plant already managed to make the 400,000th vehicle in Tanger in late spring this year and the production rhythm is picking up to get closer to productivity expectations within the near future

2.3. Analyzing the development strategy of the Renault Group in the context of globalization

According to the European Automobile Manufacturers' Association (ACEA) there are almost 300 car production facilities across Europe (both EU and non-EU) as is shown in figure 2.13. These plants produce engines, passenger cars, light commercial vehicles, trucks and buses, whereas ACEA members assemble vehicles in 21 countries in Europe which range from passenger cars to heavy-duty trucks.

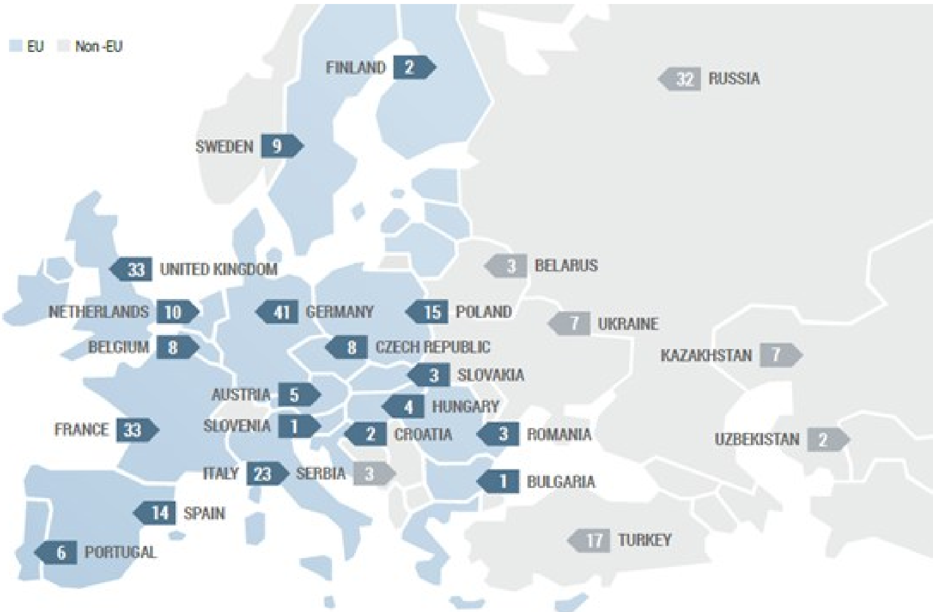


Figure 2.13. Car manufacturing facilities around Europe [1]

Last year car production reached a new peak and has 5 consecutive years of growth, after the slight drop in 2009 caused by the economic crisis. A new record number of 89,747,430 vehicles were produced in 2014, a 2.5% increase since last year which adds up to more than 2.2 million vehicles being made last year (see table 2.1) [111]. China continues to lead production figures with almost 24 million vehicles and a 7.2% increase since 2013, followed by the European Union with just under 17 million cars, which meant an increase of 4.5% in its global figures, while the United States came in third with over 11.5 million units, a 5.3% increase since last year, which showed that the global tendency is one of growth on the car market.

In the top 20 car manufacturers Russia is 11th with just under 1.9 million cars produced in 2014, the second consecutive year of contraction, France is 13th with over 1.8 million cars, followed by the UK with just under 1.6 million. The Czech Republic had an impressive 10.4% increase in production figures to 1,251,220 units thanks to the Skoda brand's continuous success and record year 2014, closely followed by Turkey in 17th place with around 1.2 million as Slovakia came close to the 1 millionth mark with Italy making just under 700,000 vehicles last year.

In Europe Germany continues to be by far the leading car manufacturer, as shown in table 2.2, with almost 6 million units made in 2014, followed by Spain where over 2.4 million vehicles left the factory gates last year, while Russia comes in third despite its more complicated economic and political context. France comes in close to the top three with more than 1.8 million vehicles produced in 2014, with Great Britain in 5th just under the 1.6 million vehicle milestone. The Czech Republic and Turkey the last countries to produce over 1 million cars in 2014, although Slovakia came very close to this mark last year after 3 very good years in car production figures.

Table 2.1. Top 10 countries by motor vehicle production between 2010-2014 [111]

Rank	Country/Region	2014	2013	2012	2011	2010
—	World	89,747,430	87,507,027	84,141,209	80,092,840	77,629,127
1	China	23,722,890	22,116,825	19,271,808	18,418,876	18,264,761
—	European Union	16,976,883	16,240,989	16,240,476	17,707,126	17,107,350
2	United States	11,660,699	11,066,432	10,335,765	8,661,535	7,743,093
3	Japan	9,774,558	9,630,181	9,943,077	8,398,630	9,628,920
4	Germany	5,907,548	5,718,222	5,649,260	6,146,948	5,905,985
5	South Korea	4,524,932	4,521,429	4,561,766	4,657,094	4,271,741
6	India	3,840,160	3,898,425	4,174,713	3,927,411	3,557,073
7	Mexico	3,365,306	3,054,849	3,001,814	2,681,050	2,342,282
8	Brazil	3,146,118	3,712,380	3,402,508	3,407,861	3,381,728
9	Spain	2,402,978	2,163,338	1,979,179	2,373,329	2,387,900
10	Canada	2,393,890	2,379,806	2,463,364	2,135,121	2,068,189

Table 2.2. Number of passenger cars produced in Europe in 2014 [140]

Rank	Country	Production		Rank	Country	Production
1	Germany	5,907,548		11	Belgium	516,832
2	Spain	2,402,978		12	Romania	391,422
3	Russia	1,886,646		13	Hungary	227,030
4	France	1,817,000		14	Portugal	161,509
5	United Kingdom	1,598,879		15	Austria	154,340
6	Czech Republic	1,251,220		16	Sweden	154,173
7	Turkey	1,170,445		17	Slovenia	118,591
8	Slovakia	993,000		18	Serbia	113,000
9	Italy	697,864		19	Finland	45,035
10	Poland	593,904		20	The Netherlands	29,807

Europe is one of the world's largest producers and markets for cars, as they are still the number one source of mobility on the old continent. In Europe around 70% of journeys are made by car, whether it is a personal car, taxi or through car-sharing. One out of five cars in the world is manufactured in the European Union (17 million units) whilst almost 13 million people, more than 5% of the EU workforce, are employed in the automotive industry.

The European automotive industry is a key element in the continent’s economy and population wellbeing as it accounts for important figures in car exports resulting in a trade balance surplus of around 100 billion euro, according to ACEA data. Moreover cars in Europe are becoming more and more environmentally aware as Europe's cars are the cleanest, safest and quietest in the world, a statement which is backed up by some interesting data. According to ACEA today’s average car engine emits 28 times less carbon monoxide than 20 years ago, whereas last year 70% of new cars emitted less than 130g CO_2 per kilometer (2014). Moreover the average fuel consumption of a new car today is 15% less than 10 years ago and the noise made by cars has been reduced by an astonishing 90% since 1970, which shows how far the automotive industry has come within the last decades.

Last year 85,395,007 cars were sold worldwide as is provided in table 2.3, around 40% in the Asia-Pacific region, more than 20% in North America, around 17.1% in Europe, while the rest was distributed in Africa Middle East-India with 9.6%, South America with 7.6% and Eurasia with around 4.5%.

Table 2.3. Worldwide car sales by region

Region	Sales	Share of total sales
Europe	14,564,768	17.1%
Africa-Middle East-India	8,189,769	9.6%
Eurasia	3,767,124	4.4%
Asia-Pacific	34,030,603	39.8%
South America	6,478,356	7.6%
North America	18,364,387	21.5%
Total (World)	85,395,007	100%

Table 2.4. Renault–Nissan Alliance world sales in 2014

Rank	Country	Total sales (vehicles)	Local market share
1	United States	1,386,895	8.4%
2	China	1,255,665	5.7%
3	Russia	764,245	30.7%
4	Japan	674,922	12.1%
5	France	653,326	30.2%
6	Mexico	318,093	28%
7	Brazil	309,547	9.3%
8	United Kingdom	259,762	9.3%
9	Germany	240,181	7.4%
10	Italy	184,416	12.5%

The Renault-Nissan Alliance sold around 8.5 million units in 2014, being ranked 4th in last year's car sales behind Toyota with 10.23 million, Volkswagen with 10.14 million and General Motors with 9.92 million vehicles sold. The Alliance outperformed the likes of Hyundai-Kia (with 7.71 million units sold last year), Ford (6.32 million), Fiat-Chrysler (4.75 million) or Honda (4.36 million) in last year's stats. The Renault – Nissan Alliance's most important 10 markets worldwide as well as the share of sales for each of the two carmakers are highlighted by table 2.4 and figure 2.14.

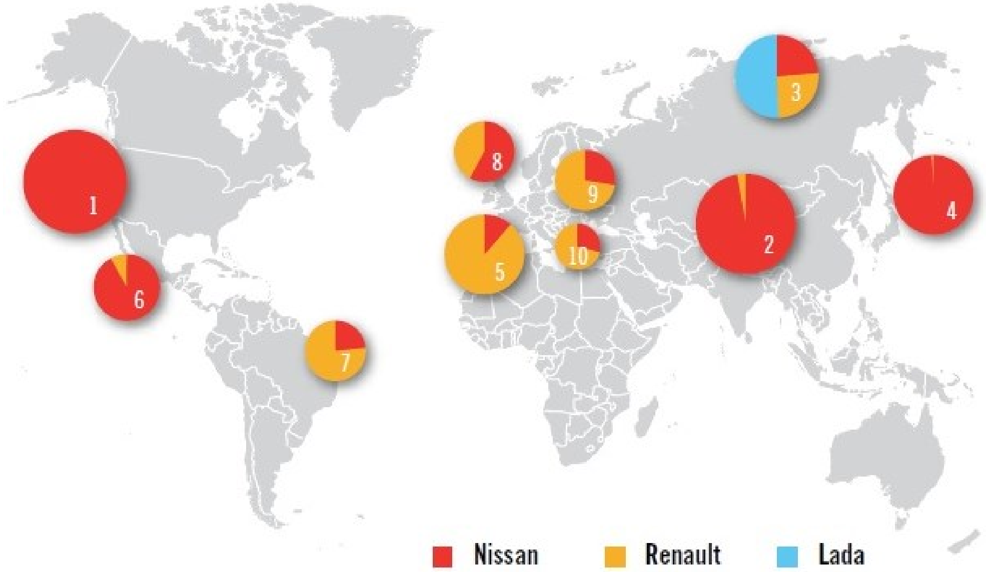


Figure 2.14. Renault and Nissan's share in the Alliance's total sales [54]

The Renault Group sold in 2014 more than 2.7 million vehicles in 125 countries, a 3.2% increase since last year and has over 117,000 employees throughout its 36 manufacturing sites. Of the 117,395 employees of 124 nationalities, 18.4% are women and have also contributed to reducing the carbon footprint by 3.3% per vehicles and per year between 2010 and 2014. The group's brands have achieved good results within the past year. The leading brand of the group, Renault is present in 12 countries and has more than 12,000 points of sale and accounts for almost 80% of sales within the group with over 2.1 million units sold in 2014.

Dacia is the second important brand of the group, with a very interesting development throughout the last decade which helped the Romanian brand to be present in 44 countries in Europe, Northwest Africa and Turkey. Dacia has attracted over 3 million customers since the launch of its first model in 2004, is the entry-level brand of the group and offers a robust line of vehicles at a reasonable and affordable price. The Romanian brand accounts for almost 20% of the Renault Group's sales and is one of the most active and dynamic players on the car market.

Renault Samsung Motors is the local Renault brand sold in South Korea and covers middle-end and high-end market segments, as well as Sport Utility Vehicles with only a 3% share in the Renault Group sales [54]. The top 15 markets of the Renault Group are summarized in table 2.5 below.

EUROPE

The Renault Group had a market share of over 10% on the old continent in 2014, an increase of more than half a percentage point since last year thanks to its 1,464,611 registrations.

Portugal (+42.1%), the UK (+41.9%), Spain (+30.2%) and Italy (+28.9%) were the best performing markets for the Group last year in terms of volume increase, while the French carmaker recorded its best market share in Italy in the last 28 years with 8.9%. overall in Europe the Renault group achieved an increase in registrations of 12.5% and easily outperformed the market average increase of 5.9%.

Table 2.5. Top 15 markets of the Renault Group in 2014

Rank	Country	Sales [units]	Market share [%]	Market share dynamic [%]
1	France	577,601	26.6	+1.3
2	Brazil	237,187	7.1	+0.5
3	Russia	194,531	7.9	+0.3
4	Germany	173,479	5.3	+0.2
5	Turkey	133,212	17.4	+0.4
6	Italy	130,996	8.9	+1.6
7	Spain	127,666	13.2	+1.0
8	United Kingdom	109,014	3.9	+0.9
9	Algeria	91,800	26.9	+0.7
10	Argentina	84,946	12.9	-2.5
11	South Korea	80,003	4.9	+0.9
12	Belgium + Luxemburg	77,303	13.0	+0.0
13	Colombia	50,362	16.6	+0.5
14	Morocco	45,174	37.0	-1.9
15	India	44,849	1.5	-0.6

The Renault brand is in third place in the European car market (passenger cars and LCVs) with a 7.6% market share, behind Volkswagen and PSA. Renault is the leading brand in France and Portugal and has regained second place in Spain. Renault is in first place in the city car market (segments A+B) thanks to the Clio and Captur, whilst the "losange" brand is for the 17th consecutive year the leader in the LCV category in Europe (with a 14.2% market share) and has sold the most electric cars in Europe thanks to the Zoe model.

For the second consecutive year, Dacia has the highest market share increase in Europe with a 0.4 percentage point increase which brings it to 2.5%. Dacia is the fifth largest brand in France with a 4.9% market share, mainly due to the success of the Duster and Sandero (third bestselling car) models. In Spain, Dacia has a market share of 4.7% where the Sandero is the best-selling car. Dacia has record volumes and market shares in almost all European countries such as Italy (2.7% market share) or in the United Kingdom, where after only two years Dacia is close to achieving a 1% market share.

AFRICA-MIDDLE EAST-INDIA

Surprisingly the volumes of the Renault Group in the Africa, Middle East, India Region, have shrunk by 9.2% in 2014 to only 308,012 registrations with a current market share at 3.8%. Some of the most important markets for the Group have decreased, such as the Maghreb (-13.2%) or even India (-0.8%).

Renault remains leader on the Algerian market with a 26.9% market share with Renault and Dacia in first and third place, although the local market contracted by 19.8%. The recent factory inaugurated in Oran in November 2014 strengthens Renault's position on the local car market, as the French company is the first car manufacturer to build a factory in Algeria and thus to contribute to the national automotive sector. This plant produces the new Renault Symbol, with a production capacity of 25,000 vehicles per year, which may eventually be increased to 75,000 vehicles per year.

In Morocco, where there is a more stable market with a 1.1% increase in 2014, the Renault Group has a 37% market share and dominates sales with its Dacia and Renault brands as last year 45,174 vehicles were sold. In India, Renault continues to be the leading carmaker from Europe with a market share of 1.5% and 44,849 registrations, where it has also unveiled as a world premiere the Renault Kwid in February 2014 at the New Delhi Motor Show which was the first Renault concept-car unveiled outside Europe.

Overall in Africa, Renault continues to grow as new showrooms have opened, especially in Nigeria, Mozambique and Ghana, where some of the models of the brand are really popular as is the case with Duster, Sandero and Koleos. The brand has also experienced a strong growth in sales especially in Angola, where over 3,700 units were sold compared to only 500 five years ago.

EURASIA

Renault progresses in the Eurasia region due to good results in Russia and in Turkey and attained a 10.3% market share in 2014. The Group performed better than the market average, with only a 5.4% decrease in registrations as in turn the Eurasia region's registrations dropped by 11.5%.

Renault is the second foreign brand in Russia and has managed a record market share of 7.9% in a difficult economic and monetary context, as the Russian car market decreased by 11% in 2014. Renault has been strengthened in its third market by the success of Duster (once again the leading SUV of the market in 2014) and the successful launch of the New Logan and the New Sandero, as they are the first Renault models produced in the Togliatti plant. Meanwhile, the Renault plant in Moscow celebrated in January 2015 the production of its one millionth vehicle.

Renault also continues to expand in Commonwealth of Independent States (CIS) countries with volumes up by 42.5% with a highly significant market share growth to 5.9%, a 1.7 percentage point increase.

Renault is the second brand in Turkey, where the Fluence is the top-selling model, while the Clio, Capture and Symbol are leaders in their segments. Although the market fell by -10.0% last year, the Group had the best performance of the last 13 years with 17.4% of the market share. Dacia brand also accounted for a record 4.5% market share last year in Turkey, with the Duster being the best-selling model in the 4x4 and SUV segments. Dacia remains the leading market brand in its home country, Romania. Overall, the Renault group has a total market share of 38.6% in the country, with sales up by 21.3% on a market which is slowly recovering after many years of massive contraction after the economic crisis.

ASIA-PACIFIC

The volumes of the Renault Group in the Asia-Pacific Region have increased by 23% to 133,172 vehicles sold on a market which had a growth of 4.6% in 2014. The South Korean car market had a growth of 9% in 2014 with Renault Samsung Motors (RSM) achieving one of the most impressive sales increases of 33.3% and market share of 5.7%, thanks to a renewed range and an expanding network.

RSM was the service quality leader for sales and after-sales in 2014, as its success was confirmed QM3, the South Korean version of the Renault Captur, which sold nearly 20,000 units since it was first marketed at the end of 2013, and which was elected best SUV in South Korea. In China, the Renault Group sold over 34,000 vehicles while the French carmaker continued to strengthen its market presence by launching new models (Koleos Sport Way, Fluence phase 3 and Mégane R.S.) and developing its network which included approximately 100 dealerships by the end of the year. As a result of the local assembly agreement between Renault and Tan Chong Motors, the Fluence is now assembled and sold on the local market in Malaysia, being the first stage of Renault’s growth acceleration phase on the Malaysian market and on a wider scale, in South-East Asia, a real source of growth for the Group. Renault also grew in Australia with 42.7% to 10,014 units and by 23.5% in Japan to 4,659 vehicles.

SOUTH AMERICA

Renault retains a market share of 6.4% for the group through its successes in Brazil and in Colombia, with 416,934 units sold in 2014. The volumes of the Renault Group in the Americas region decreased however by 10.7% in a market that has contracted due to the economic situation in Argentina by 7.5% last year.

Brazil is the Renault Group’s second market where 237,187 units have been sold in 2014, for a record market share of 7.1%. The Renault Group recently announced new investments on its second market of around 240 million euro dedicated to the production of new vehicles in the Curitiba plant over the next 5 years and to the creation of a new logistics center over the next ten years.

Renault unveiled the world premiere of the Duster Oroch, a leisure pick-up at the São Paolo Motor Show which was designed by the French carmaker’s design center in São Paulo. Renault is also the second brand in Colombia with a market share of 16.6%, where the car manufacturer achieved record sales of 50,362 units (a 13.5% increase) in 2014.

Renault chose to limit its exposure to the peso in Argentina within a difficult local financial context and therefore limit the quantity of imports. Thus new registrations were affected and shrunk by almost 40% compared to 2013, leading to a total market share of 12.9% for the “losange” brand. Table 2.6 and figure 2.15 provide a summary of the Renault Group’s sales results per every region.

Table 2.6. Overview of Renault Group sales per region and per brand

Region / brand	Sales 2014	Sales 2013	Dynamics [%]
Total (World)	2,712,432	2,628,183	+3.2
Renault	2,118,844	2,131546	-0.6
Dacia	511,465	429,540	+19.1
Renault Samsung Motors	82,123	67,097	+22.4
Europe	1,464,611	1,301,896	+12.5
Renault	1,103,067	1,011,398	+9.1
Dacia	361,544	290,498	+24.5
South America	416,934	466,891	-10.7
Renault	415,701	460,833	-9.8
Renault Samsung Motors	1,233	6,058	-79.6
Asia-Pacific	133,172	108,237	+23.0
Renault	51,914	47,092	+10.2
Dacia	1,070	1,015	+5.4
Renault Samsung Motors	80,188	60,130	+33.4
Africa Middle-East India	308,012	339,289	-9.2
Renault	226,832	265,135	-14.4
Dacia	80,580	73,367	+9.8
Renault Samsung Motors	600	787	-23.8
Eurasia	389,703	411,870	-5.4
Renault	321,330	347,032	-7.4
Dacia	68,271	64,716	+5.5
Renault Samsung Motors	102	122	-16.4

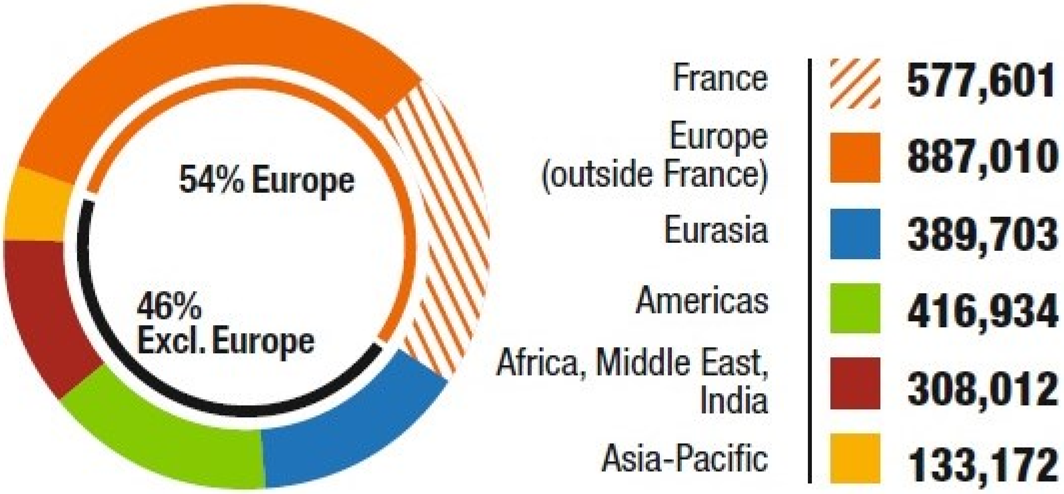


Figure 2.15. Renault Group volume sales by region in 2014 [53]

Dacia had a very good year 2014 as their global sales went up by 19.1% to 511,465 vehicles at end-2014, mainly based on the Duster, Sandero and Logan models, which are also among the best-selling Renault models (see figure 2.16 and table 2.7 below). Europe is one of its main markets, where Dacia is growing faster than all the other brands due to its refreshed range of vehicles, that helped achieve a sales volume of 361,544 units in 2014, an impressive 24.5% year-to-year increase. In France, Dacia is currently the 5th brand in the passenger car market, with its volumes adding up to an important 14.1% increase whilst on the challenging markets of the Mediterranean basin, Dacia is also increasing its market share across all countries. Dacia is the undisputed leader on the markets where it also has its factories, in Romania and Morocco, where it achieved sound performances in sales growth of 19% and 11% respectively.

Figure 2.16. The Renault Group's best-selling 5 car models in 2014 [53]

In addition to its commercial success, Dacia has also managed to unite its customers around a "smart purchase" concept, as in many countries, customers come together to discuss and share on common values such as freedom of spirit, simplicity and generosity. These community events are inspired by the Dacia forum meetings held by Dacia model owners who gather occasionally to discuss diverse topics on their cars and to get to know each other. This sort of events gets bigger every year, as they prove truly convivial moments which create a strong bond between customers and the brand. Moreover the Romanian brand is also active on social networks, where Dacia already has over two million Facebook fans in under four years.

Dacia Duster is one of the best-selling models of the brand and has proved a real success with sales of over 630,000 units in five years on the market thanks to its design, space, reliability and off-road capabilities, which all come at an affordable price. The model has sold only short of 400,000 units in 2014 under both the Dacia and Renault logo and was the "losange" brand's leading car model in sales last year, almost 20,000 units more than the Clio IV.

Table 2.7. Overview of the best sold models of the Renault Group in 2014

Rank	Renault model	Sales 2014	Sales 2013	Dynamics [%]
1	Clio	457,822	461,971	-0.9
2	Duster	395,350	376,606	+5.0
3	Sandero	351,126	354,883	-1.1
4	Logan	309,549	257,354	+20.3
5	Mégane/Scenic	274,843	302,205	-9.1
6	Captur/QM3	196,592	94,954	+107.0
7	Kangoo	145,421	146,668	-0.9
8	Fluence	111,299	134,835	-17.5
9	Master	91,213	89,687	+1.7
10	Trafic	67,778	61,609	+10.0

Automobile Dacia, which is the second largest company in Romania, is the fifth biggest car manufacturing plant in Europe with a total production of 423,718 units (both cars and complete knock down kits) in 2013 according to rankings provided by Inovev, an automotive industry market research company. According to Inovev the largest car manufacturing facility in Europe is the Volkswagen factory from Wolfsburg, Germany with production figures exceeding 800,000 vehicles and a 1.9% increase since 2012 for the second brand in the world.

The other top three factories are Lada's Avtovaz facility in Togliatti, Russia which although has a capacity of 1 million vehicles, produced only 544,000 in 2013 and the Nissan plant in Sunderland, United Kingdom, which became the first UK car plant in history to produce 1,000,000 cars in two years after making 501,756 in 2013, both belonging to the Renault-Nissan Alliance. The Audi factory from Ingolstadt misses out on the top three, with a capacity to build around 600,000 units per year, but is in fourth, one position above the Dacia plant in Mioveni, Romania. All in all the first 10 European car manufacturing plants made 4.6 million vehicles in 2013, which is a quarter of Europe's car output. Dacia's fifth place is impressive as it outruns two other plants from Germany, the Ford plant in Cologne or Audi's second factory in Neckarsulm.

Dacia's main market in 2014 was again France with over 100,000 units sold in the Hexagone last year as is highlighted by table 2.8. France has always been one of Dacia's best markets ever since 2010 when Dacia sold more than 110,000 cars, while since then the French market has been more or less near the 100,000 figure. Germany, Dacia's second market in 2014 was one of its main markets since the late 2000's when the Romanian brand would sell 84,708 cars in Europe's most important automotive country (2009). Last year Dacia sold over 50,000 cars in Germany. Very good sales for Dacia in Spain, Italy and Algeria, all of these three countries having an interesting growth dynamic in the Romanian carmaker's sales figures within the last couple of years as well as in its two production countries, Romania and Morocco. After many years when sales had plunged year by year, also due to the economic difficulties, in the last two years Dacia has once again began to improve its sales and to mark a steady growth on the national market as Romania tries to overcome the Moroccan market where the brand had a very good performance in recent years, which is due to both the kingdom's policies and the reliability of the Dacia cars. Interestingly the UK comes next with well over 20,000 vehicles, followed by Belgium where around 18,000 units have been sold in 2014.

Table 2.8. Dacia's top 10 markets in 2014

Rank	Country	Sales 2014	Share of total sales [%]
1	France	105,893	20.7
2	Germany	50,704	9.9
3	Spain	45,896	8.9
4	Italy	39,964	7.8
5	Algeria	39,741	7.8
6	Turkey	34,469	7.6
7	Morocco	33,734	6.6
8	Romania	29,625	5.8
9	United Kingdom	23,862	4.7
10	Belgium	18,000	3.5

The Renault Group made a profit 1.9 billion euros in 2014, an impressive increase on a year-to-year basis (only 586 million euros in 2013 for the French group) thanks to its cost-cutting policy and improved sales on the European market. The 5.7% growth on the European car market helped the "losange" brand overcome its decline in Russia and Brazil, where economies are underperforming due to different reasons. Another reason for the Renault group's good results is the performance of the Dacia brand, which had a profit 371.6 million lei (around 83 million euro) in 2014, a 10.1% increase as well as a 2.3% increase in turnover to 18.8 billion lei (around 4.2 billion euros) and a 4.4% profit margin according to the Romanian company's financial statements.

2.4. Implementing the X90 model – Logan project at the Dacia plant in Mioveni

Automotive industry is one of the most important industries worldwide due to its major implications in the economy through high added value products, a complex supply chain which comprises an important network of suppliers and the associated jobs. People choose to buy cars from certain brands for different reasons, but the common reason for buying any car is mobility which is a very important feature in our days and thus the car has gained an important place in society. The demand for cars has developed and has undergone different shifts and challenges throughout the last century to which car manufacturers have had to react and adapt [63]. Not only did carmakers develop their activities, but so did their supply chain too in order to remain in a competitive position on the global market. The recent financial crisis made car sales plunge within the last couple of years as car manufacturers had to temporarily cease activity, layoff workforce or even close down certain factories in order to adjust to market dynamics and reduce losses [51]. A crisis is always an opportunity to learn to cope with harsh and difficult times and to rearrange organizational culture as to be better prepared for future challenges and it is up to the car manufacturers to implement projects which can better handle such economic shifts [69]. However, anticipating economic development and future trends is not an easy task as rapid changes make it hard to make sound strategic decisions within this context [132]. Sometimes some decisions or projects fail and others succeed due to these shifts in the market or in the economy, but how often do we see them do both ? [150]

After competing to provide more and more options to improve comfort and driving experience, the economic crisis has realigned carmakers towards improving their cost-effectiveness. Today carmakers face one of the most interesting shifts in car market dynamics within the last decade that have influenced strategic decisions and have brought about changes in the automotive industry: to provide more car for less money. As car manufacturers have made plans and projects for future development, the challenges in the auto industry have realigned the market within the last couple of years and have forced them to adapt to new market requirements. Competition is getting more and harsher and carmakers strive to improve their overall performance and overcome the slow market revival in their attempt to remain globally competitive.

The following case research analyzes the ambitious project of the French car manufacturer Renault to produce a modern affordable car for emerging markets and describes how the different challenges in car industry have impacted the Romanian brand Dacia. Data and indicators within the last decade are analyzed and compared to provide an overview on car market dynamics and future perspectives. Results show that drivers of carmaker competitiveness are mainly related to market specifics, a strategic management policy and the agility to adapt to market dynamics.

The research conducts an analysis of the 5,000 euro car in its initial boundaries, prompted by the intent to provide emerging markets with a good quality-price ratio car and provides insights on how to identify structural issues and improve competitiveness in order to assure the sustainable development of car manufacturers, their supply chain and the automotive industry as a whole.

2.4.1. Background information on Renault’s 5000 euro car project

Dacia had always enjoyed collaboration with French manufacturer Renault through licenses to produce Renault models within the factory in Pitesti for several decades [89]. As the auto market started to grow in Romania and reached a production record of over 100,000 vehicles in 1998, Renault decided to buy the factory and had interesting plans to develop the Dacia plant [126]. The factory needed investments to upgrade existing technologies in order to adapt to more modern production techniques, restructuring the workforce would also be required as well as a change in organizational culture [11]. These structural issues needed taking care of before Renault could launch one if its new projects, Louis Schweitzer’s ambitious plan of the 5,000 euro car.

Renault bought the Dacia factory in the summer of 1999 but before it could actually start building the 5,000 euro car it had to focus on the existing production at Dacia to at least slightly improve the quality of the cars that were already in production. Hence by the year 2001 it already made an impact by fitting the Dacia Nova, the first car to have ever been fully designed by Romanian engineers, with a new engine, gearbox and improved interior design and renamed the car to Dacia SupeRNova. The Dacia SupeRNova would thus be the first Dacia model built after Renault became the new owner of the factory, which was also marked by capitalizing the letters R and N within the models name. Just two years later they would improve the exterior design as well and make some other changes and launch the Solenza model, the first ever Dacia model to have a choice of engines (1.4 petrol and 1.9 diesel) along with the classic Pick-up, which also received a Renault 1.9 diesel engine. Dacia slowly but surely started to implement improvements to its existing vehicles and was approaching the moment where it would replace these existing models with a completely new model, more affordable and with an overall better quality and market adaptation. After 20 years Renault regained leadership in Western Europe as best-selling auto brand and Louis Schweitzer wanted to continue the strategy of profitable growth by extending towards developing markets outside its core market. In 2004, 5 years after being bought by Renault, Dacia launches the Logan model, a model which should have cost 5,000 euro and which was destined for emerging markets, where chairman Schweitzer wanted to make modern cars more accessible towards a larger part of the population, as was Eastern Europe. The Logan was built using only the strictly necessary parts and materials as the plan was to make a modern, reliable and affordable car, hence a simple, ordinary and decent car. Although it did not turn out to the projected cost, the basic version being available for 5,800 euro, the Logan was the cheapest new car available with a good quality-price ratio and set an example to car manufacturers around the world of efficient production. It had thus all the premises to become a success in lower income and emerging markets, as were Romania or Eastern Europe, but surprisingly it failed do so.

2.4.2. Dacia key figures after launching the Logan model

Renault made investments in the Dacia factory in order to prepare the plant for the production of the Logan model of around 2.2 billion euro within the last decade to improve equipment and working conditions for workers. The results were impressive as the capacity was increased to a maximum of 350,000 vehicles by the end of 2008 and in recent years production has twice been close to reaching full capacity. Table 2.9 presents production and sales data for Dacia regarding internal production (IP), global sales (GS), sales on international markets (IM), Romanian car market evolution (RM), i.e. new car sales, sales of Dacia on its national market (DR), i.e. in Romania, and Dacia sales in Morocco (DM).

Thus within the first year of the launching of the Logan model, the production at Dacia had nearly doubled, in 2006 and 2008 production increased by almost 10%, while in 2007 and 2009 output volumes had increased by more than 20% (see figure 2.17). Only one year later production came very close to full capacity, being 3.5 times more than in 2004 and twice the level of the year 2005. Within the following two years production decreased by almost 10%, but after only one year Dacia beat its previous production record as it produced 342,610 vehicles in 2013. Last year’s forecasts showed that production figures will slightly decrease to about 310-320.000 vehicles at the factory in Pitesti.

Table 2.9. Key figures for the Dacia brand

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
IP	94720	170000	183958	222808	242415	296010	341299	327620	307152	342610	320000
GS	95296	163899	196708	230473	257594	311282	348723	343233	359822	429540	511465
IM	15283	50623	88931	128411	172886	269420	311993	312366	337674	404650	481840
RM	145120	215532	256364	312532	285504	116016	94541	81709	72179	57700	70172
DR	80013	113276	107777	102062	84708	41862	36730	30867	22148	24890	29625
DM	N/A	N/A	12750	12639	14996	18112	18087	22356	27097	30388	33734

Global sales also follow the tendency shown by production figures during the last decade, with some interesting remarks. First of all, excepting the year 2005, global sales have always surpassed production levels at the Pitesti plant: this is possible due to the fact that the plant in Pitesti is not only an assembly factory, it also has several different plants which also produce all the needed parts, ready to be assembled, which is known as complete knock-down or knock-down kit. These kits can get exported towards other Renault or Dacia factories where they can be assembled to cars, thus relieving a part of production from the plant in Romania. This allowed for sales to have a remarkable boost in evolution throughout the last 10 years, as is managed to constantly register growth, except for the year 2011, when sales contracted by 1,5%. Within the first year of the Logan sales had increased by over 70% and except for the year 2012, sales evolution has never been under at least a 10% yearly growth, while within the last 3 years record sales have been attained, 2013 and 2014 being years when sales had gone up by almost 20% on a year-by-year comparison.

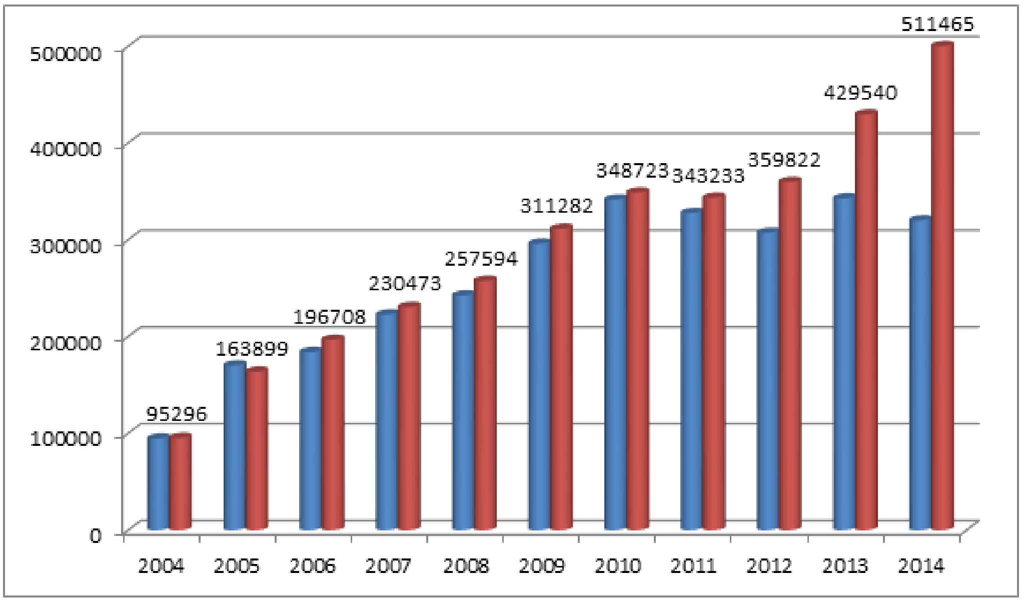


Figure 2.17. Evolution of internal production and global sales of Dacia

2.4.3. Dacia on the Romanian market

The Romanian car market managed to more than double its sales between 2004-2007, having a very interesting development of more than 300,000 vehicles sold after its first year of EU-accession (see figure 2.18). The year 2008 saw sales slightly drop by around 10%, before plunging by 60% one year later. This tendency would continue and within the next five years, sales dropped yet again, this time by 50% to only 57700 cars in 2013. Last year the market managed to achieve a growth of just under 20%, but this meant that volumes were only half the level of 2004 or just over a fifth of that in 2007, thus still quite low for the industry.

Although the Logan model had a very impressive start on the Romanian market, having a massive impact within its first year and good sales figures until 2007, what was to follow was an unexpected shift in customer behavior and in the evolution of the national car market. After good sales figures in 2004, Dacia managed to increase sales by more than 40% only one year later thanks to the Logan model. However within the next two years sales would decrease by 10% but were still above 100,000 vehicles. The beginning of the financial crisis would however plunge sales, after a 20% drop in 2008, Dacia sales would contract by 50% in 2009, a severe change and realignment of internal market dynamics for the Romanian brand. Moreover within the next three years Dacia would yet again suffer an overall 50% decrease in sales to just over 20,000 vehicles sold in 2012. 2013 and 2014 have meant two consecutive years of increase for the Romanian brand, but despite the overall 33% increase since 2012, sales are still below the figures of 2011 and approach only a quarter of the volumes reached a decade ago.

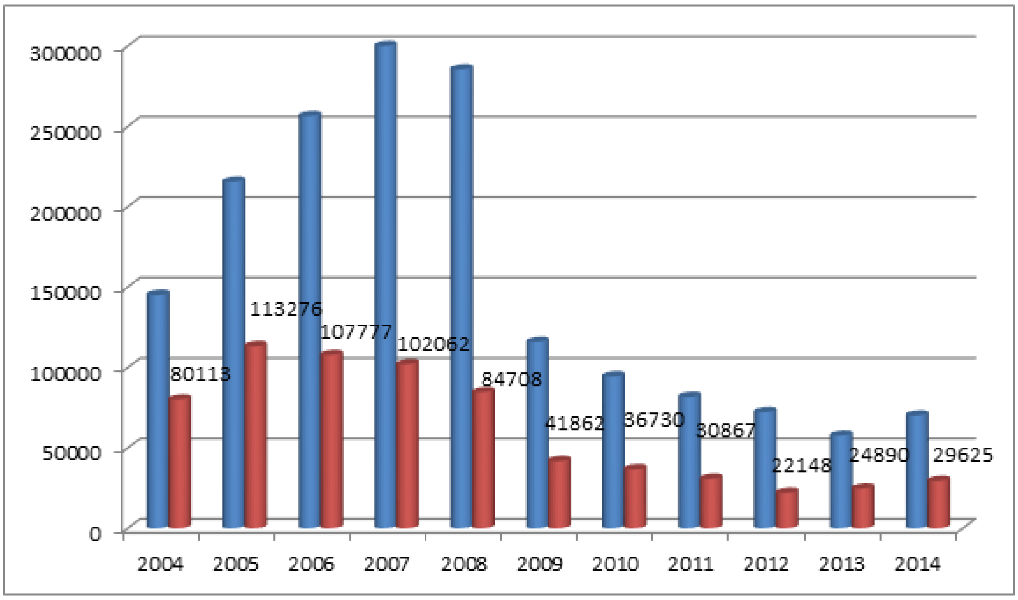


Figure 2.18. Romanian auto market evolution (blue) and Dacia figures (red) on national market

2.4.4. Dacia on the international market

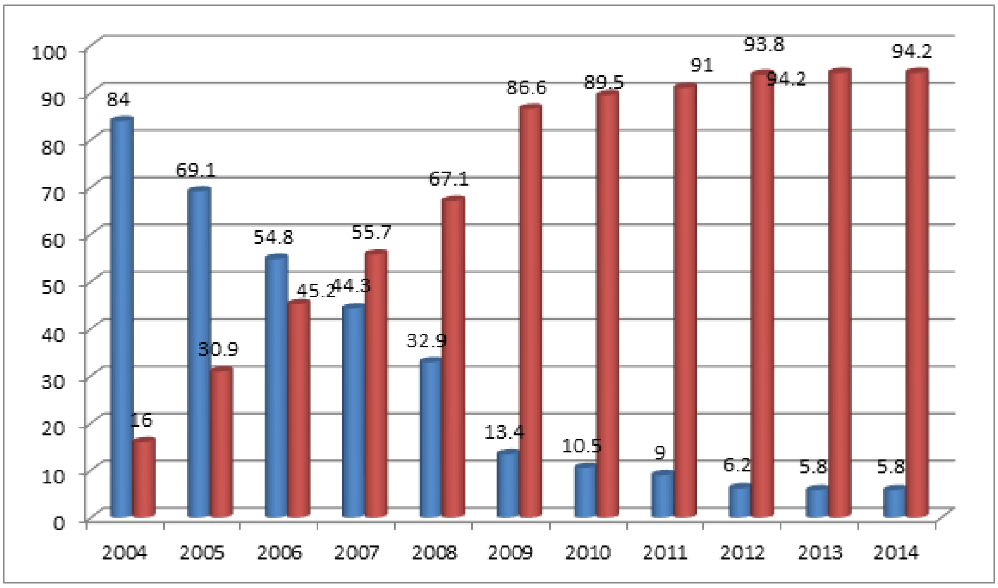


Figure 2.19. Proportion [%] of Dacia sales on national (blue) and international market (red)

By the year 2009 it was clear that the Dacia models were having a much better success on international markets and that the production capacity had to be augmented in order to sustain demand as figures 2.19 and table 2.10 show.

Capacity had been increased several times in Pitesti already and was nearing its maximum potential, therefore there was an extension of the factory in question or building a new one somewhere more convenient and appropriate for the sales dynamics of the brand. Given the importance of such a decision which would have strategic implications within a large horizon of time special attention had to be given to several criteria, details and to future perspectives, both of the brand and of the market development.

Table 2.10. Dacia's sales and share in external sales on its best international markets in 2014

	France	Germany	Spain	Italy	Algeria	Turkey	Morocco	UK	Belgium	Poland	Total
units	105893	50704	45896	39964	39741	34469	33734	23862	18000	14689	406952
[%]	22,0	10,5	9,5	8,3	8,2	7,2	7,0	5,0	3,7	3,0	84,5

According to Renault officials, the company chose to build a new factory in Tangier, Morocco, because there were favorable conditions to do so, a stable political climate, government incentives, workforce costs and logistical infrastructure, which basically sum up the main criteria for strategic decisions: market, infrastructure, costs and macroeconomic stability and predictability.

2.4.5. Strategic management criteria and decision-making framework

Dacia is leading sales figures in both Romania and Morocco, but the position and dynamic of these two markets are different: the Romanian market is still at one of its lowest levels yet and although the last two years have meant a 19% increase for Dacia, the volumes sold are still scarcely recovering. On the other hand, the Moroccan market has a completely opposite dynamic as it has almost tripled for Dacia's figures within the last decade and it shows no signs of slowing down (see figure 1.20). Since 2012 the African market has outgrown the home market of the Dacia brand and the new factory in Tangier is bound to boost sales in the forthcoming years. The evolution of both markets in terms of absolute figures are marked in table 2.9, whereas the evolution of market share of the Dacia sales in Romania and Morocco is presented in figures 2.20 and 2.21.

As far as infrastructure is concerned, the Dacia factory in Pitesti is located in the center of the country at 460 kilometers from the Hungarian border and at 360 kilometers from the port in Constanta. Access to these two gateways is however difficult due to the lack of motorways directly linking these facilities. Traffic jams, accidents and the two-lane roads make driving conditions difficult, as extra expenses occur with damage assurances or drivers' wages. Dacia officials estimated that 30 euro per each vehicle would be saved if the motorway Pitesti-Sibiu would be built by the government, plans however for it are yet to be implemented. Moreover the performance of the railway system is also lacking consistency as trains often are late and their lateness usually ranges from 8 hours to 2 days, mainly because of the scarce maintenance of the national railway infrastructure. Morocco on the other side has a very good logistic position, especially due to the fact that the factory in

Tangier is very close to the port (32 kilometers) and also to Spain, a country which is one of Dacia's best markets and the European country with the largest motorway network, of over 16,200 kilometers and the fifth in the world. Thus exporting production from Tangier towards Western Europe is done a lot faster, cheaper and with much better reliability as far as logistics is concerned.

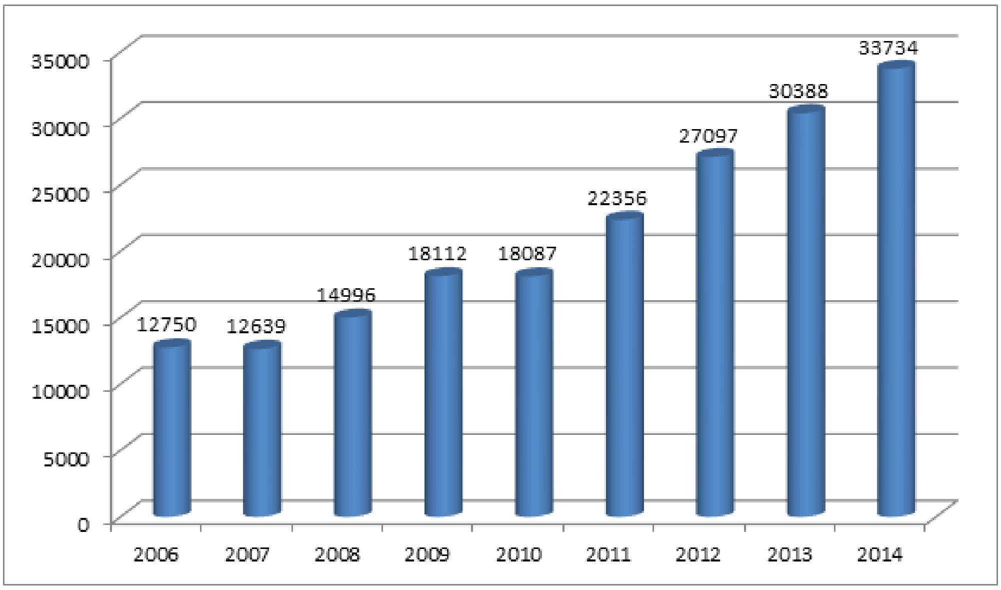


Figure 2.20. Dacia sales on the Moroccan market

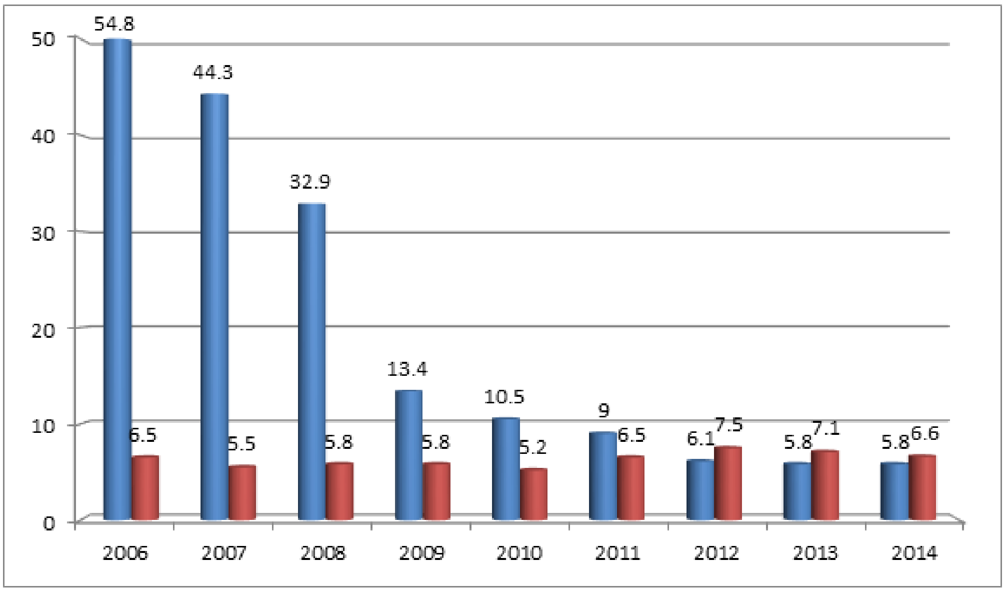


Figure 2.21. Share in Dacia sales of the Romanian (blue) and Moroccan (red) market

Workforce in Romania is better qualified and their performance and productivity is at a very good standard. This in turn is balanced by higher wages than national average in the country as employees at Dacia gain twice as much as the net average income. Costs for the car manufacturer additionally occur through income tax, corporate tax, VAT or others. In spring 2013 Dacia workers in Romania went on strike for two days, causing production to stop and cost the manufacturer around 20 million euro.

The factory in Morocco was inaugurated only in 2012, therefore it will take a couple of years before it can become as productive as the one in Romania, but through intercultural exchange and a good management of knowledge and know-how sharing between the plants, the factory in Tangier has good chances to level performance in the future as it is ready to produce up to 340,000 vehicles a year. Salaries in the North African country are lower than in Romania, Turkey or Russia and income tax is also at a lower level, therefore making workforce costs at around a third of those in the other countries. Discipline and the emergence of the African markets can prove important in assuring a sustainable growth for the car industry within the country and within Dacia's supply chain partners in that part of the world.

Although financial aid from the Romanian government has been provided for Dacia throughout the years, more important issues were left unsolved for the past decade. The main one is the Pitesti-Sibiu motorway, repeatedly requested by the Renault and Dacia officials, not to mention that the road that links the factory's premises to the road transport, a portion of almost 10 kilometers, was built by the manufacturer himself. This lack of interest in the development of Dacia and the horizontal industries it supplies has been a deciding factor to choose building the plant in Morocco instead of extending the one in Romania as well as the lack of predictability of the political environment, where last year an extra tax of 7 cents has been introduced to further tax gas prices. Direct aid can be estimated at around 150 million euro during the last decade.

The Moroccan state however gave out only for the building of the factory more than 500 million euro, along with other complementary incentives as well as tax exemptions or fiscal advantages, providing a very serious offer towards Renault.

Table 2.11. Strategic management decision-making framework

	Romania	Morocco
Car market 1) volume:	from 113,276 (2005) to 29,625 (2014)	from 12,750 (2006) to 33,734 (2014)
2) dynamics:	descending tendency since 2007, 50% contraction (in 2009 and between 2009-2012)	emerging market, 50% growth (between 2007-2009 and between 2010-2012)
3) share of Dacia sales on national market:	5,8% (2014)	6,6% (2014)
4) market position:	leader on the market with 31,2% share (2014)	leader on the market with 28% share (2013)
5) last year evolution:	19% growth (2014)	11% growth (2014)

Infrastructure: 1) motorways:	655 km of motorways (2014)	1,511 km of motorways (2014)
2) paved roads:	60,042 km of paved roads (2014)	40,192 km of paved roads (2014)
3) shipping:	360 km to port of Constanta, 460 km to border with Hungary, unreliable railways network (average 8h-2 day lateness)	32 km to port of Tangier, quick access to both ship transport or by West-European motorway network (Spain)
4) features:	unreliable times on national roads, high traffic, risk of accidents, lateness is common	reliable times on both road and water, moderate traffic, increased safety, lateness is uncommon
5) access:	moderate distance towards main market, access is rather difficult and slow	close, easy and fast access to main market
Corporate costs: 1) net salary:	735 euro/month	320 euro/month
2) workforce:	highly qualified and well-trained (very productive)	qualified and in need of training (slowly productive)
3) discipline:	2 day strike costs Dacia 20 million euro (2013)	no recorded incidents yet
4) taxes:	16% corporate tax, 45% average earning tax, 24% VAT, no customs due (EU regulations)	30% corporate tax, 12-40% average earning tax, 20% VAT, customs due
5) incentives:	* 3.5 million euro from the Ministry of Environment (2000-2002) * scrapping program (since 2005) * 100 million euro state aid (until 2007) * corporate tax exemption until 2007 * no customs and VAT for imports (prior to EU accession) * 3 year lag to pay VAT for cars sold on the national market * 28 million euro for the investment in the Titu technical centre of Renault (2010)	* Tangier site provided free of charge *47.6% aid (around 523 million euro) from the Deposit and Management Fund (CDG) for the investment in the Tangier platform (1,1 billion euro) * corporate tax exemption for the first 5 years and 8.75% for the Tangier platform for the following 20 years * customs facilities (increased speed in processing formal requirements) * training infrastructure set up costs covered by the state (to assure proper development of workforce)
6) political status:	stable, weak logistical support, predictability is rather low	stable, very good logistical support, predictability is rather good

Car market emergence has also been interesting as it has more than doubled within the last decade to more than 120,000 cars sold in 2012 and economic growth has been during this time somewhere around a yearly average of 4,5%. Moreover the openness and the stability of the macro economic and political changes are another asset of the African country and make it an appropriate decision for the French manufacturer. All this data is summarized in table 2.11.

2.4.6. Conclusions

The 5,000 euro car project as it was originally designed by Louis Schweitzer, chairman of Renault in the beginning of the new millennium, failed. It should have increased sales in emerging markets, mainly Eastern Europe and particularly in Romania, the home of the Dacia brand. After a great start, the Dacia models started losing ground and today the whole Romanian market is still suffering from the effects of the financial crisis and second hand car registrations are still significantly surpassing new car registrations. Dacia has lost an important part of its market share, it sells fewer cars than it did prior to the Logan model and its production is mainly exported, national sales being just over 5%, a very worrying percentage.

The fact that the initial plan failed did not also mean that the idea in itself was a failure, as Dacia was as the origin of what today we know as low-cost or smart-buy car cars. It is a segment which did not exist prior to the Logan, and in this sense the idea has been innovative as it introduced a new category of vehicles into automotive vocabulary. Furthermore as the effects of the crisis are still not suppressed, the Dacia models enjoy massive success in Western Europe, and even in countries with important automobile history as Germany, France or Italy. New markets are also within Dacia’s range of sales and the brand has had probably the most impressive development of all brands within the last decade, therefore success came not from the niche markets as originally planned, but from the classic European markets, where dynamics are still only slightly picking up.

The case research also proposes a couple of important criteria to focus on in decision making through the framework of strategic management decisions presented at the end of paragraph 2.5 which mainly apply to car manufacturers. By analyzing aspects related to market specifics, infrastructure, corporate costs, incentive schemes and macroeconomic indicators, strategic decisions can significantly increase their chance of having the desired effect in the long-term. However the proposed criteria are not exhaustive and sometimes market sensibility of particular conditions can severely influence the outcome of such decisions as well as crises or unexpected social or political movements.

Innovative projects do not always equal competitiveness, it is however essential to be innovative in order to be able to become competitive, but it is not enough. Strategic management is a key element in the equation as it sets the lines for future development and if the goals and targets set are compliant with markets dynamics and specifics, then there is a good chance to succeed, as is the case with the Renault-Nissan cross-cultural management policy which is today a benchmark in car industry alliances and shows that by working together important synergies can be achieved.

The case of Dacia is an example that even though sometimes plans and projects do not turn out the way they were intended to or even fail, it is important to know how to manage them through all the further steps as to either ease losses or to find an opportunity to adapt products towards new niches. All decisions, plans or projects are based on certain forecasts or the vision of their deciders, but ultimately it is the market who gives the verdict, and its behavior and dynamics cannot be precisely and accurately predicted. Criteria is generally very subjective and it is always best to anticipate needs and desires of the market prior to the general trend building up and to focus mainly on value added activities, because if the customer does not feel that he is getting good value for his money, he will not purchase the product, no matter how good it actually is from a technical point of view. This may seem harsh for car manufacturers, who do their best to try and provide their products with a large variety of improvements and new features, and it actually is, but the customer is always right.

2.5. Influence of costs upon strategic decisions in project development of the Renault Group

Car manufacturing has been one of the most important industries during the last century with an impressive development both on technological and social level. As car manufacturers developed so did their activities, business partners and customers. The complexity of car manufacturing has since increased and today car manufacturing is only a part of automotive industry. The high amount of suppliers which work with car manufacturers have made automotive industry one of the most important employers and sources of a country's wellbeing. However as car sales in some markets have reached maturity and are achieving only a slow growth margin some car manufacturers have had to temporarily cease activity, lay off workforce and even close down certain factories to adjust to market demand and reduce losses. Changes in consumer behavior are also shifting after the financial crisis and car manufacturers are trying to adapt their strategies to meet their objectives in a highly competitive market according to Buckley and Carter [16].

Automotive industry is a concept which refers to all those companies and activities involved in the manufacture of motor vehicles (cars), as are design, development, manufacture, marketing and distribution of cars towards customers. Last year more than 80 million cars have been sold worldwide, which means an average of 2.5 cars is sold every second. China is the largest car manufacturing country with more than 22 million cars produced in 2013, while the traditional car manufacturing countries, USA, Japan and Germany account for more than 25 million. Almost 2 million people are employed within the automotive industry in Japan, more than 2.3 million in the EU and almost 3 million in the US. Car manufacturers usually contribute with an average 3% to a country's Gross Domestic Product (GDP), however the amount can add up even to 7% in emerging countries as are China or India and can vary according to market conditions and car manufacturer performance. Moreover automotive industry has an important share in a car manufacturing country's exports and can contribute to its competitiveness: automotive industry has an 18% share of exports in Germany, 19% in the US and reaches 20.8% in Japan.

2013 was the sixth year in a row when European car sales had dropped, giving signs that the market has already reached a phase of maturity and that growth would be possible only in certain conditions and with a weak progression. During 2007-2013 European car sales went down by more than 25% giving an indication that there is no more room left for future growth and that car manufacturers will have to focus on keeping their existing market shares or increasing them in order to boost their own sales figures whilst facing strong competition. As the European market is now a market of consolidation, manufacturers have to find other markets to compensate weak sales and seek development opportunities. Melander [100] outlines some of the most important aspects of buyer-supplier collaboration within the context of new product development as is their ability to work together effectively. Chatzipanagioti, Iakovou, Vlachos and Hajidimitriouet [20] confirm that reducing costs is one of the main themes and besides operational or tactical cost cutting policies, relocating factories or building new facilities arise as potential strategic decisions in order to adapt to current and future market shifts and development. Eslamipoor and Sepehriar [39] argue that relocating production is one of the solutions chosen in order to cut down costs, but is it really a winning strategy?

One of the most sensible and delicate issues carmakers face is the current concern of relocation in automotive industry in order to adapt to market conditions by shifting production towards emerging countries. Car manufacturers strive to reduce their operational costs to compensate weak sales in an attempt to overcome the slow market revival and remain globally competitive.

The following case research conducted on the Dacia-Renault low-cost car policy describes the differences in consumer behavior on the French, Romanian and Moroccan car markets. Relevant data and indicators for automotive industry from these 3 countries are analyzed and compared by using linear interpolation providing an aggregate indicator with an overview on market dynamics and perspectives. Preliminary results show that drivers of relocation are mainly related to market opportunity, workforce costs and infrastructure. Macroeconomic indicators, acquiring needed skills by local workforce and a good management capacity seem to be more delicate issues. Moreover authorities from emerging countries provide fiscal advantages for car manufacturers willing to relocate their activity or build a new factory as they are a source of wellbeing for its population and economic growth for the country. The Dacia-Renault case research conducts an analysis of advantages and disadvantages of relocation and provides recommendations to improve competitiveness and assure sustainable development of both car manufacturing companies and their supply chain [102].

2.5.1. Driving factors of relocation in the automotive industry

Car manufacturing and automotive industry require heavy investments in building factories, equipping them with technology and workforce in order to produce cars. The investment in facilities, equipment, maintenance and indirect costs, car design and development, workforce and marketing can only be recovered if cars sales bring profit to the company so that it can continue to invest in research and development in order to assure better working conditions for its employees and produce better cars for its customers as suggested by Bueno and Ordonez [17].

When the market is dynamic and sales rise car manufacturers can easily recover investments and make healthy profits, however when the market trend is lagging behind and sales are weak, cars are not sold and generate additional costs of storage and immobilize money. The recent financial crisis, among other effects, has also changed consumer attitude and behavior and made them more aware of what they can or cannot afford. When referring to car industry, customers have shifted from complex accessorized cars to ones that are less equipped with gadgets and more practical: a basic car with just the minimum of extras at an affordable price and with decent maintenance and consumption figures.

The main reason for relocating a factory is of economic nature and consists in companies not making enough or even losing money in the current state of their businesses. This kind of decision is however strategic and will need serious consideration before being implemented as it affects and challenges the company's current way of integrating operations. Pennings and Sleuwaegen [116] point out that savings in workforce wages are the driver of such a decision as they prove to be quite important in the aggregate costs of car production.

Usually wages account for up to 10% of costs in a car and depending on automatisation levels and manual labor the percentage can vary accordingly. In time salaries will rise, thus slowly increasing their proportion in total costs and adding extra pressure on car manufacturers to improve their performance by selling as much of their cars as possible in order to sustain a healthy business development. These increases are generally covered from a company's benefits or profit which usually ranges around 5% but can vary according to several factors and be very scarce during tough times and even double when business is booming. However when company performance is lagging behind and results do not improve within a certain time horizon management will try to cut down costs in all areas where this is possible and the most convenient solution is to cut down wages based on weak company performance, which is justified, but Guo [56] insists this should not be the primary and only solution taken into account and applied by the executive.

Relocating business to other countries where wages are lower than in the current one provides an immediate effect on the expenditures with workforce and savings of up to 50% or even more can be made. Jungnickel, Keller, Peters and Borrmann [73] imply that contribution of wages in the cost of a car is also proportionate to the amount and volume of tasks to be done manually by workers, the more the processes are automatized the less human intervention is required and hence the less wages with workforce impact total costs. If automatisation is however low and manual labor is performed to a certain extent, then the contribution of wages in total costs will be higher and thus relocating could be considered.

At the same time when breaking down costs associated with car manufacturing research and development costs with current models have already been undertaken and the associated financial effort made, parts have been designed and engineered and contracts are usually under way to support manufacturing of the models in a horizon of up to 5 years with suppliers. Equally marketing expenditures have also been made in order to advertise the brand's model or models and thus workforce expenditures are among the few ones where adjustments can be made as to reduce their impact within total cost as claimed by Woolliscroft, Caganova, Cambal, Sefcikova and Kamenova [163].

Having plants throughout more locations provides a series of important advantages for carmakers: proximity towards clients, a more smoothened production capability and benchmarking amongst the different facilities. Infrastructure and transport networks also account for key factors as presented in table 2.12. Wells [158] suggests that factories in different parts of the world mean a much better capacity to provide quicker and more adapted services for customers as distribution accounts for less time and effort as it would be in case of a single-based factory premises. As it is in essence a mean to provide better customer service and support, Woolliscroft, Caganova, Cambal, Holecek and Pucikova [162] underline that the location of these factories should be well thought out to assure optimum market coverage and a high customer service rate.

Table 2.12. Infrastructure data

Data	Roads [km]	Of which paved [%]	Motorways [km]
France	1,000,960	100	12,000
Romania	198,817	30.2	644
Morocco	57,625	70.32	1,511

Another advantage is the fact that having several plants allows carmakers to adjust production levels of each facility according to demand and have a more flexible production planning and follow-up.

Table 2.13. Taxation and FDI incentives

Data	France	Romania	Morocco
Corporate tax	33%	16%	30%
Value Added Tax (VAT)	20 %	24%	20%
Average earnings tax	48.9%	45%	12-40%
Imports/Exports	EU regulations	EU regulations	Customs due
Other	- 155 million euros State aid to encourage buying more eco-friendly cars (2003) - 800 million euros to support hybrid cars (2006-2008) - scrapping program (2008-2010) - 6.5 billion euro loan for Renault and PSA during crisis (2009) - 850 million euros State aid to support electric and hybrid vehicles (2012)	- 100 million euros state aid (until 2007) - corporate tax exemption until 2007 - no customs and VAT for imports (prior to EU accession) - 3 year lag to pay VAT for cars sold on the local market - 3.5 million euros from the Ministry of Environment (2000-2002) - scrapping program (since 2005)	- site provided free of charge by the State - corporate tax exemption for the first 5 years and 8.75% for the Tangier platform for the following 20 years - customs facilities - 47.6% aid from the Deposit and Management Fund (CDG) for the Tangier platform investment (523 million euros) - training infrastructure set up costs covered by the state

This provides for better organization and can help generate important savings in costs and help make corporate activity more efficient and account for improved performance. Of course operating different facilities in different parts of the world implies a more costs than in the case of a single-based facility, but the multiple-based factories provide for further important assets for a carmaker: benchmarking among the different plants, possibility to relocate a part of business towards other locations according to unexpected and unforeseeable events and increased negotiating power with local authorities.

Benchmarking among several production sites provides a rich information, organization and synergy exchange and serves as a continuous performance improvement tool for both individual plants as well as for the global group operations. Lind, Pirttilä, Viskari, Schupp and Kärri [93] emphasize that when working on international level, cultural differences and differences in handling specific market differences often provide for productivity and efficiency gains as they serve towards better understanding employees work-related challenges and problem-solving techniques. Benchmarking is thus a simple to use key-tool for continuous improvement and provides a dynamic an up to date data on current and future challenges which contributes to the company's organizational culture and its global competitiveness.

One of the most important factors which influence the investment decision is predictability. Special fiscal policies are provided for foreign direct investments (FDI) as incentives as shown in table 2.13 to encourage investments, but GDP growth, exchange rate dynamics and inflation are equally important. FDI provide employment and contribute to the country's well-being, therefore authorities seldom ignore or engage in policies without consulting or giving consideration to industry opinions prior to policies susceptible of affecting them. Having multiple-based plants enhances the negotiation power of the company as it can choose to relocate thus blowing a big hole in the country's budget whilst rendering workers unemployed.

The proposed methodological approach assumes a two-step comparison of economic indicators which are considered relevant in identifying positive evolution within a company, especially car manufacturers which account for an important impact in national economies. The first step of analysis is to calculate the yearly utilities for the four proposed indicators: GDP, new car registrations (NCR), net profit (NPr) and average net salary (AvSal). Data reported by Renault, Dacia and the National Institute of Statistics from France, Romania and Morocco between the years 2004 - 2013 was processed using linear interpolation in order to make data comparable among each country, resulting in a high level of accuracy for the analysis. The yearly utilities for each individual economic indicator (u_{ij}) are calculated by using the following formula:

$$u_{ij} = \frac{a_{ij} - min\, a_{ij}}{max\, a_{ij} - min\, a_{ij}} \quad (1)$$

where a_{ij} is the corresponding value for each economic indicator; i represents the indicator analyzed whereas j represents the year for which values of that indicator have been calculated using the methodology

The obtained values for the utilities will range between 0, for the minimum value, and 1, for the maximum value, within the considered range of data while the rest will be intermediate values. In the next step of analysis we consider the results identified for each period of time, these are being summed up in order to obtain a global market dynamics and perspectives indicator for every year since 2004 where the initial aggregated elements from step one are equally weighted. The newly obtained market dynamics and perspectives indicator (MDP) shows an evolution from year to year of each carmaker's results within its country and provides an indication on possible future development. Year to year growth of utilities indices for the proposed indicators suggests good performance and is the basis for achieving an encouraging dynamic for the MDP indicator. A value of 0.75 or higher for the MDP indicator is considered to be very good, 0.5 is good whereas a value under 0.5 is a sign that development is rather scarce. A value of 0.25 is considered worrying. The decision of relocating plants in other countries needs to assess the capacity of the economy to assure sustainable development through economic growth and good car market perspectives which will bring about profits for the manufacturers and competitive wages for its employees. These two latter indicators will enhance economic competitiveness and will provide further development possibilities. Relocation to countries where such dynamics are not met is considered inopportune.

2.5.2. Automotive Industry key figures in France

The French car market has had a constant level of newly registered cars between 1999 and 2011 with years of growth and reduction, but still within the same amount of cars sold and registered in France, around 2 to 2.2 million each year (see figure 2.22). Being a country with indigene car manufacturing the French have a pronounced preference towards their local brands, today roughly 50% of all cars in France are national brands. Renault models account for around 20% of new cars sold, whilst the second hand market has been at a steady 5.3-5.5 million.

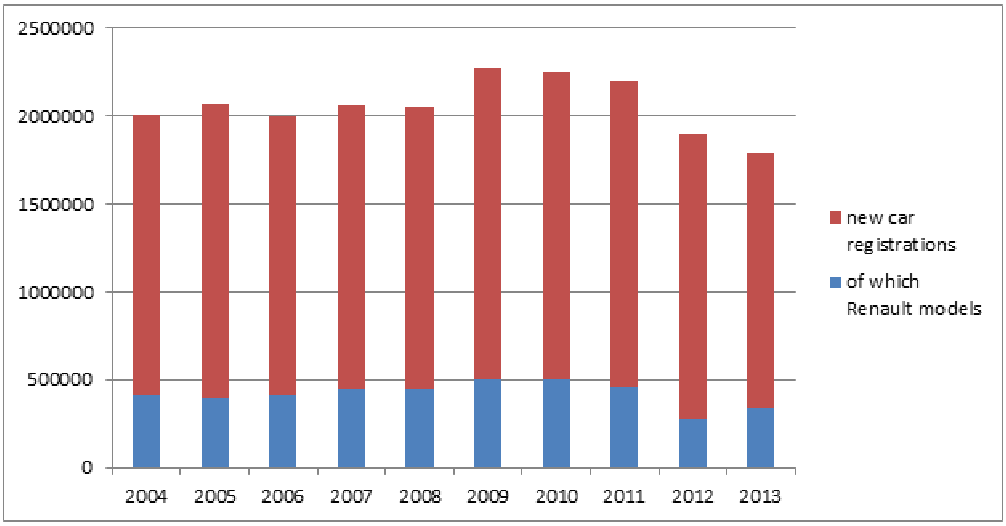


Figure 2.22. New car registrations in France

The drop in new car registrations in recent years by more than 10% has its roots in the customers' change of behavior after the financial crisis. Even in countries like Germany and France a slight shift is noticeable as customers are more and more oriented towards more practical cars, which better suit their needs rather than spending money on over equipped models which provide options most of them don't even use. As foreign brands are winning more and more market shares and car sales are dropping local manufacturers like PSA Peugeot Citroen that have mainly focused on the French market are facing severe difficulties and have had to turn to the French government as well as private foreign investors to help them temporarily overcome serious issues like bankruptcy and remain in business. Renault's policy to introduce the range of low-cost models Dacia has won them an important part of the market and is making up for its own brand's slight downturn and rendering company figures efficient. Today just over 25% of Renault passenger cars are sold in France, while the rest are shipped towards the company's most important foreign markets: Brazil, Russia, Germany and Turkey. Table 2.14 presents data for the French car manufacturer Renault whilst by using formula (1) we obtain the yearly utilities values for those economic indicators (see table 2.15).

Table 2.14. Economic indicators for Renault, France

Indicator	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
GDP [%]	2.5	1.8	2.5	2.3	-0.1	-3.1	1.7	2	0	0.3
NCR [million units]	2.01	2.07	2	2.06	2.05	2.26	2.25	2.2	1.9	1.79
NPr [million €]	3551	3453	2943	2734	599	-3068	3490	2139	1735	695
AvSal [€]	1985	2150	2285	2460	2850	2622	2824	3019	2200	2422

Table 2.15. Utilities and MDP indicator for Renault, France

indicator	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
GDP	1.00	0.88	1.00	0.96	0.54	0.00	0.86	0.91	0.55	0.61
NCR	0.46	0.58	0.44	0.57	0.54	1.00	0.96	0.86	0.23	0.00
NPr	1.00	0.99	0.91	0.88	0.55	0.00	0.99	0.79	0.73	0.57
AvSal	0.00	0.16	0.29	0.46	0.84	0.62	0.81	1.00	0.21	0.42
MDP	0.61	0.65	0.66	0.72	0.62	0.40	0.91	0.89	0.43	0.40

Within the last decade GDP in France has risen by 28% from 1,655 billion euros to 2,119 billion euros. Since 2004 the economy had a steady average increase of around 2 % with 2 years of recession during the crisis. The French economy is showing shy signs of recovery, but only with a scarce progress during the last 2 years. After attaining a record level of 2,268,700 new car registrations in 2009, the auto market is currently recording a 20% fall since 2004 with only 1,790,473 new cars registered. Excepting the loss in 2009, Renault has managed to make profits every year during the last 10 years but the 695 million euros in 2013 represent only 19.5% of the earnings in 2004. The challenges faced by the French car manufacturer are also emphasized by the evolution of the average net salary which today is 22% more than a decade ago, but at the same level as in 2007. The MDP indicator has been for five years over 0.61 and dropped during the crisis. The years 2010 and 2011 showed an impressive recovery as the value of the indicator was around 0.90, more than double the value of 2009. With the yearly 10% drop in new car registrations since 2012 however the tendency has been reversed and the MDR indicator is now at its lowest value of 0.40. This situation can be overcome by a better performing economy and by improving efficiency and productivity within Renault.

2.5.3. Automotive Industry key figures in Romania

After Renault had bought Dacia and the company started making cars with the aid of the French manufacturer car industry in Romania had managed to boost new car sales year after year in a highly impressive manner until 2007 as figure 2.23 shows. The stunning development of the car market was first hit by the crisis which seriously reduced volumes being sold, while on the other hand second hand imports had started growing as the population could more easily afford second hand cars rather than new ones, German brands being particularly preferred.

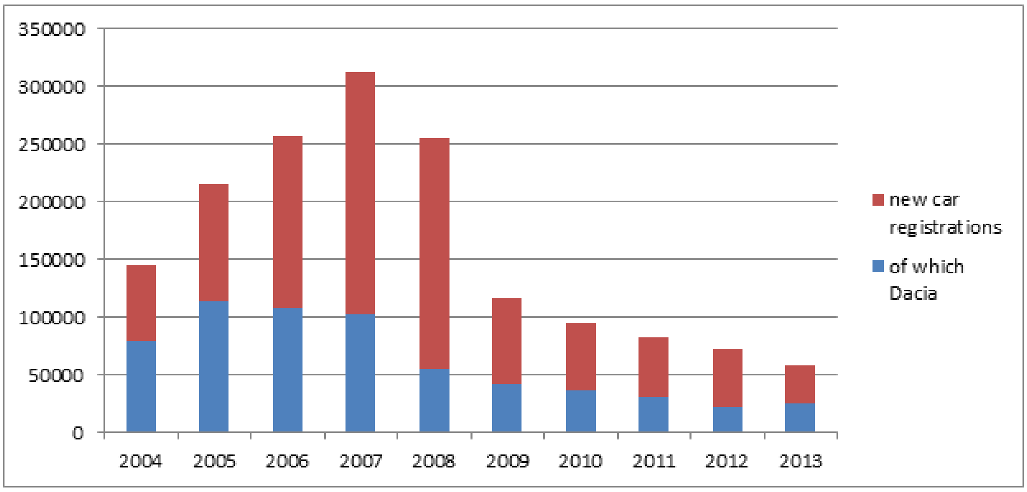


Figure 2.23. New car registrations in Romania

The government decided to introduce a tax on first registration for all imported vehicles. The tax was mainly introduced to discourage customers buying second hand cars from abroad in an attempt to force them into buying new cars manufactured within the country. Taxation varied according to engine size, year of production and CO_2 emissions and in some cases would even double the price of the car whilst in average accounting for an extra 30% on car price. However the tax violated the right to free circulation of goods within the EU and was proved illegal in court after many customers sued the Romanian state. The tax slightly changed its calculation method or its name, but the idea remained the same. Currently the tax is called environmental stamp, but this tax avalanche did not stop second hand imports, as they continuously raised above new car sales, only last year being four times more in volume than new cars. Despite the environmental stamp, people still prefer buying second hand imported cars (see figure 2.24). However the new form of the tax works as a boomerang against the Romanian state and local car manufacturers as the level of the tax renders any sale of a local second hand vehicle unattractive and thus owners prefer keeping their old cars seen as they would obtain only silly money for their current ones in the attempt to finance a new car through the sale of the one they possess.

Figure 2.24. New and second hand car registrations in Romania

Currently 92% of the local car manufacturers' production Dacia and Ford is exported, as Dacia only sells around 5% of its global production in Romania and has a market share of 31.6% on the local market with 24.890 models sold last year. Car manufacturing is an important industry where Dacia accounts for 3% of GDP and 10% of Romania's exports, with France and Germany being its main markets. Today Dacia is a notorious brand of Renault and its sales have a positive influence on the French car manufacturer's global performance. At the same time it is one of the most important low-cost brands and continues to acquire market share, being a real success policy of the French group. Other car manufacturers have announced they would also develop low-cost models in the coming years, but until then Dacia still has time to consolidate its strong market position and gain more brand value on its operating markets. Table 2.16 presents data for the Romanian car manufacturer Dacia whilst by using formula (1) we obtain the yearly utilities values for those economic indicators (see table 2.17).

Within the last decade GDP in Romania has nearly doubled from 79.3 billion euros to around 140 billion euros. For five years the economy had an impressive average increase of 6.6% before the 7.2% drop in 2008. The Romanian economy is recovering however, GDP has grown within the last 3 years with a 3.5% progress last year. New car registrations however are at their lowest ever level, the auto market is currently recording a 39.7% fall since 2004 with only 57,700 new cars registered last year, more than five times less than in 2007. Dacia has made profits every year during the last 10 years, earnings ranging from around 57 million euros in 2004 to 77 million last year, with a peak of 100.6 million achieved in 2007. An average exchange rate of 4.4 lei/euro has been considered. High demand for the Romanian brand has had a significant influence on average net salary evolution which today is four times higher than a decade ago at around 715 euros/month. The MDP indicator for Romania is within its fourth consecutive year of growth with a value of 0.55 in 2013 but it is being slowed down by the drop in new car registrations. Nevertheless the indicator is 30% higher than in 2004 and has attained a record value of 0.77 prior to the crisis. The car market in Romania is still suffering as second hand imported cars are getting the better of the new cars, but a good performing economy may be able to even the odds and reverse this trend within a few years.

Table 2.16. Economic indicators for Dacia, Romania

Indicator	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
GDP [%]	8.4	4.1	7.7	6.1	7.1	-7.2	-1.3	2.3	0.7	3.5
NCR [units]	145120	215532	256364	312532	285504	116016	94541	81709	72179	57700
NPr [million lei]	296.63	298.29	377.27	442.34	222.02	230.28	300.02	275.11	277.24	337.44
AvSal [lei]	729	892	1055	1328	1580	1880	2288	2548	2781	3154

Table 2.17. Utilities and MDP indicator for Dacia, Romania

indicator	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
GDP	1.00	0.72	0.96	0.85	0.92	0.00	0.38	0.61	0.51	0.69
NCR	0.34	0.62	0.78	1.00	0.89	0.23	0.14	0.09	0.06	0.00
NPr	0.34	0.35	0.70	1.00	0.00	0.04	0.35	0.24	0.25	0.52
AvSal	0.00	0.07	0.13	0.25	0.35	0.47	0.64	0.75	0.85	1.00
MDP	0.42	0.44	0.64	0.77	0.54	0.19	0.38	0.42	0.42	0.55

2.5.4. Automotive industry key figures in Morocco

The rapid development of the Dacia brand and its growing sales in Western Europe have made the factory located in Romania to work very close to its maximum capacity during recent years with a peak production of 343.000 in 2013. In order to smooth production levels, the French group decided to build a new Dacia factory in Tangier, Morocco to ease production for the Mioveni site and to have easier and quicker access towards the Western European markets for its demanded models. The fact that Renault now has 2 factories which will be able to produce the

Dacia models means that in ever needed capacities can be shifted from one factory to the other according to demand.

Renault has further plants in Russia, Brazil and India and the factory in Tangier is the second for the group, after the Casablanca site: thus the French car manufacturer covers its current major markets outside France and Western Europe. The range of its factories enables the group to cover more markets and can account for a smoother distribution in case of important fluctuations in customer demand. In Morocco after a good development between 2003 and 2008 a slight drop interrupted the growing tendency which continued in 2011 and 2012 only to drop again last year. Car industry is important in the country and has increased its importance after Renault opened a new Dacia plant in Tangier, making it the second one after its facility in Casablanca. Renault has a leading 39% market share in Morocco and is a main contributor to the country's 13.6% share in exports of car industry while around 72% of local production is sent towards other countries, as are France, Spain, Portugal, Turkey or Tunisia. Table 2.18 presents data for the Dacia car brand whilst by using formula (1) we obtain the yearly utilities values for those economic indicators (see table 2.19).

Table 2.18. Economic indicators for Dacia, Morocco

Indicator	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
GDP [%]	4.8	2.98	7.76	2.71	5.59	4.76	3.64	4.99	2.69	4.4
NCR [units]	54808	64000	84666	103000	121511	109966	103436	112100	130316	120766
NPr	Not enough data available									
AvSal	Not enough data available									

Table 2.19. Utilities and MDP indicator for Dacia, Morocco

indicator	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
GDP	0.42	0.06	1.00	0.00	0.57	0.41	0.19	0.45	0.00	0.34
NCR	0.00	0.12	0.40	0.64	0.88	0.73	0.64	0.76	1.00	0.87
NPr	Not enough data available									
AvSal	Not enough data available									
MDP	0.21	0.09	0.70	0.32	0.73	0.57	0.42	0.61	0.50	0.61

Morocco is currently the 6th African economy by GDP as within the last 10 years its economy has risen by more than 16% from around 42.8 billion euros to around 72.1 billion euros. Since 2004 the economy had a continuous increase ranging from 2.69% in 2012 to 7.76% in 2006 with a yearly average of around 4.4%. The Moroccan economy is thus performing well and signs show that future development is to be expected. After attaining a record level of 130,316 new car registrations in 2012, the auto market is currently recording a slight 7.3% fall with just over 120,000 new cars registered last year. However the new car market in Morocco has more than doubled within the last decade. This development has drawn the attention of the Renault and the French manufacturer decided to extend its operations in Morocco by building a new site in Tangier for its Dacia brand. As any new plant, until reaching a certain level of production and efficiency no significant profits will be recorded within the first couple of years. On the other hand, seen as the European market has reached maturity, Africa is among the new emerging markets where carmakers will try to sell their vehicles and continue expansion. Moreover workforce is a lot cheaper than in Europe as the average salary in the Tangier plant will only amount up to around 250 euros, nearly 10 times less than in France or a third of the wages received within Dacia in Romania. The partial MDP indicator for Morocco shows good progress as its value is roughly 3 times the one in 2004 while during the last six years it has only once been under 0.50 with a peak value of 0.73 in 2007. Within a few years the Moroccan MDP indicator has good chances to develop in line with car market development and raise overall competitiveness of the national economy.

2.5.5. Conclusions

The market dynamics and perspectives indicator is an aggregate performance indicator which indicates how close one country is towards achieving a positive competitive spiral. The competitive spiral is the effect at a given time generated by the evolution of certain indicators that have the ability to enhance future development for both a car manufacturer and a country by achieving constant growth and providing wellbeing for all stakeholders in a sustainable manner. Achieving continuous growth is however difficult to achieve and results may sometimes fall from one year to the other. Nevertheless it is important to have a growing tendency throughout the years and engage in performance enhancement which will assure business sustainability.

GDP growth is important for macroeconomic stability, new car sales are the key towards achieving profits for carmakers and provide the possibility to continue development and increase employee wages in line with productivity and competitiveness. The latter will be reintroduced into the economy and will continue to support GDP growth for the following years and will thus create the premises for demand to grow within other sectors (including new car sales) and generate more profits which is an important decision factor to raise wages and so on and so forth. A healthy economy will manage to maintain a positive competitive spiral which will generate wellbeing for its population and increase the overall quality of life.

Research shows that relocation is mainly related to market opportunity, as emerging markets have the potential to sustain a car manufacturers' business when other markets approach maturity. Such a strategic decision has to imply the aspects of quality, cost and lead time which have to fall within brand expectations as is also shown by Surjandari, Sudarto and Anggarini [143]. Economic stability and business predictability are key pillars for any long-term business as well as FDI incentives, which are important within the decision-making process. Qualifying workforce and integrating specific management capacity are equally important as pointed out by Yokozawa, Steenhuis and de Bruijn [165] and need time in order to evenly match a group's organizational culture and performance will lag for a few years before being able to achieve good results. Workforce costs are more important within labor-intensive plants, whereas infrastructure is of utter importance for lead times, delivery dates and transport costs and should account for highly efficient response times.

Another important factor to take into account is the social response to these decisions, as they well may prove to be less inspired than at a first glance. In this matter, surely the emerging country would have a much better attitude towards relocating part of a carmakers activity to its premises than the country from where the activity will be relocated. Relocating means facing the effects of people losing their jobs, less output to stimulate national economy as well as compensation plans, all of which can seriously affect the image of any car brand. One of the most important countries with such social protection is France, where laying off workforce is a very delicate and serious decision as the French unions and workers benefit from a series of rights and protests and movements even against French carmakers are not seldom in these cases. Especially for their local brands, the "made in France" is a really important decision factor in buying high added-value products as are cars. Discontentment is already manifesting as the Twingo is entirely produced in Slovenia whilst the production of the Clio, one of the most iconic Renault brands, is made to an extent of 70% in Turkey and carmakers should be equally aware of the social aspect in their decisions as well.

With a proper implication from all stakeholders relocation can prove to have several benefits and should be seen as an opportunity for future growth, economic and social welfare. By relocating activities that have lower added value, the facility which has a part of its activity relieved may focus on higher added value activities and in line with its core competences can provide a win-win situation to all its stakeholders. The main challenge is however the capacity of the new premises to integrate within a carmakers' supply chain and provide comparable performance throughout all stages. This requires acquiring skills, motivation to increase productivity and improve local and global competitiveness of the group which will in turn provide economic development within the country and assure the premises for further investments.

3. PERFORMANCE ANALYSIS TOOLS USED IN THE AUTOMOTIVE INDUSTRY

3.1. Research on performance analysis in the automotive industry

3.1.1. Production-related performance analysis criteria

Performance analysis has always been a central point in any car manufacturer's activity and was later extended to the car industry and more recent to its entire supply chain network. Carmakers have always been very eager to be the best they could be in order to be competitive on the market and outsell their competitors. Automotive industry has been a very challenging and competitive industry since its early days and although today carmakers are focusing on concentration of their activities, one of the main leviers of competitiveness is to be able to respond to the market demands with a broad variety of vehicles.

This response capacity is however leveraged by the flexibility of a carmaker, which is one of the most important production challenges because it influences the business performance of the manufacturer and can also impact its competitive position on the car market [27].

The strategic goals of the company will ultimately determine its manufacturing capabilities on which it will compete on the car market. These capabilities usually refer to cost and quality, which also establish the segment of the market where the brand competes, but can also include delivery reliability and speed, or even flexibility. The competitive strengths provided by these capabilities are then assessed relative to competitors' positions and the attributes provided by the carmaker will the pass through the market filter. If the carmaker provides features which are sought by the market and it outperforms its competitors, then it will win customer orders and gain a competitive position on a specific market [25].

Carmakers however cannot master all manufacturing capabilities simultaneously, as they are interconnected to several links of the internal production system and subject to human activities and errors. Although a manufacturing system is not able to perform equally well on all capabilities. it can however continuously improve its design and try to achieve synergies between the existing physical, technical, informational and human realities that limit the performance of the system.

It can therefore achieve in a fair amount of time the feature of flexibility which will prove as an important asset for achieving a competitive position on the car market.

Because it is multi-dimensional, flexibility is a complex concept which requires investments, generates additional costs and imposes trade-offs within the manufacturing activity (machines, routing design, product mix, etc.) in order to achieve end benefits, which are not immediately effective as they may occur on a more medium or long-term level. Moreover, manufacturing policies have to be adapted to be in line with the goals of flexibility as being able to make many products requires a very different set of manufacturing policies than being able to handle severe volume fluctuations caused by unequal market demand [134, 135].

One of the most extensive studies on flexibility concerns the differences between American and Japanese carmakers with regard to the stamping presses used. American producers would usually dedicate these presses to making a specific part for several months in order to increase productivity and achieve scale economies, whereas Japanese producers preferred to change their stamping dies every couple of hours which resulted in a much higher number of options and thus focused more on flexibility. In this particular case both producers performed only stamping operations with these presses, as this always involves the same operation with only the dies changing. In the 1970s, prior to mounting efforts to reduce setup times, American stamping presses would need from 8 hours to around a full day for machine changeover, thereby limiting the number of different stamping operations the machine performed. Meanwhile, Japanese producers had already managed to achieve significant setup time reductions and were managing changeovers of around 5 minutes, a massive improvement when compared to the Americans. This different approach in manufacturing also brought about the issue of quality level. As their changeover was done over a longer time span, large lot sizes often resulted in large quantities of defective parts being produced before a quality problem could be detected. Although American carmakers have improved since then, the Japanese are still the benchmark in production organization [31].

A more unconventional approach was carried out by Volvo, who conducted an interesting experiment in Sweden in an attempt to find an alternative to line assembly production techniques. Existing research shows beneficial outcomes in productivity and overall worker motivation, the Swedish efforts remained singular in the industry and only little research has been done to fully cover the subject. The main argument was that in a more free work environment for employees, where they could work in groups and on several different workstations, overall productivity would increase and would bring more benefits than the traditional assembly line approach [34].

Results surprisingly showed that these productivity increases actually existed and some researchers state that there would have even been room for a further 15% growth if efforts had not been ceased. Nevertheless the implementation of such a new manufacturing philosophy was favored by a series of fortuitous circumstances on the Swedish labor market as well as the social ambitions of the Swedish company’s management [35].

Productivity in a factory is linked to the capacity of the machines to run at full capacity and of the workers to be able to sustain a similar level within their daily activities with the aid of those machines [104]. The extent of the final output is influenced by the ergonomics of the workstations which can have a massive impact on achieving target production levels and workers’ efficiency.

The benefits provided by applying good ergonomics in an assembly system design of a factory are first of all linked to the reduction of occupational injury risks [71]. This brings about not just an improvement of the physical and psychosocial conditions of the workforce, but it also triggers an important reduction in costs associated with absence, medical insurance or rehabilitation.

It is proven that good ergonomics improves quality and operators productivity. This is usually the job of ergonomists, however sometimes workplace layouts are designed by planning engineers and the results prove often to be unsatisfactory and do not improve productivity.

Achieving high productivity and best results are more likely to be accomplished with the optimization of both production time and operator load. This means harmonizing both technological and environmental variables such as assembly tasks, assembly cycle and flow, process setup times or available space (technological variables) and tasks repetitiveness, length of movements, body posture, handled weight or automation level (environmental variables) [10].

As a car manufacturing facility has lots of workshops prior to the final assembly, it is important to have in depth knowledge about each and every workshop's productivity and efficiency. By having a good and complete overview on their manufacturing capabilities, carmakers may decide to outsource some of the parts, as this may prove beneficial to focus more on their core competence.

Thus car manufacturers can choose to assemble some modules internally or to outsource the units assembling the modules (modular assembly). These module assembly units (MAUs) can be located inside or outside the assembly plants.

Modules are often used in automotive industry as a way for companies to divide a complex whole into more manageable parts and can especially help the flow of the production system. Product modules imply modular assembly, which refers to the sub-assembly of components into product modules, in parallel with work on the final assembly line. The main benefit is that mass customization can be performed more efficiently, which is why it is primarily used in automotive industry as it is a source of competitiveness. Usual car modules are seats, cockpits, frontends, headliners, door panels, fuel tanks or others which contain variant specific components and a large number of possible variants of each module, which means that keeping stocks is highly inefficient as some variants may never be requested.

Each module is unique in the flow and has to be assembled and delivered within tight time constraints in the right sequence to the final assembly line. The module assembly units therefore perform primarily assembly and need to be located very close to the manufacturer's final assembly plant in order to support a tightly integrated industrial system.

Many western car manufacturers have outsourced some module assembly to suppliers. Skoda and Daimler, for example, have had suppliers establish MAUs with a direct connection to the final assembly lines inside their own plants. Japanese car manufacturers did not choose to follow this trend as they prefer to assemble the product modules internally and primarily outsource component production. This is mainly due to their ease of coordinating and improving internal operations and to avoid depending on a single supplier.

Car manufacturers have different choices concerning organizational forms for MAUs as no particular form clearly stands out as best. A supplier-owned MAU has better opportunities to achieve scale and specialization benefits internally, whereas a customer-owned one may be better in line with customer expectations. A module which is labor intensive and does not require extensive interaction between the MAU and the assembly line, provides better conditions when sourced outside rather than pre-assembly within the manufacturing facility.

The degree of control the car manufacturer exerts over the MAU strongly influences its conditions and performances. Therefore the MAU's degree of autonomy from the car manufacturer's control is as important to consider as ownership and location in order to comply with established objectives. Nevertheless these organizational forms have a temporary alignment, because the structure of the car industry, the companies themselves and their technologies will change over time and so will the conditions provided by the organizational forms [45].

Changes occur today with much greater speed than a decade ago, technology is developing and so are cars as they constantly englobe more and more of the new technologies. These changes also need to be integrated in new production and assembly techniques, which in turn also means giving the workforce the proper training to be able to perform these tasks. Productivity growth can only be achieved if employees manage to increase the produced output at a higher rate than the rate of increase in the quantity of inputs used within the production process. Note that knowledge acquisition is a gradual process, so that even when workers and managers know the standard of maximum efficiency which is to be attained, that standard may take some time to be attained and reaching a level close to that target is still considered satisfactory as the whole process is subject to human errors. An increase in productivity of 50% can be achieved at a manufacturing facility only after investments in both technology and human workforce after six or seven years, as is the case with the Opel factory in Zaragoza, Spain. The increase was not linear during those years, as speed of learning and speed of adjustment are two completely different things in an assembly plant. The speed of learning measures the pace at which knowledge is acquired by workers, whereas the speed of adjustment measures how fast that what is learned during training is then transformed into higher productive efficiency. In the Opel plant from Zaragoza it took between five and six months to adjust results to targets set, which is an important lag that is to be considered by management when establishing realistic time spans for worker assessment and output planning [127].

Training is necessary because both workers and managers have to be prepared to manage everyday challenges and sometimes deal with unforeseen events. The way they manage these situations can be very important for overall performance and for building healthy business relationships with suppliers and customers. The benchmark in automotive industry organization is Japanese manufacturer Toyota, who has built its success on a couple of simple principles as structural work design and a systematic approach to problem solving. The Japanese way of conducting business at Toyota through the Toyota Way have intrigued many carmakers and today many of the Japanese principles used at Toyota are applied within every car manufacturing facility from the car industry. The Japanese have a very proactive attitude towards problem solving and continuous improvement within their jobs as is shown in figure 3.1 below. When a problem occurs, workers at Toyota identify the sources of system variation which are usually linked with part or product variation due to poor quality of inputs provided by suppliers, flawed design of those parts or products or misaligned processes. These flaws are then addressed in order to solve both the root problem and to improve the quality of flow. Even workers at Toyota can induce variations in system performance due to fatigue, improper training or lack of motivation, but Toyota implemented a decentralized approach to address this issue by empowering workers to make decisions and mitigate these causes. Toyota has a policy of respect for people, which enables its employees to be trained on the job, taught to treat any problem that arises as a learning opportunity and encouraged to develop suggestions for improvement, thus creating the foundation for a healthy work environment. This is also one of the reasons why the Toyota Production System (TPS) is so hard to replicate, because there is a lot more to it than just a couple of Japanese organization concepts. Carefully calibrated however, implementing TPS could have an important impact on overall plant performance and contribute to essential improvements, including cost, quality, manufacturing cycle time and delivery performance [70].

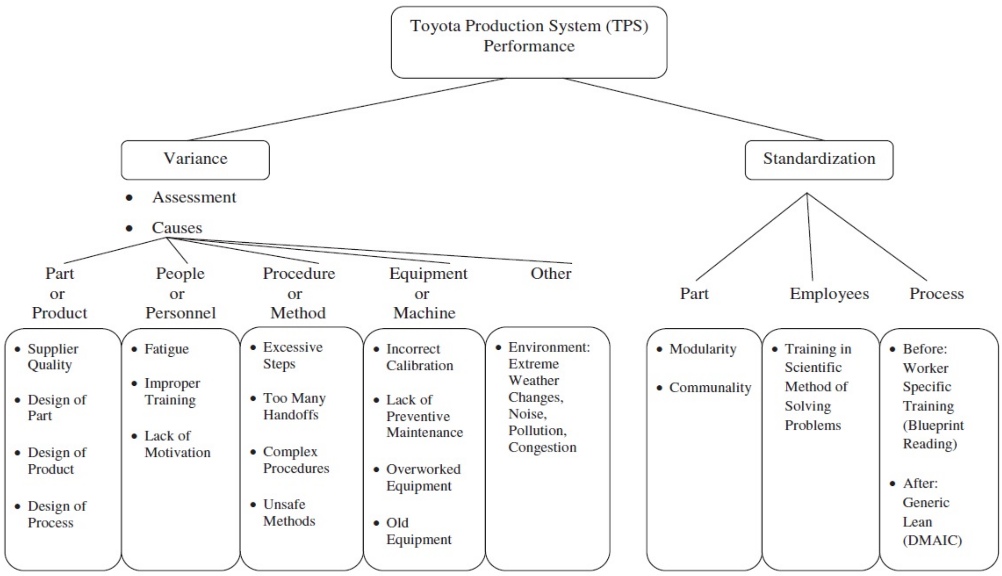


Figure 3.1. Toyota's problem-solving framework [70]

This is confirmed by the concept of agile manufacturing which emphasizes the idea that manufacturing excellence may generate a certain level of performance, but that alone is not enough as it is necessary to achieve supply chain integration in order to achieve additional improvements and strengthen the network. Customer perspective (marketing performance), internal business perspective (operational performance) and financial perspective (financial performance) are equally important and have to be part of the business philosophy in order to support Just-In-Time production, enhance manufacturing agility and generate a solid long-term development [69].

Managing volume flexibility is perhaps one of the most challenging tasks as orders vary in accordance with actual demand fluctuations. This is why manufacturing flexibility is considered a major competitive attribute and of strategic importance on the auto market [101].

This is also one of the opportunities the Japanese carmakers used in their favor to gain a competitive position on the global automobile car market to the surprise of the Western and American traditional players [128].

In more recent years the concept of lean manufacturing has arisen as a new goal towards improvement in automotive industry, but it lacks a straightforward quantitative approach as it is part of Japanese production management. Nevertheless comparisons exist and leanness can be measured to an extent, as with the case study of Ford's production system being 17% leaner than General Motors by using Honda's benchmark system as a benchmark [11].

Lean management is associated with Just-In-Time (JIT), but also with some classic concepts as Total Quality Management (TQM), Total Preventive Maintenance (TPM) and Human Resource Management (HRM), which all have effects on

operational performance according to contextual factors such as factory size, plant age and unionization status.
Evidence shows that the synergistic effects of all lean practices are associated with better manufacturing performance, regardless of size, age or level of unionization of the factory in question and provide a competitive advantage over those who do not implement this manufacturing philosophy [132].

This is supported by another research that shows 10 factors which are likely to be at the heart of lean manufacturing philosophy and practice. The factors address all major links of the supply chain and they also integrate the lean philosophy into the equation. Upstream there is supplier feedback, JIT delivery by suppliers and supplier development, whereas downstream customer involvement is mentioned. These are linked together by operational performance through pull techniques, continuous flow, set up time reduction, total productive/preventive maintenance and statistical process control. Operational performance is however tied to productivity, therefore employee involvement is the last of the 10 key factors.

Lean production is an integrated system composed of highly inter-related elements. Unfortunately researchers usually rely on the statistical significance of the empirical results to explain interrelationships and neglect the fact that statistical significance is a necessary but not a sufficient condition to explain the inter-relationships in a system. A system is a lot more than the sum of its individual components, because these components come together and achieve synergies which create added value to the customer.

This is what gives lean production its unique character and its superior ability to achieve multiple performance goals. Although every factor individually wants to perform better it is the overall improvement or the optimization of the whole which enables the desired outcome to result in sustainable competitive advantage. The major difficulty for most companies is thus to implement the many elements of lean simultaneously and because simultaneous implementation of several aspects is so difficult to achieve, it is also difficult to imitate [131].

These difficulties are pointed out when it comes to applying one of the most simple and useful tools, namely Value Stream Mapping (VSM), which is a mapping of material and information flow throughout the factory. The goal of VSM is to understand the flow and to eliminate non-added value activities from the floor. Usually there are discrepancies between standardized work and actual work within a factory due to workers not strictly following assembly standards, but these gaps can be eliminated if operators are fully aware on the long-term commitment to practice Lean [120].

3.1.2. Management-related performance analysis criteria

One of the main reasons automotive industry is so competitive and important for global economies is that it makes high added-value products, but in order to make them it also needs to have an important amount of financial, technical and human resources which usually come in the form of Foreign Direct Investments (FDI).

Economic development consultants at Area Development Magazine conducted a recent survey and identified 12 important factors to consider when selecting the premises for a new facility for companies within automotive industry. These were the overall cost of doing business, incentives programs, business friendliness, corporate tax environment, labor availability, labor costs, workforce development programs, rail and highway accessibility, certified sites and shovel-ready programs, competitive utility rates, access to global markets and economic recovery.

Besides these technical aspects there is also the importance of a business-friendly environment, which goes beyond the 12 previously stated factors. Things like drawing up a plan to seek ways to lower firms' entire cost of doing business, employee training plans or infrastructure prioritization can help offer a perspective to companies interested in extending their businesses. These additional points help carmakers feel assured that their business is supported and such policies in the United States helped Alabama to succeed in recruiting Mercedes or Tennessee to reach an agreement with Volkswagen.

Car manufacturing is a business which is guided by figures and automakers will prefer to invest in countries where authorities will be seeking to stabilize economies, enhance infrastructure, reduce costs and trade barriers and promote a competitive market in an attempt to provide well-being for their communities [154].

In order to be competitive on their markets, carmakers have to have a good management policy to assure their quality and brand requirements are rigorously met, that their suppliers are well aware of them and that they provide a reliable service so the factory can operate within normal conditions. Each company is different in its own particular way and quality management practices do differentiate suppliers with different overall ratings. One of the most important management policies in automotive industry is process management, which is of high priority for high performing suppliers. Process management mainly includes the use of statistical techniques, employs process performance charts and it enables both cycle time reduction and continuous improvement. These specific techniques can remove bottlenecks, one of the most important issues in manufacturing and consequently increase productivity, reduce lead times, improve delivery performance and reducing overall costs, which can have a massive impact for supplier operations. Process management is thus an essential approach towards improving quality, costs and delivery performance.

In the meantime employee satisfaction can also help contribute to a supplier's competitiveness as is evidence from South Korea, where it accounts for a 10% level in overall performance and productivity. Workers that are motivated are keener to get a good job done and to ensure product quality conformance and compliance, which is only an order qualifier, but it accounts for 17% in supplier's overall performance [115].

Being competitive requires very strong organizational effectiveness, as was proven by Nissan in the last 20th century. Carlos Ghosn was appointed CEO of Nissan in 1999 as the company was facing serious financial problems, was going through decline and had lost money in all but one of the previous eight years. Renault saved Nissan from bankruptcy by acquiring a share of the Japanese manufacturer's losses within the Renault-Nissan Alliance.

The problems at Nissan included excessive costs, declining sales and a weak management, whilst everyone seriously doubted that the alliance between the French and Japanese carmakers could succeed and that a non-Japanese company could save Nissan. Only one year later however, in 2000, Nissan was once again profitable and in 2001 earnings reached a record high, a stunning turnaround witnessed by the automobile industry, which was possible thanks to effective and efficient management and leadership techniques.

The first order of business was to make the company more efficient financially. Purchasing costs normally represent around 60% of the cost of a vehicle, but at Nissan they were exceeding this margin. Compared to Renault, Nissan has purchasing costs higher by 25%. Ghosn formed a cross-functional team and gave them the task to find ways to reduce purchasing costs. The main solutions chosen were to reduce the number of local suppliers by half and place larger orders with a smaller number of global sources and to eliminate the overly exact specifications which the Nissan engineers imposed on their suppliers. These solutions brought purchasing costs down by 20%.

Another source of unnecessary costs was production overcapacity, as Nissan could manufacture up to a million more cars than it could actually sell, however any reduction in production capacity would have affected plans to increase sales in the future. Carlos Ghosn closed five factories in Japan and eliminated more than 21,000 jobs as well as reducing the number of different car platforms and power-train combinations. This meant production operations were simplified at the other Nissan factories, which in turn made them more efficient.

At the time Nissan cars lacked customer appeal so the new CEO encouraged the engineers to be innovative and try out more modern designs, which also proved a success as their cars began having better styling. Ghosn also addressed a more sensible issue: that of employee benefits such as guaranteed lifetime employment as well as pay and promotion based on seniority, which were not motivating employees to perform at their best.

He established a merit pay plan, where workers would have to earn their promotions and salary increases based on effective performance instead of seniority. Responsibility areas were clearly defined so that performance could be measured accurately to see if they matched the established targets as well as bonuses could add up to a third of one's annual salary based on performance. This made it possible for more competent employees to get ahead and become more competent managers than the former ones. One of the main responsibilities of top management is to ensure that the organization follows its core values, with the leaders at all levels having to build the support for this core ideology to be passed through, understood and used by every worker in a manner that these values guide their daily actions.

A very important success factor in Carlos Ghosn's approach at Nissan was the fact that in the months before assuming the CEO position, Ghosn had met with hundreds of people (including employees, dealers, suppliers, union officials, even members of the Japanese government) in order to know the company better and to gain an in-depth understanding of Nissan with both its strengths and weaknesses.

The successful turnaround at Nissan demonstrates the importance of having a good approach and choosing to think long-term when applying more delicate measures. Making Nissan profitable again required mutual and consistent changes to improve the Japanese company's efficiency, adaptation capacity and the motivation of its human resources. Some Ghosn's changes yielded immediate short-term gains, while others would take much longer to show positive benefits, but he managed to make everyone understand why that was more important. And he did. This is because Ghosn understood that sustained high performance at Nissan required more than the usual and convenient temporary ''quick fixes'' which are commonly used when there is a financial crisis.

He also gained trust by demonstrating the same accountability he expected from all employees when he formally announced his turnaround plan for the Japanese carmaker: Ghosn said he would resign if the company would fail to earn profits by the end of the following year (in 2000), which was an impressive demonstration of his commitment and confidence and made his demands towards the others seem more acceptable [166].

As options on cars are getting more and more sophisticated, customers have a wide range of choices when equipping their cars, thus one of the most important challenges for carmakers is to be in line with market demand for these extras and to provide useful and handy features. This measures a car manufacturer's capability to be market flexible and to have a decent range of available extras. Recent research compared the market flexible customizing system (MFCS) of three Japanese vehicle manufacturers: Toyota, Nissan and Mitsubishi from 2001 to 2008 with interesting results.

A research team engaged in-depth interviews of executives from the three Japanese automakers (Toyota, Nissan and Mitsubishi) and from their suppliers to examine their management philosophies and manufacturing practices.

Results show that Japanese manufacturers adopted MFCS by integrating long-term market-driven production planning with short-term customer-specified order demands. They combine make-to-plan (MTP) with make-to-order (MTO) and implement incentive practices for their suppliers and manage inventory risks. Toyota however implements responsive market production practices a few days shorter than Nissan and Mitsubishi, due to Toyota's highly flexible customizing system. Implement MFCS is seen by Japanese carmakers as a way to secure their competitive advantage worldwide.

At the beginning of each month, dealers receive data which estimates demand for the next three months by each car model from national sales offices. Manufacturers then prepare the sales projection of each sales dealership. However demand estimation by dealership does not immediately establish the actual production plans of the manufacturer as it only serves as a more realistic production plan and helps provide useful guidance to their component suppliers. Figure 3.2 schematically represents the development process of the production schedule.

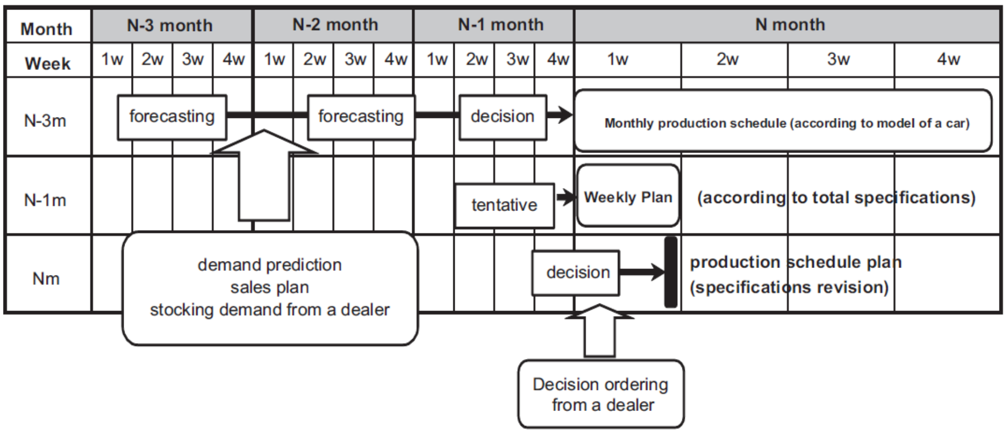


Figure 3.2. Production schedule development process [148]

Japanese carmakers have different mechanics of establishing production scheduling. Of the three carmakers in question, Toyota accepts customer specified change requests even three days prior to production, as dealerships may still ask for changes of color, engine form or types of equipment. Nissan and Mitsubishi allow for such changes with four or five days before production starts, thus Toyota customers usually receive their orders about one week faster than those of Nissan and Mitsubishi as production is only five days per week. Figure 3.3 shows the process details of an order for vehicles at Toyota, Nissan and Mitsubishi.

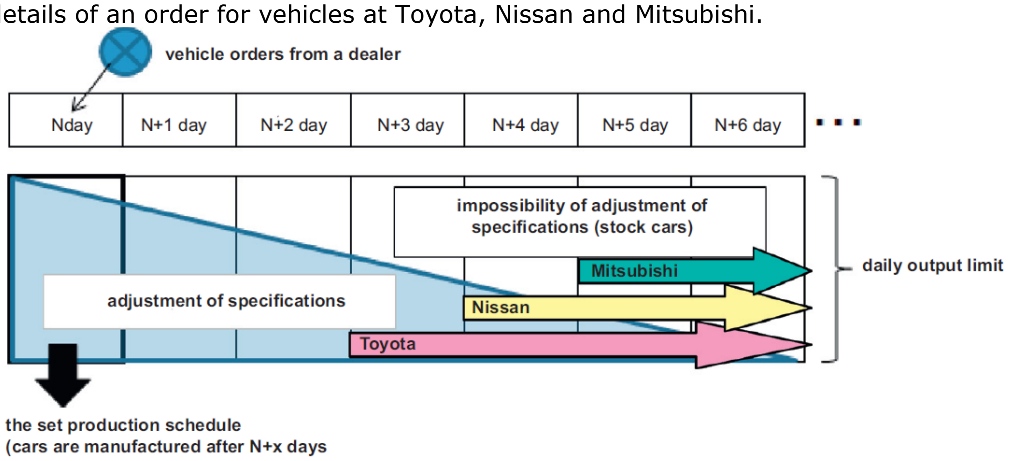


Figure 3.3. Production scheduling comparison of Toyota, Nissan and Mitsubishi [148]

Nevertheless, the maximum margin of allowable order changes is set at 10% of planned specifications, but even so, these changes can add up to 50–60% of the initial orders. Japanese OEMs use both MTP and MTO, due to certain specifics of their component suppliers (as is the case with the newer high intensity discharge (HID) lamps). A passenger car has in general 20,000 to 30,000 component parts and Japanese OEMs receive nearly 70% of these components from their suppliers. Therefore any changes in production schedule directly impact purchase plans for parts and the production schedules of component suppliers. This is one of the more sensible aspects of changing orders prior to production. In this sense, OEMs need to have a plan to provide flexible production plans while at the same time trying to stabilize the schedule for component procurement, as this is the center point of inventory risk and delivery time issues where large numbers of suppliers are involved [148].

Working capital management is an essential part of the short-term finance of a company and is of special significance in the automotive industry. Efficient working capital management can allow a company to release capital for more strategic objectives, reduce the financial costs and improve profitability. Supply chain management is usually associated with the physical flow of goods and services, but these flows are only possible if they are consequently supported by working capital management, which handles the financial flows. The automotive industry faced profitability problems even before the financial crisis, but when activity was booming, these seemed minor, however when the downturn appeared the car industry suffered from raised pressure on costs and competition, which aroused the interest to improve working capital management.

Working capital management can be measured through the Cash Conversion Cycle(CCC) [42] which represents the length of time (in days) a company has funds tied up in working capital, beginning from the moment of payment of its purchases to the supplier and ending with the moment it receives the payment for its sales from customers. The CCC thus consists of the cycle times of inventories, accounts receivable and accounts payable and is calculated as days inventory outstanding (DIO) + days accounts receivable outstanding (DSO) – days accounts payable outstanding (DPO). DIO shows how quickly management can turn inventories into cash, whereas DPO measures the average number of days a company takes to pay its suppliers. The CCC is represented in figure 3.4 below.

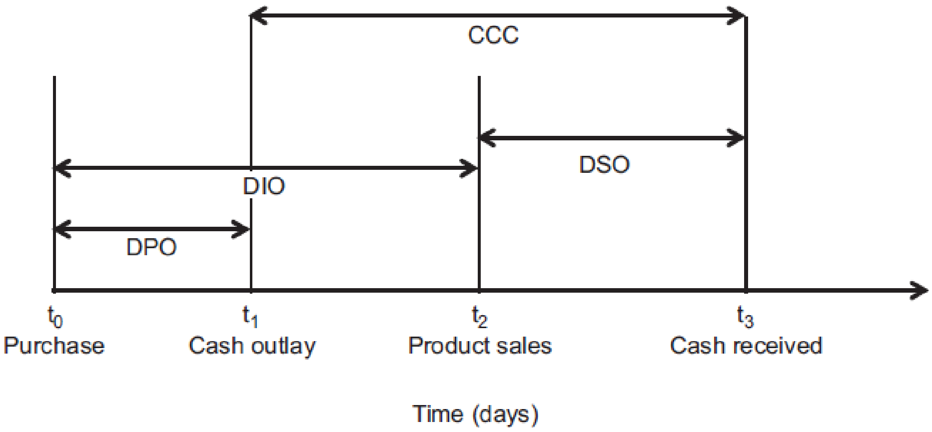


Figure 3.4. Cash Conversion Cycle (adapted from [123])

The financial value chain analysis offers a holistic view of the value chain from raw materials to the end customers and examines working capital management by cycle times in the value chain of the automotive industry during 2006–2008. The average cash conversion cycle of the value chain in automotive industry was 67 days. Although it is important for a car manufacturer to achieve good working capital management, it is equally important to think of its supporting supply chain which has to also be balanced out correctly in order to be able to sustain car manufacturing companies on the a financially sustainable basis. An example of the structure of value chains in automotive industry is presented in figures 3.5 and 3.6 below.

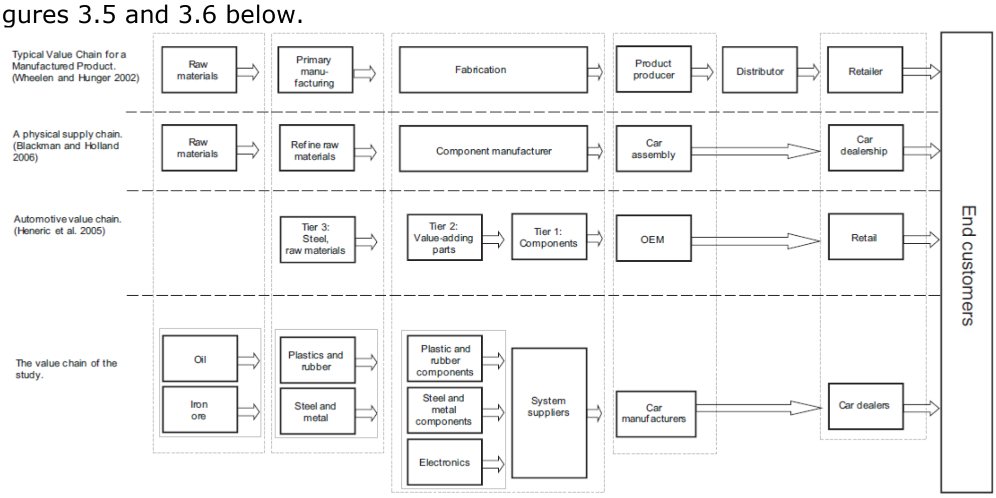


Figure 3.5. Structure of the value chain in the present and previous studies [93]

An interesting aspect related to the analysis shows that in each stage of the automotive industry, turnover time of accounts receivable had shortened, which indicates companies had focuses more on management of accounts receivable and gave more attention to collecting remittance from their customers. Working capital management is a good method of financial value chain analysis which provides a holistic view to the company on the value chain it operates. Moreover this allows a company to benchmark its position against competitors within its own stage and/or position in the value chain and enables it to see the most efficient partners of the chain and how it fits in into the supply chain [93].

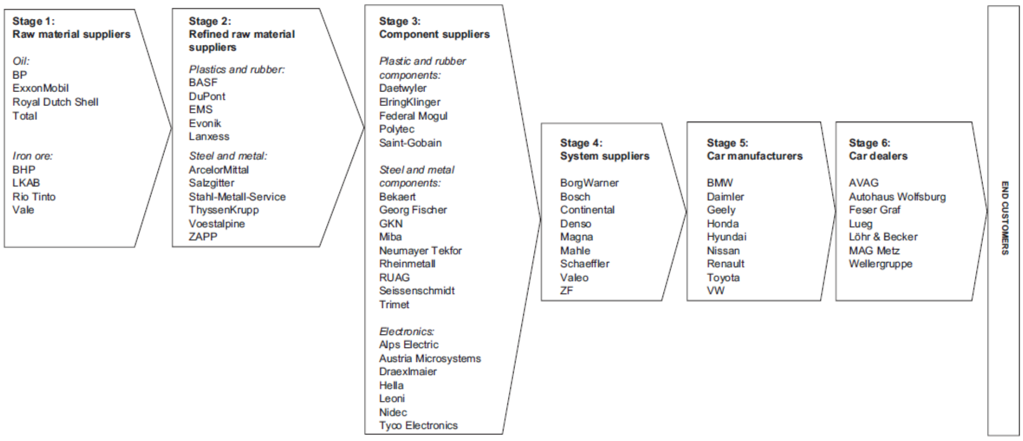


Figure 3.6. Value chain of the automotive industry with the companies of the sample [93]

Another more logistical challenge for carmakers is to adjust their production capacities rapidly and efficiently to a volatile market demand even despite distant suppliers within its supply chain. Sales and operations planning effectiveness relies on finding the best trade-off between sales requirements and industrial constraints while limiting inventories, emergency supplies and keeping delivery lead times reasonable for customers. Renault had an ambitious objective not long ago to deliver vehicles within 15 days which seemed and later proved to be unadapted to current automotive industry supply chain configuration and effective possibilities.

The automotive industry presents several specificities that make production planning in an uncertain environment really complex. Although it is an important characteristic to the industry, product variety hinders reliable forecasts and limits visibility on future demand as carmakers have to schedule thousands of components per final product, with exponential possible combinations. Besides being a source of competitive advantage, product variety also features an increase of operational costs and makes forecasting an even more difficult challenge, especially for very specific vehicle parts and requires complex techniques to handle and manage its range. Furthermore a carmakers supply chain must be able to respond to changing demands and the supplier responsiveness plays a key role in the automotive industry as reasonable delivery times are expected by customers.

Ford uses a virtual build-to-order method for its vehicle order fulfillment process with Renault having developed a similar method to improve its ordering processes, however although gains exist, they are not considered sufficient, especially for car models with very high variability of demand. There are also other system designs that manage to slightly improve the supply chain flexibility. The virtual-build-to-order from Ford and Renault's system design are also completely compatible, as is the case with other systems as well, which means it may be possible to cumulate the benefits of both for an improved version. However each system is tailored to match specific requirements of manufacturers, therefore this assumption must be dealt with care. Although features may also be common, they still may be implemented very differently from one manufacturer to the other in terms of coordinating sales and supply chain for production planning with long procurement lead times, demand uncertainty, the progressive arrival of customer orders, possibility to delay orders with flexibility rates, stochastic customer impatience and the necessity to use emergency supplies in the case of inventory shortage [92].

One of the most important management features of automotive industry is the necessity of coordination of several links within the supply chain. Coordination implies a harmonization of values and logistic performance between several business partners, internal corporate departments, business processes and diverse customers across the supply chain. Supply chain management (SCM) enables gaining competitive advantage through effective supply chain integration (SCI). Integrating several links from a complex network of automotive suppliers allows the subsequent supply chain to operate as a whole which is driven directly by customer demand. There are some challenges associated with supply chain integration as information sharing, physical goods flow coordination and business processes integration.

Business process management (BPM) is an approach to make the workflow of an organization more effective and efficient, but also, maybe most important, more capable of adapting to a changing environment. The goal of BPM is not only to make a company more cost efficient, but to see its processes as important assets, to understand, manage and develop them and provide value-added products and services to clients or customers. This is of course quite similar to other total quality management or continual improvement process methodologies with a different focus area: modifying existing processes so that they align with a desired future state of affairs which should imply an improvement of some sort. Essentially BPM is about formalizing better ways for work to be carried out within internal processes as a continuous cycle of evaluating and improving a company's activity.

Redesigning business processes is a consistent effort which has a certain sequence as there are certain steps to be followed. First of all there is the need of vision and commitment towards this approach by top management which is absolutely necessary for the success of the project. Next to commitment there is the need to understand the business in-depth in order to be able to identify relevant processes of the supply chain and choose the appropriate targets to be redesigned within the process and establish the improvement objectives.

After drawing up an analysis of the current process flows and their shortcomings, the improvements are introduced through a new design which is the projection of the future state of process flow within the facility. The entire approach is quite similar to the Deming cycle, as in the next phase the newly proposed design is implemented and changes brought about by it are to be assessed within a reasonable and agreed upon timespan. When applied correctly BPM can support supply chain integration and contribute to strengthening the overall network links within the complex automotive industry supply chains [114].

As in any business activity, automotive industry is no exception when it comes to information sharing which is an essential tool given the industry's complexity as well as an important enabler for supply chain integration and overall competitiveness. Information sharing is one of the most important forms of developing collaborative activities between suppliers, manufacturers and customers which enable the supply chain links to work together on improving product quality and logistics effectiveness.

Recent research has introduced a conceptual framework that shows the relationship among dimensions of supply chain integration and dimensions of product quality within the manufacturing sector. This framework indicates that internal integration is closely linked with both supplier and customer integration as they are interconnected. Product quality is linked with the effects of design quality and conformance quality as each dimension of supply chain integration in turn affects each dimension of product quality. Evidence shows that supplier and customer integration have an important impact on enhancing the product quality capability of a car manufacturer [95].

Supply chain risk management practices have been recently studied within a research done upon 67 manufacturing plants from the German automotive industry. Vulnerability of supply chains in general is generated by analyzing the likelihood of their occurrence and their potential impacts on the supply chain. There is a distinction to be made between internal and external supply chain risks as well as reactive and preventive supply chain risk management. Results show that manufacturers with a high implementation degree of supply chain risk management show a better supply chain performance. This was to be expected as having a plan prior to problems or issues actually occurring makes the company more ready to handle the situation when that particular issues really occurs and gives a certain degree of confidence to manage unexpected events. In addition the research provided evidence that carmakers applying supply chain risk management had higher average value in terms of disruptions resilience and a better capacity to reduce bullwhip effect, whilst the preventive supply chain risk management approach enabled better flexibility and more reliable and appropriate safety stock levels.

Risk management handles identifying and analyzing risks as well as their control and management. Supply Chain Risk Management (SCRM) is different to risk management in the sense that it is characterized by cross-company orientation and aims to identify and reduce risks within the entire supply chain.

Although carmakers are quite aware of the consequences of risks for them and their supply chain, research shows that only a minority of manufacturers have adequate methods for risk management implemented to handle problems associate with their occurrence. This is worrying although automotive industry companies report to monitor their supply chain risks often. A special challenge of supply chain risk management also refers to the multitude of possible risks within a supply chain as their overall relevance and particular risks are very important to be known in case they actually impact the supply chain.

The analysis conducted reveals that supply chains within the German automotive industry are predominantly regarded as being vulnerable. The reason for this low implementation degree of the instruments of supply chain risk management is probably related to evidence from the research literature which suggests scarce existence of mitigation methods.

Globalization and product variants contribute to rising complexity, whereas outsourcing or supplier reduction tend to increase efficiency and are at the same time key developments which drive supply chain risks and consequently increase supply chain vulnerability. Reducing the amount of supplier can additionally improve supplier relationships, but may eventually lead to a dependency on certain suppliers which is undesired. Moreover, the current ongoing trend towards offshoring will also contribute to increasing vulnerability of supply chains, since supply relationships will become more complex and at the same time susceptible to faults due to the established cross-national connections. This strengthens the idea that preventive supply chain risk management helps support creating a resilient supply chain [146].

3.1.3. Collaboration-related performance analysis criteria

Competitive advantage within supply chains is driven by value-adding aspects of not only the core competencies of each tier in the network, but also via tangential supporting factors as are partnerships between these supply chain links. Strong relationships between logistics and marketing functions can enhance successful partnerships throughout the challenging make–to-order requirements and can lead to relational sustainability. The relationship between logistics partnership success factors and the links to industrial branding and business sustainability was studied within the Malaysian automotive industry with a focus on car manufacturers. Delivery time accuracy is an essential parameter of a well-functioning supply chain, but support, reliable route planning and product quality integrity are equally important parts of a successful logistics partnership. Developing long term relationships can increase overall organizational performance in terms of profitability or sales growth, but can also provide a solid foundation for a sustainable business partnership which enables partner to achieve common win-win strategies and strengthen their link within the supply chain. Such long-term advantages include a continuous cost-cutting policy or improving overall performance in terms of productivity for manufacturers [121].

The Japanese automotive industry is a very different system due to its specific culture to the same industry in Europe or North America. This is especially true when risk sharing is concerned within the relationship between Japanese car manufacturers and automotive parts suppliers. Despite recent changes within the structure of the Japanese supplier system, carmakers partially absorb the business risks of the suppliers. Thus relative stability of these suppliers' profit rate is significantly influenced by the intensity at which they are conducting business with the main customer.

Japanese large corporations as are car manufacturers have quite stable ownership structures in Japan as well as stable long-term relations with banks, suppliers and customers. Such lasting and steady arrangements enable them to agree upon flexible terms when doing business in order to stabilize prices, business performance and include an important insurance or risk sharing mechanism.

Large companies have a much better capacity to deal with risk aversion and to handle its consequences than their supplies who only have a small share of the business figures of their customers. However as in the automotive industry the supply chain is of equal importance, the manufacturers take great care in stabilizing their suppliers capacity to feed the chain with the needed upstream materials and parts and thus are prepared to take a larger part of the business risk and insure their suppliers against profit fluctuation in return for obtaining a larger share of the profit from the business relationship.

Although affiliation of the suppliers with their main customer contributes to stabilize their profit rate, the effect is much stronger when comparing sales dependence. This is because profit stability of the suppliers is significantly influenced by the profitability of their main customer, but not as much by its profit stability. Profit fluctuation of the suppliers is not entirely a subject of risk absorption by their car manufacturer customers as the relationship only accounts for around a third of associated risks. This situation applies very well to the suppliers for Toyota, but not to those for Nissan, which suggests there are significant differences in risk absorption policies even among the Japanese carmakers, which imply that risk absorption is provided to suppliers selectively [112].

This is nevertheless most likely as assembler customers and car manufacturers ask for higher and higher standards from their suppliers, with more frequent deliveries, higher quality, lower prices and a larger role in design. It seems they are seeking the lean production philosophy from their buyer-supplier relationships, without necessarily imposing the actual lean production means, especially if these suppliers operate abroad. This is however where benefits of relationships with the Japanese car plants come in, as any supplier from Japan obviously knows the lean production system and has detailed knowledge of how it should work and how it should be applied within its own premises to provide best results. These suppliers are able to supply the Japanese car manufacturing facilities more efficiently and competitively and generate mutually beneficial cost reductions, a very important asset within supplier-buyer long-term relationships. Furthermore these suppliers also have an increased competitive ability to meet the needs of other, non-Japanese assemblers as well and deal with their increased demands in terms of delivery, quality and price, which enables the supplier to achieve leverage and a strong competitive market position [118].

Opportunities for additional value creation exist by using cheaper or better quality materials and technological innovation driven by suppliers, which can also help provide associated savings and allow for greater margins [15].

Carmakers may also seek to collaborate with skilled suppliers not only to access existing technologies but also to jointly develop new concepts, knowledge transfer and integration practices, possible differences in experiences and innovation may provide valuable competitive advantages for both parties involved in the supplier-buyer relationship and help strengthen the supply chain. Original equipment manufacturers (OEM) automotive companies and skilled suppliers also engage in these collaborations and enable better supply chain coordination in automotive industry.

It's been admitted even by managers working within automotive industry companies that not all technological advances can come from within their firms, which brings about the importance and potential value of partnerships and gives a better insight as to why such work collaborations are still the object of much joint research [85].

Collaborative supplier–buyer relationships are thus both a direct and indirect source of competitive advantage for manufacturing firms either by direct contact with the carmaker or by helping increase the links in its horizontal or vertical supply chain. Evidence from the German automotive industry shows superior operational performance is achieved due to enhanced trust, supplier relation-specific investments and reliable information exchange. A survey of 346 automotive supplier–buyer relationships highlighted the complementary roles of these factors in influencing and improving operational performance. Japan as the forerunner of this principle and more specifically Japanese manufacturers Honda and Toyota have encouraged suppliers to deploy supplier relation-specific investments and dedicate assets. Collaborations of this kind have enabled automotive industry companies to lower both transaction and operational costs, to reduce defects and to foster innovation to the mutual advantage of both suppliers and buyers. In this sense Toyota's supplier networks have a very productive structure [26].

The raising importance of supplier-manufacturer relationships is also emphasized within the U.K. automotive industry. Turnover in 2014 of the British car industry reached an all-time high of almost 70 billion pounds, supported by growing manufacturing output, vehicle sales, jobs and export values. The UK automotive supply chain typically generates around 5 billion pounds of added value annually while today around 80% of all component types required for vehicle assembly operations can be procured by UK suppliers. Car manufacturers in Britain export around 80% of their production.

The 1,598,879 vehicles manufactured in the UK enabled large investments to be committed to new and expanded production facilities. These consequently result in sector-wide recruitment and additional employment, as an additional 27,000 jobs were created only in 2014, meaning a 3.5% increase on the previous year. This brought the number of people employed in automotive industry (both manufacturing and retail) to just short of 800,000. Investment in training and skills improvement has also been promoted by more than 35% whilst around 500 new trainees were employed by the sector last year.

International demand for vehicles made in the UK also supported British export value by a rise of 1.8% to around 35 billion pounds, more than double within the last 15 years. These results also account for a considerable increase in the industry's direct contribution to the British economy in 2014 of 6.2% to 15.5 billion pounds.

Environmental impact from vehicle production has been reduced dramatically despite greater production volumes. Generated waste was reduced by almost 20% per vehicle, a record low, with energy and water consumption being also reduced to benchmark lows by 7.5% and 6.2% respectively. The industry also managed a 5% year-on-year reduction in CO_2 emissions per vehicle produced. Last year saw total waste to landfill from all automotive production decrease by more than 25% and by more than 90% within the last 15 years. The automotive industry in the UK also made considerable improvements to its already outstanding safety record. This was possible as the number of workplace incidents per 1,000 employees has fallen in 2014 to an absolute low of 2.2, a decrease of more than 80% since the early 2000's when such data was first collected.

This clearly shows how important the management of automotive supply chain relationships between manufacturers, OEMs and their suppliers is likely to be a particularly pertinent issue not only within British car industry but global car industry as well [88, 136].

The role of small or medium suppliers in the car industry is equally important as is proven in the Italian automotive industry where these companies receive support measures from car manufacturers to encourage innovation. Three strategic trends have been observed in Italy regarding and small and medium suppliers: vertical disintegration, reorganization of the supply base and the development of buyer-supplier relationships. Small-medium suppliers tend to help improve organization and communication in the supply chain by increasing verticalization in the lower tiers and setting up horizontal joint-ventures with same-tier competitors.

Procurement policies of small and medium suppliers have had an important impact on increasing turnover and employment. Reorganization of the car industry has enabled verticalization of internal activities, as 60% of companies have introduced new phases in the production cycle either by purchasing new equipment or by taking over other smaller companies. Diversification strategies of the final market and production specialization have also had their relevance. Furthermore car manufacturers see the tiering of their suppliers as a means to simplify the communications process and also limits their contacts to the direct suppliers accounting for improved effectiveness.

Associative linkages between small and medium competitors have also been observed in the form of more or less in-depth collaborations. These agreements usually involve joint involvement in the globalization process of carmakers (production joint-venture with competitors) and setting-up common product development departments (research and development joint-ventures). The support measures received within these situations by suppliers from their customers can be subdivided into indirect and direct actions according to the degree of involvement in order to encourage their innovative process [18].

Management of multinational suppliers is somewhat different due to their improved consistency as it is highlighted by the German automotive industry, one of the most mature and well-organized in Europe and also worldwide. In Germany acquisitions were employed as a means to complement existing competence profiles and provide complete systems and modules. This is because acquisitions allow for a fast competence building in contrast to the more difficult in-house competence building strategies. The persistent consolidation pressures urge competitors to operate aggressively especially within highly competitive markets that are commonly characterized by a small number of global and fast-growing first-tier suppliers, as is the case with the brake system companies. The German automotive supplier landscape is ideal for such a business landscape background and favors acquisitions because it comprises lots of technologically sophisticated small and medium-sized supplier companies [117].

One of the most important things to be understood when entering such an important collaboration as supplier-buyer relationships in automotive industry is that both the supplier and the OEM or vehicle manufacturer have to agree upon clear expectations and investments needed over time [87]. These aspects should be thoroughly discussed and understood as well as agreed upon early in the relationship in order for both parties to get the most out of the partnership as they are essential in enabling a win-win strategy within the supply chain [156].

Another important and essential asset is the ability to communicate efficiently and effectively as is proven by results from the Turkish automotive industry where interaction between suppliers and buyer could be improved by more extensive information for business planning, sharing business knowledge of core processes and informing each other about events and changes that may affect the supply chain partners [76].

3.1.4. Supply Chain-related performance analysis criteria

Supply chain is the most important linking activity in automotive industry, as it accounts for upstream and downstream distribution and flow of materials and end products and is of particular operational importance in automotive industry where complexity of tasks, tight deadlines and huge competitive pressures add on extra challenges to logistic service providers. Although logistics only accounts for an average of around 2% of total cost within a sold vehicle's retail price, it is essential for this service to be reliable in order to sustain a reliable supply chain and to maintain car manufacturers competitiveness on the global market. The cost breakdown structure is highlighted in figure 4. The sold vehicle price is the total cost of the vehicle and the profit margin. Raw materials and parts account for almost half the retail price, while product development and manufacturing contribute with a 20% share. Logistics has only a 2.2% share in total price, while distribution costs add another 28% which include dealership costs, marketing and other associated costs [66].

An interesting way to improve on build-to-order (BTO) challenges is to use supplier parks, which has provided different results as it is important to assess whether such a supplier park actually needs to be established in reference to demand for flexibility from customers. There are a number of different types of supplier parks, but only some of these have the appropriate characteristics to enable BTO. These facilities are usually are large-scale sites, not more than 1km away from the OEM assembly plant and provide both volume and product mix flexibility, based on agreed mutually advantageous contracts. These sites also account for low start-up costs and manage to reduce logistics costs. Within these partnerships around 80% of the supplied value is delivered by sequenced in-line supply (SILS), as is the case with Volvo (Torslanda, Sweden and Gent, Belgium), Audi (Ingolstadt, Germany) or Seat (Abrera, Spain).There are also supplier parks that do not enable BTO. These are generally small-scale, and can only provide volume and product mix flexibility to a limited degree as they are characterized as onsite or adjacent to the OEM assembly plant. This is the case of Ford (Bridgend, Wales) and Jaguar (Halewood, England) [67].

Suppliers, buyers, OEMs and car manufacturers need to work together within their supply chains to be able to provide good quality cars, appropriately priced and reliably delivered to customers. This means managing activity and challenges and offsetting differences amongst them to work together and find the best solutions in the interest of the customer and within a win-win long-term strategy. Different examples come from the Turkish automotive industry where there are tensions within supplier-buyer relationships [83] and the automotive industry in Slovakia, where relationships have managed to create a synergic effect [162]. Strategies, policies or decisions may not immediately prove effective, but only by working together in the interest of strengthening their collaboration and the consistency of their supply chain can they achieve a sustainable growth and development within automotive industry [59].

Current trends, especially concerning purchasing costs, are shifting toward consolidation despite high supplier diversity. Supplier diversity initiatives can be successful and become a source of competitive advantage for automotive industry players if they are properly integrated into the overall corporate strategy. Smaller suppliers also need to realize the fact that their success or failure in the highly competitive automotive environment depends on their ability to be learning organizations and continually develop their overall competences. This also means being open to horizontal and vertical development by building strategic alliances amongst themselves and with their buyer customers. This provides a very good opportunity for competitive suppliers to increase their potential and performance and improve their strategic position within the supply chain [2].

Perhaps one of the most competitive supply chain management takes place in Japan where automotive industry has a competitive advantage over Western European and North American countries. This is due to a very complex but effective design of distribution flows of materials, parts and cars throughout the country. By using cross-docking the inconvenience of longer distances can be mitigated effectively, whereas from there Third-Party-Logistics (3PL) providers take over to organize shipments toward car manufacturing facilities and handle the network design of their distribution process. This accounts for a very productive Just-In-Time production strategy implementation which is at the heart of Japanese automotive industry [74].

Linkages between just in time (JIT), supply chain management (SCM) and quality management (TQM) also exist as the relationships between these three principles can improve and exploit their synergy achieved by automotive industry companies.

By integrating these practices into operations strategy, the company adds value and enables itself to respond better to competitive pressures. JIT, TQM, and SCM practices all have somewhat different characteristics and goals on operational level, but they also have common elements that can help successfully reinforce synergies amongst them [75].

Implementing JIT practices usually make companies experience considerable benefits in many of their operating areas: quality improvements, better time-based responses, employee flexibility, enhanced simplification, company profitability or inventory reductions [48]. There are however differences in the outcome of implementing JIT, as within every company there are slight differences and thus not all principles can be applied equally, but to an important extent JIT helps support production and improves productivity which allows for better financial performance [96, 160, 80, 29].

Company differences and different production, operational techniques mean that solutions to make the buyer-supplier relationship work are not standard and that they have to be adapted to the specifics of each collaboration pattern. Differences have to be considered and when managed appropriately they can enable a rich exchange experience and help support both the activity of the supplier and its customer. In order to be able to achieve this, a mutual information sharing platform has to be operational in order to provide both links with reliable information [7].

Sometimes principles have different effects due to several reasons as are organizational culture, miscomprehension or different implementation, but if business partners understand the importance of a consolidated chain they will work together to bridge these differences [61].

The significance of information integration in a supply chain especially in automotive industry is of increased importance. This is mainly due to the fact that Information sharing may bring a significant amount of advantages to car manufacturers which range from improved inventory performance (inventory reduction, more efficient inventory management, cost reductions) to increased visibility by mitigating negative effects of uncertainty to operational performance improvements (better handling of bullwhip effect, improved productivity and resource utilization, organizational efficiency through early problem detection and quick response times, reduced order-delivery lead times, improving tracing and tracking in logistics dynamics) [30].

There are also some barriers to sharing information amongst supply chain partners, but although to some extent this may be reasonable and understandable it is in the best interest of both supplier and buyer to eliminate these barriers and work together for a common sustainable strategy to help them thrive in the challenges of the automotive industry [94].

General Motors and Ford both compete on cost and model variety, whereas most other companies as are the likes of Toyota, Volkswagen, Audi, Renault of BMW are in rather focusing on diversity and customization. The latter manufacturers alternatively form a different competitive profile by innovative design and make efforts to improving their supply networks in terms of leanness and agility. Other carmakers Honda, Daihatsu, Hyundai and Kia compete in the fierce automotive market on the low-cost segment where they strive to revise and redesign their networks to support and enable an efficient production chain. Sustainable competitiveness in challenging automotive industry depends however on carmakers ability to redesign the network structure of their supply chains in order to enable them to increase responsiveness to globally distributed customer demands and to provide an improved response to product and model variety [41].

3.2. Forecasting models in the European automotive industry

Forecasting is an important tool used by carmakers to estimate a future production level needed that can satisfy customer demand and not generate excessive inventory. It also determines the allocation of budgets for an upcoming period of time, which is based on the estimated potential demand of cars by the customers for that specific timespan [97].

Forecasting is rarely accurate, but based on the experience, knowledge and good judgment of the management team these projected estimates can help planning production very much and can help balance peaks and bottoms throughout the considered time range. There are several techniques used in forecasting, but the author chose to apply a specific mathematical model of consumer behavior in the European automotive industry which provided interesting results and was considered relevant in order to increase a carmaker's forecast accuracy. Automotive industry specific supply chains can obtain valid information of future demand, in order to better scale their structures of production, thereby reducing costs and thus increasing the value provided to the customer, which enables a beneficial approach for improving the competitiveness level attained on the global market. Using historical data on new car registrations in the EU, appropriate autoregressive models were identified for consumers' behavior that can be used as real solutions to increase the accuracy of forecasts made within the automotive industry.

Time plays a fundamental role in our life and activity, both economic and financial, embedding certain states which change along with it. Hence a natural statistic study arises on the modification and development of socioeconomic phenomena and processes which have a remarkable qualitative character. Analyzing economic phenomena observed in time is a useful basis for explaining and addressing some directions taken on by organizations following decisions made by their managers, considered as a necessary support of the managerial decision [125]. Application of analytical techniques for processing time series is not limited to economic problems, as management research uses the results of these analyzes especially in order to adjust industrial processes to improve quality, efficiency and profits. This involves using proper selection data for achieving influence – estimates, predictions and decision making, a problem that requires an appropriate mathematical apparatus [86].

Forecasted data and information are key elements of the decision-making process regarding supply chain management, because they provide information on the possible customer demand, allowing supply chain companies to prepare/size themselves in order to satisfy that demand level.

The automotive industry is a particularly important subject to study due to its economic, social and technological scale, as the effects of a non-concordance in the supply chain are emphasized [21]. On the website of the European Automobile Manufacturer's Association (ACEA) a few key indicators that can provide an insight into the importance of automotive industry were presented.

From the economic point of view - "Turnover generated by the automotive sector represents 6.9% of the European Union (EU)'s Gross Domestic Product (GDP)." The turnover of the sector is 897 billion euros, at a GDP of the EU of about 13,000 billion euros in the year 2012, according to data published on the website of the European Union. (12,945,402 euros - [40])

From the social point of view - "12.9 million people, or 5.3% of the EU workforce are employed in the sector"

From the technical and technological point of view - "Automobile manufacturers operate 290 assembly and production plants in 25 countries of the EU." "The automotive industry is the largest private investor in research and development in Europe, investing more than 32 billion euros in these activities and applying for 9,500 patents every year" [1].

Regarding production figures, the same ACEA report for the year 2012 identifies that 23.6% of the cars produced in the world come from the EU, in units 14,611,284 new cars, with a rising global trend of the number of units produced. These numbers are exceeded only by the BRIC countries (Brazil, Russia, India and China) which recorded a production of 23,401,647 units for the year 2012, representing 37.1% of world production.

The global production trend is increasing, in 2012 a growth of 5.2 percentage points compared to the previous year was recorded, which represents a huge potential for development for the European automotive industry, which through the supply chains must be able to permanently provide value in the market.

Supply chains developed within the industry must face the global positive effect, be able to correctly anticipate market trends, and manage resources efficiently in order to find the best solutions for providing customer value.

For a more accurate sizing of production capacities and with medium and long-term effects it is necessary to develop mathematical forecasting systems that study specific customer behavior, systems which must provide adequate solutions with the lowest possible costs to not adversely affect the overall competitiveness of the European segment.

3.2.1 Autoregressive process

Mathematically, an autoregressive process AR (p) of a series y_t may be represented by equation 1,

$$y_t = a_0 + a_1 y_{t-1} + a_2\, y_{t-2} + \dots + a_p\, y_{t-p} + \varepsilon_t \qquad (1)$$

where a_0 is the intercept term and a_1 , a_2 ,..., a_p are autoregressive parameters and ε_t are normally distributed random error terms with a zero mean and a finite varianceσ^2.

When referring to the order estimation of an autoregressive process we suppose that there is some true model which generated our time series data, $y_1, . . . , y_n$. This true model is *not* AR. But we do want to consider using AR models to describe our data, since they provide a flexible, estimable, and interpretable class of models. Although the AR models have only a few parameters, the true model presumably has a huge number of parameters (perhaps *infinitely* many). By using the *AR* models to describe our data, we are providing a simple description of what is in fact an extremely complicated situation (i.e., "real life").

An important choice the data analyst must make in *AR* modeling is the autoregressive order *p* to be used. This choice entails a trade-off of bias and variance, and a poor choice can result in a virtually useless estimator. Many order selection criteria have been employed in the economic study to determine the Autoregressive (AR) order of time series variables. Briefly, an AR process of order *p* refers to a time series in which its current value is dependent on its first *p* lagged values and is normally denoted by AR (*p*). Note that the AR order *p* is always unknown and therefore has to be estimated via various order selection criteria such as the Akaike information criterion (AIC) [4], Schwarz information criterion (SIC) [129], Hannan-Quinn criterion (HQC) [58], final prediction error (FPE) [5], and Bayesian information criterion (BIC) [3].

In 1973, Akaike proposed the Akaike Information Criterion, *AIC*, which achieves this goal by providing an asymptotically unbiased estimate of the "distance" (actually, Kullback-Leibler information) between the various fitted *AR* models and the truth. Remarkably, this can be carried out without knowing the true model. The *AIC* is defined in general as in equation 2,

$$AIC = -2 \log likelihood + 2 \#parameters \quad (2)$$

where *log likelihood* is the maximized (Gaussian) log likelihood, and *#parameters* is the number of independently adjusted parameters in the candidate model. For an *AR* (*p*) model fitted by the Yule-Walker method, instead of evaluating the likelihood function we can use equation 3:

$$AIC = n (\log (s*s) +1) + 2(p+1) \quad (3)$$

It is seen that *AIC* consists of two terms. The first is a decreasing function of *p*, and measures the fidelity of the fitted model to the data. But what we really want is the most parsimonious (i.e., low dimensional) model that provides a reasonable description of the data. To enforce this parsimony, *AIC* also contains the term 2(*p*+1), which acts as a penalty term to guard against over-fitting. If we choose *p* to minimize *AIC*, we can hope to obtain a balance between fidelity and parsimony.

The estimation of AR (*p*) process involves 2 stages: First, identify the AR order *p* based on certain rules such as order selection criteria. Second, estimate the numerical values for intercept and parameters using regression analysis. This study is confined to the study of the performances of various commonly used order selection criteria in identifying the true order *p*. The error term is generated from standard normal distribution, whereas the intercept term is omitted without loss of generality.

The estimated order $\hat{p}$ is allowed to be determined from any integer ranging from 1 to 20 inclusively. In this respect, we compute the values for all 20 orders for each specific criterion and $\hat{p}$ is taken from the one that minimizes that criterion. Note that each criterion independently selects one $\hat{p}$ for the same simulated series.

3.2.2. Exponential smoothing

Exponential smoothing is a procedure for continually revising a forecast in the light of more recent experience. Exponential smoothing assigns exponentially decreasing weights as the observation get older. In other words, recent observations are given relatively more weight in forecasting than the older observations.

This is also known as simple exponential smoothing. Simple smoothing is used for short-range forecasting, usually just one month into the future. The model assumes that the data fluctuates around a reasonably stable mean (no trend or consistent pattern of growth).

The specific formula for simple exponential smoothing is represented in equation 4:

$$S_t = alpha * X_t + (1 - alpha) * S_{t-1} (1) \quad (4)$$

When applied recursively to each successive observation in the series, each new smoothed value (forecast) is computed as the weighted average of the current observation and the previous smoothed observation; the previous smoothed observation was computed in turn from the previous observed value and the smoothed value before the previous observation, and so on.

Thus, in effect, each smoothed value is the weighted average of the previous observations, where the weights decrease exponentially depending on the value of parameter (alpha). If it is equal to 1 (one) then the previous observations are ignored entirely; if it is equal to 0 (zero), then the current observation is ignored entirely, and the smoothed value consists entirely of the previous smoothed value (which in turn is computed from the smoothed observation before it, and so on; thus all smoothed values will be equal to the initial smoothed value S_0). In-between values will produce intermediate results.

The initial value of S_t plays an important role in computing all the subsequent values. Setting it to y_1 is one method of initialization. Another possibility would be to average the first four or five observations. The smaller the value of (alpha), the more important is the selection of the initial value of S_t [103].

3.2.3. Applying the model on car registrations in the European Union

In order to identify the demand function statistical data on car registrations in the European Union (PC - passenger cars) were used, provided by the International Organization of Motor Vehicle Manufacturers (OICA) [111]. The data analyzed are the monthly results for the period between 2000 and 2012, amounting to a total of 156 values. The wide range considered can provide us with a comprehensive picture of the phenomenon, and at the same time also being a good support for making forecasts.

The authors consider the number of car registrations a starting indicator for estimating a future demand, while some limitations are accepted and assumed:

- it represents the satisfied demand and not the actual demand at a particular time, thus differences between the time of registration for the request and the actual delivery of the car are possible;
- the indicator representing new car registrations does not include data recorded for second hand traded cars.

By including a long timespan in the analysis – 156 monthly values, a reduction (not elimination) of the assumed limitations is desired:

- two different cycles of 6 years are included (or 3 of 4 years), the maximum warranty period provided by the manufacturers, and which may include several decisions of sale made by the same individuals,
- including decisions emerging 10 years from the previous purchase for markets where the purchasing power of the population is low,
- by including all brands on the market, and the different product categories for the current needs in terms of transportation by car, a coverage of as many requests as possible is desired, as well as the inclusion of possible conversions / decisions to shift towards a new car.

The software used for the time series analysis is *MATLAB v. 7.12 - R2011a*.

The first statistical analysis of this series is to determine the trend, as evidenced by the graphic representation in figure 3.7 [38].
When identifying the stationary model the exponential smoothing method is used to "average" the original series, however more tests are needed to determine the weights of the current results and of the previous forecast.
This method uses the weighted sum of terms of the present and past in order to ensure complementary weights of terms in terms of the present and past. We have suggested weights by the geometric series which decreases with a rate α belonging to the set [0,1].

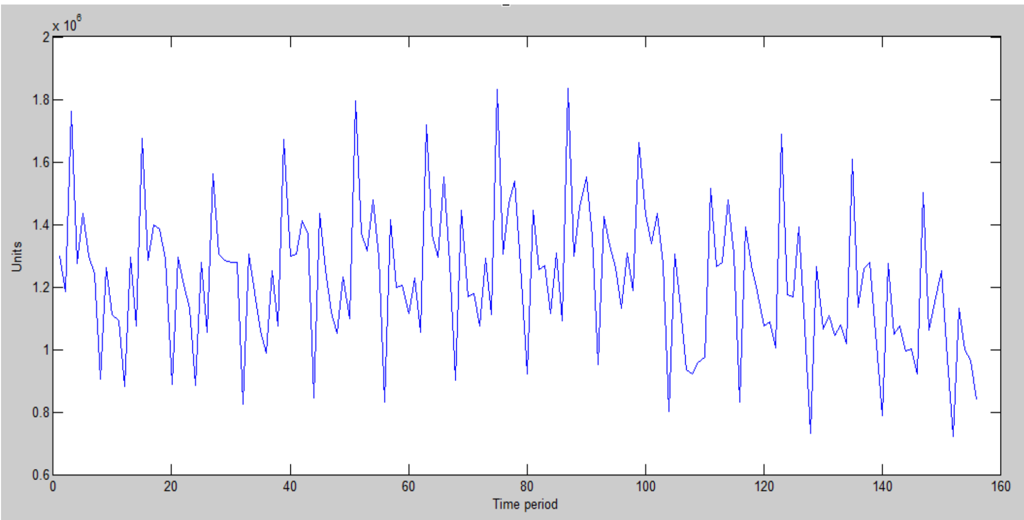


Figure 3.7. Time series – Monthly registrations in the EU

We consider two separate values of the coefficient α - smoothing constant: 0.2 and 0.5. The first option considered proportions of 20% for present values and

80% "historic" values are assigned, and the second value of the smoothing constant 50% for current data and 50% for "historic". For such series a prompt response to changes in the market is very important.

Figure 3.8 shows that forecasts made using the exponential smoothing method, using smoothing factor 0.5, have smaller deviations from the original series than the one with alpha value of 0.2.

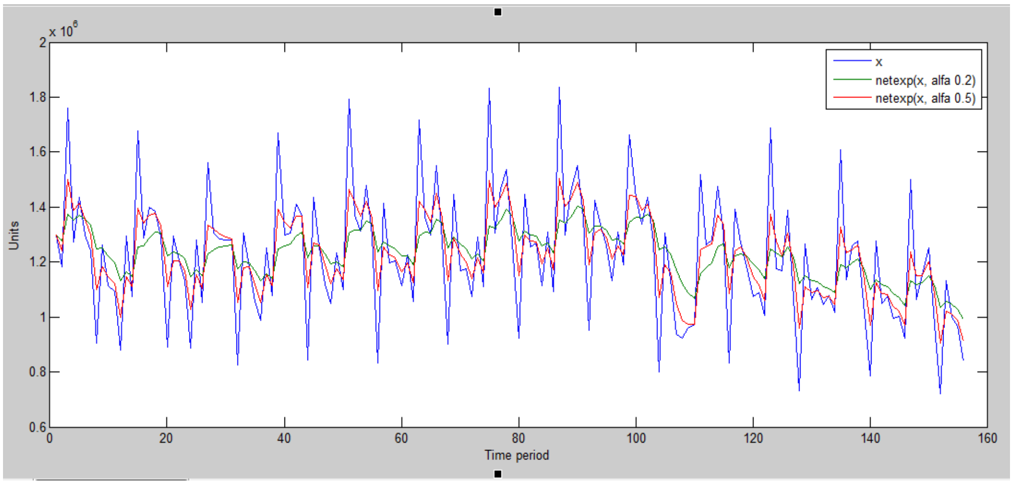


Figure 3.8. Resulting series from exponential smoothing

Very important is the fact that such a result is considered satisfactory to perform forecasts by large organizations (manufacturers, original equipment manufacturers (OEM)), as they are mainly interested in trends and cyclical elements in order to develop appropriate strategies.

For a high degree of accuracy, as well as for the other organizations that are part of the supply chain the series have to be decomposed, and an analysis including the "rest" resulting from the use of traditional forecasting methods is to be made. In this case a high degree of accuracy is much more important, due to the limited capacity to engage resources.

Further analyzing of the considered time series and determining "pure" consumer behavior need to identify a *stationary model*, as biased, cyclical and seasonal components are removed (of the obtained result by exponential smoothing with a constant of 0.5).We obtain a new time series by subtracting from the original series the resulting biased component after applying the exponential smoothing method (constant 0.5), this series is plotted in figure 3.9.

Further analysis involves identifying an autoregressive model to faithfully reproduce the previously identified random behavior.

A first step in this process is finding the model size order, to estimate it we use the Akaike Information Criterion method – AIC, which aims to identify the smallest values resulting from the application of the criterion on those time series.

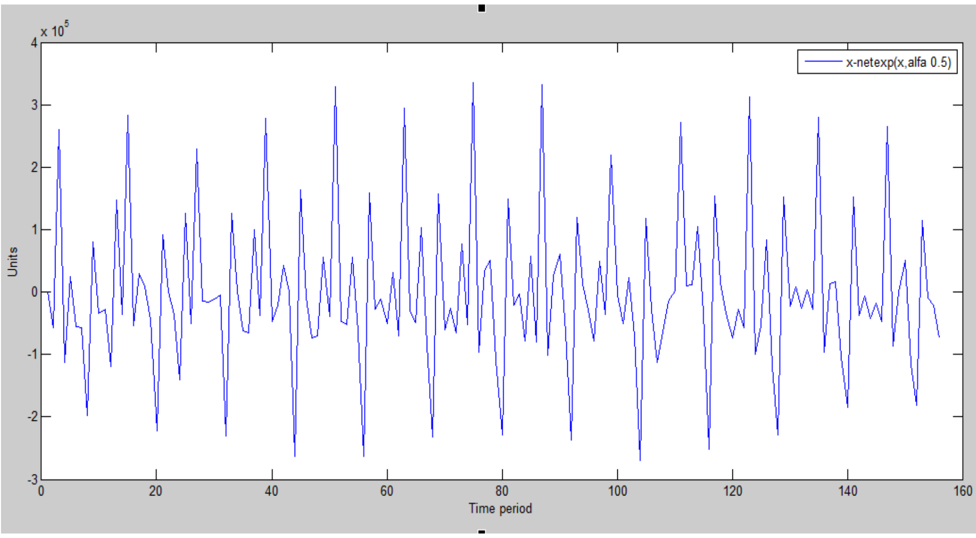


Figure 3.9. Series representation without biased component

Figure 3.10 shows that the minimum value for the 8 successive tests is obtained for a function of the order 7 - AR(7), but it may be difficult to operate in practice and in other applications, for which *the local minimum AIC = 23.3777 obtained for AR(3) is to be taken into account*.

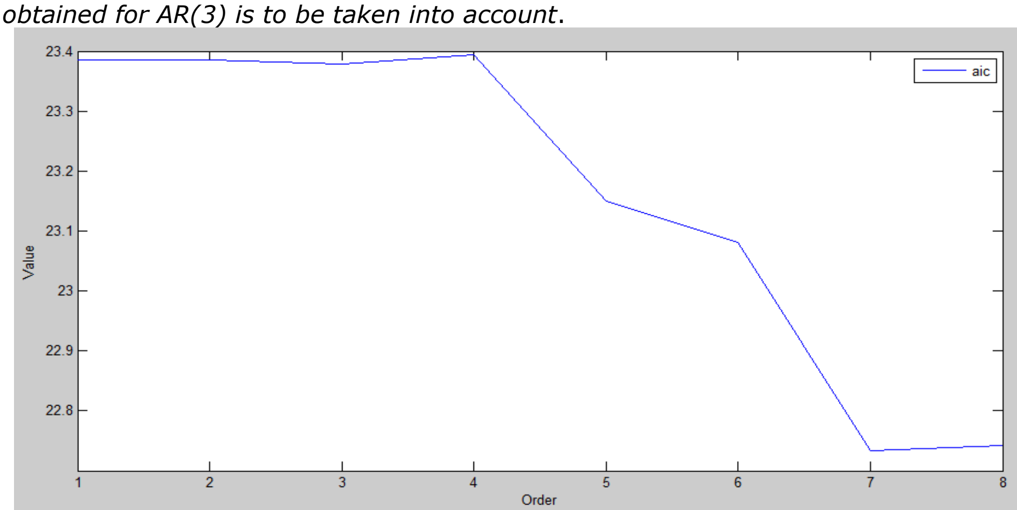


Figure 3.10. Graphical representation of the results by applying the AIC criterion

Thus we generate two AR models for comparison, one that considers the last three historical values and the other the last 7. Results should be compared with each other to identify the model that will be used further.

The model of order 3 – AR(3)

$$y_n = -0.3467 * y_{n-1} - 0.1371 * y_{n-2} - 0.01876 * y_{n-3} + \varepsilon_n$$

The model of order 7 – AR(7)

$$y_n = -0.02134 * y_{n-1} - 0.3074 * y_{n-2} - 0.08365 * y_{n-3} - 0.09757 * y_{n-4} - 0.4417 * y_{n-5} + 0.1899 * y_{n-6} - 0.5513 * y_{n-7} + \varepsilon_n$$

For a more realistic reproduction of the outlined situations adding a *Gaussian white noise*, the average μ = 0 and the deviation σ is also required.

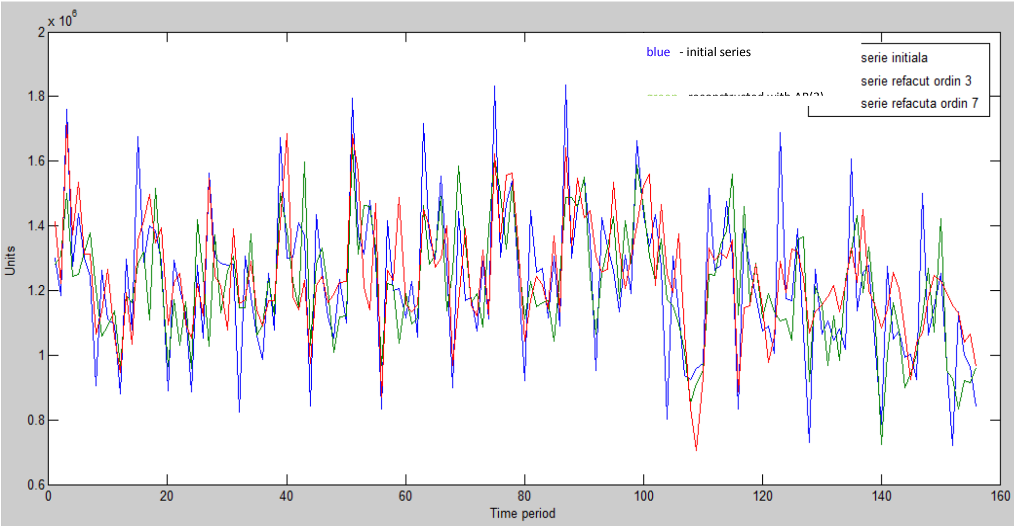


Figure 3.11. Comparison between the developed series and the original one

As shown in figure 3.11 both models show a high degree of accuracy. Situations were identified in which both reconstructed series show deviations from the graph of the original series. Minor differences between them are graphically identified which induces the need to measure the accuracy of identified models based on indicators measuring forecast errors.

Table 3.1. Comparing forecast accuracy of the proposed methods

Methods / Indicators	**Expsmo (0.5)**	**Expsmo (0.5) + AR(3)**	**Expsmo (0.5) + AR(7)**
MAE - Mean Absolute Error	164,563.0096	139,873.3105	133,851.3462
MSE – Mean Squared Error	53,977,088,094	47,558,118,297	27,371,936,720
MAPE – Mean Absolute Percentage Error (%)	16.047	14.173	13.508

The AR model validation is achieved by performing a comparison with new car registrations. Comparing data is made by simultaneous analysis of error indicators (Mean Absolute Error (MAE), Mean Squared Error (MSE) and Mean Absolute Percentage Error (MAPE)), obtained using data recorded *for the year 2012* and historical data from the previous year for AR(3) models – the last three months of the year 2011 and AR (7) – the last 7 months of the year 2011, data presented in table 3.1.

Table 3.2. Validating proposed forecasting methods

2013 (units)	New car Registration (R)	Expsmo (0.5) + AR(3)		Expsmo (0.5) + AR(7)	
		Forecast (P)	Error (P-R)	Forecast (P)	Error (P-R)
January	*916,875*	970,486	53,611	968,477	51,602
February	*830,043*	934,529	104,486	922,758	92,715
March	*1,349,290*	904,025	-445,265	1,142,676	-206,614
April	*1,081,156*	957,068	-124,088	1,029,524	-51,632
May	*1,084,303*	1,042,514	-41,789	1,025,280	-59,023
June	*1,177,003*	1,089,338	-87,665	1,061,592	-115,411
MAE		142,817.268		96,166.30437	
MSE		47,376,348,133		14,683,503,493	
MAPE (%)		12.369		8.689	

After a comparative analysis of the results one can observe that both proposed models show better results than by simply using the exponential smoothing method (Expsmo). The mean absolute error identified by using the AR(3) model is 139,873 units, which represents a percentage of 14.17% compared to results obtained in the market at the same time. When using the AR(7) model the mean absolute error is 133,851 units, or 13.5% of actual recorded registrations, in both cases being under the percentage error of 16% resulting from the use of the exponential smoothing method.

The difference, still low, of the two proposed alternatives requires additional comparison with data recorded in the market for the year 2013. Statistical data from the first 6 months of the year will be used in order to validate a new data range, see table 3.2.

The AR(7) model has the best values for the three considered indicators, the occurred forecast error is much lower than the one induced by using the AR(3) model. For the first six months of the year 2013, forecasts made with the exponential smoothing method, to which the autoregressive model of order 7 is added induces a mean absolute error of 96,166 units, representing, in average values, 8.69% of the figures relating to registrations for the same period. Instead, by using the AR(3) model the mean absolute error is 142,817 units, or 12.36%, values that are bigger than in the previous case.

All these comparisons give the decision maker an aspect of trust in using the proposed forecasting method (*exponential smoothing + autoregressive model*), thus proving the high level of accuracy of such forecasts. This is proved even within the following timespan for which the data that was considered was the data that lead to the generation of the model.

3.2.4. Conclusions

Although three different periods of the EU were successively considered, it is appropriate to analyse data in such a manner due to the necessity to include a large timespan that should cover as many aspects of behaviour as possible. The general trend is decreasing, being more emphasized by such an approach. From another point of view, data represents a real reference basis and because it concerns registrations of new cars, it is not greatly affected by the accession of new states, at least in the last considered stage, as the low purchasing power made customers shift towards the second hand car market and not towards the new cars, data not being thus contaminated.

Proposed forecasting models show that the exponential smoothing method with a factor of 0.5 provides the best results in time for such series, adding an additional component which weights historical forecasting errors is still necessary though. The autoregressive model AR(7) considering the last 7 historical values of the errors found after making forecasts with exponential smoothing, is proven to bring an additional level of accuracy to forecasts, materialized in a forecast error of 8.68%, applied including to subsequent data of that initially considered.

With a high degree of forecast accuracy the supply chain can achieve better performances in the supply process, providing companies with superior financial results, also increasing the quality of provided services.

Using proposed models together with exponential smoothing, the behavior and the operational need of a supply chain can be simulated with more accurate results, which may be a substantial subject for future research in this field.

3.3. Detailing the main performance analysis tools in the automotive industry

Automotive industry is one of the most competitive industries worldwide and also one of the most challenging due to its complex structure and diversity of supply chain partners and links which operate on local, regional, national or international level.

Being competitive also implies constantly improving performance, both own performance and the performance as a whole. This can only be done through good synchronization and common quality and process standards in order to assure a reliable business partnership.

In order to describe and quantify the extent to which a business entity is performing well or is lagging behind a performance analysis tool is needed, but due to the complexity of the business partners and their different levels of development it has been difficult to establish a common framework that assesses business partners properly and applies to them equally.

Nevertheless the industry has developed throughout recent years a series of important and reliable tools in order to improve the activity of companies as well as their upstream suppliers of different tiers. This helps business partners improve not only their individual results but also enables them to provide better, faster, cheaper and more competitive products and services for its customers.

The automotive industry has its key players and throughout the last decades partnerships have emerged to constantly improve quality of cars manufactured, their safety and innovative technologies with which they are equipped. Also, throughout recent years quality of cars has significantly improved and thus the battle today is mainly upon differentiation strategies among car manufacturers where they apply different brand policies under careful group guidance. However although common efforts are already well under way to harmonize standards, mutualize platforms and tighten collaboration, performance analysis tools are yet to be used and applied within the automotive industry.

This is also due to the fact that each car manufacturer or group has different development strategies, different ways of managing their internal activities and different supply chain and partnership standards and requirements. Hence this also translates to the differences in carmaker's results presentation where the emphasis is upon different criteria and indicators as to assess their performance, which makes it difficult to compare the different carmakers and draw pertinent conclusions.

3.3.1. The Supply Chain Operations Reference model (SCOR)

Among the most renowned tools used in the automotive industry is the Supply Chain Operations Reference (SCOR) model. SCOR is the Supply Chain Council (SCC) official standard for supply chain management diagnostics and is the world's leading supply chain framework, linking business processes, performance metrics, best practices and technology into a unified structure [142].

The model's methodology, diagnostic and benchmarking tools help organizations make significant and faster improvements in their supply chain processes by evaluating and comparing supply chain activities and performance. The reference model equally supports communication among supply chain partners and improves the effectiveness of supply chain management and its related improvement activities.

Thus, SCOR enables an organization to increase the speed of system implementations, it supports its organizational learning goals and also helps improve inventory turns.

The supply-chain operations reference-model was developed in 1996 by PRTM, a management consulting firm named after its founding partners Pittiglio, Rabin, Todd and McGrath. PRTM is today part of PricewaterhouseCoopers (PwC) and is supported by the Supply Chain Council (SCC), which is since August 2014 part of APICS, as the cross-industry de facto standard strategy, performance management, and process improvement diagnostic tool for supply chain management. Nevertheless, it should be clearly stated that SCOR does not attempt to prescribe how a particular organization should conduct its business or tailor its systems and information flow.

Instead, the supply chain operations reference is a process reference model for supply chain management, as SCOR enables its users to address, improve, and communicate supply chain management practices within and between all interested parties in the extended network of business partners. A very useful feature of the model is the fact that it provides standard definitions for the specific skills required to perform certain supply chain processes.

According to its handbook, SCOR is a reference management tool, spanning from the supplier's supplier to the customer's customer and describes the business activities associated with all phases of satisfying a customer's demand [130].

SCOR is broken down into three major segments: process modeling, performance measurement and supply chain best practices.

1. Process modeling is further broken down into six other management processes. These address the following activities: planning supply chain operations, sourcing goods and services, making/manufacturing products, delivering finished goods, handling product returns and enabling new processes.
2. The performance measurement segment of SCOR uses more than 150 key performance indicators approved by the Supply Chain Council for measuring the success of a supply chain operation.
3. SCOR requires four requirements to be met in order to consider certain activities as best practices: they should be current (not emerging or old-fashioned), structured (with goals and procedures clearly stated), proven (their success should be demonstrated in real-world environments) and they should be repeatable (in the sense that they should have worked in more than one single environment).

These performance metrics proposed by SCOR derive from the experience and contribution of the Supply Chain Council members and are organized in a hierarchical structure on three levels.

First level metrics (level 1) are at the most aggregated level as they are usually used by the top decision makers to measure the performance of the company's overall supply chain.
The second level metrics (level 2) are primary, high level measures that normally cross multiple SCOR processes, whereas the third level metrics (level 3) do not necessarily have to relate to level 1 SCOR processes.

These metrics are used together with performance attributes, as these represent characteristics of the supply chain that allows it to be analyzed and evaluated against other supply chains with similar or different competing strategies. The performance section of SCOR therefore consists of performance attributes and metrics. Even though an attribute cannot be measured it can still be very useful to set a strategic direction. Performance attributes are a grouping of metrics used to express a strategy, whereas the metrics measure the ability of a supply chain to achieve these strategic attributes. Supply chains also requires standard characteristics in order for them to be described, because without these characteristics it would be extremely difficult to compare a business organization that has a low-cost provider policy to another organization that prefers to compete on a policy of reliability and performance.

The performance measurement and benchmarking within SCOR is done at a supply chain level and not at the organizational and individual level of a particular company. This is good in the sense of the theory of optimizing the whole rather than its individual component links, but it provides little to scarce information about the actual performance of each business entity involved in the supply chain and in its capacity to assure a well-functioning and sustainable long-term business relationship or partnership. In practice it is very difficult to say which strategy of managing a supply chain is best, because as each company is different and interactions between them are also different, there are no universal solutions to render a supply chain reliable. However it is safe to state that because of these differences, the business partners have to find the appropriate tools to improve, strengthen and optimize their supply chains. This requires them to find a tailored solution which best fits and works for their supplier-buyer relationships as the best solution for one particular supply chain may not provide similar results when applied to a different supply chain. The best solution is the one which works within one particular given situation and it is seldom a simple one, due to the complexity of supply chains today, especially in the automotive industry.

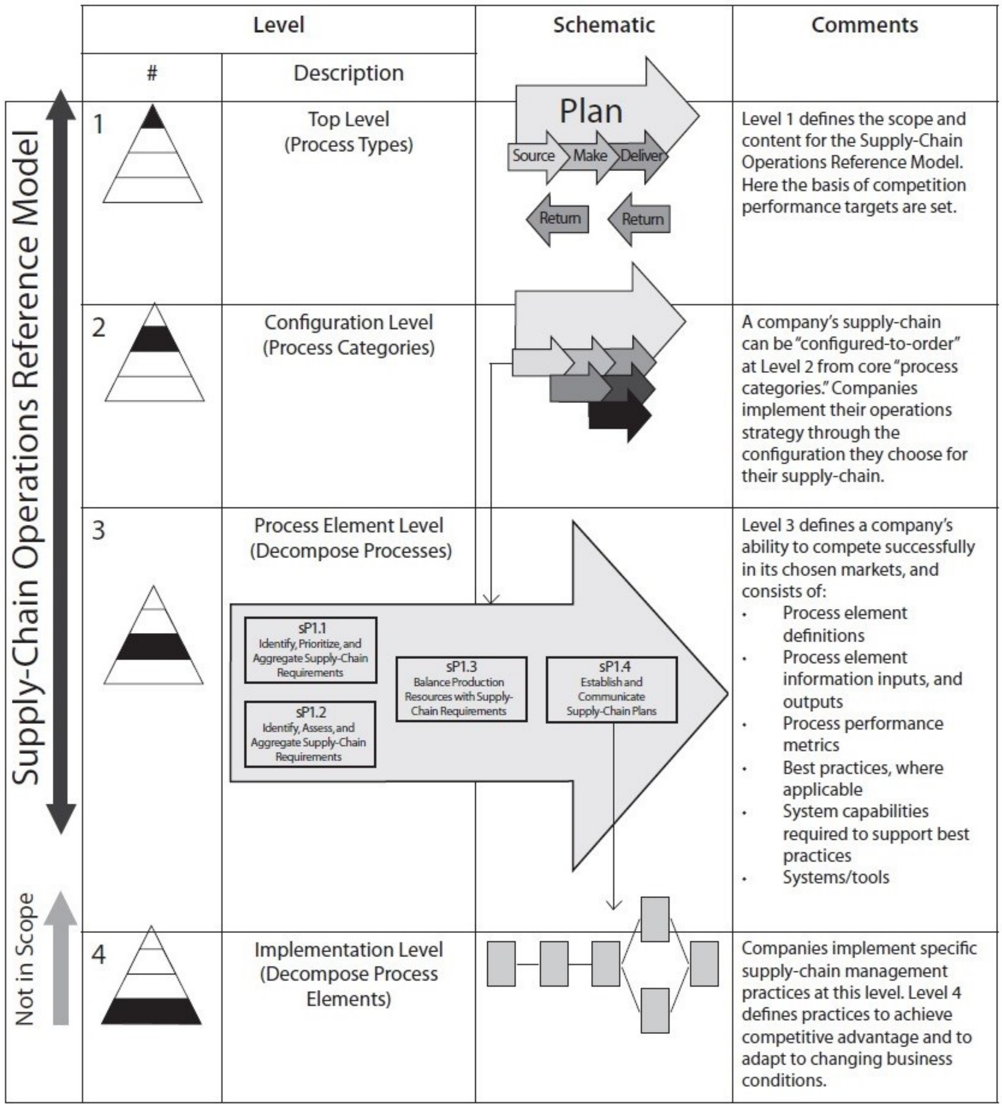


Figure 3.12. The SCOR hierarchical model [130]

SCOR and more specifically its key performance indicator component is a more strategic approach which analyzes the performance of the whole with a special focus on processes which influence, involve and affect the supply chain. Nevertheless this analysis provides little pertinent information on the performance of the individual links that are part of the network and neglect their business health by not providing enough in-depth insights to their performance dynamics. This is especially important when considering the theory of the weakest link, as the supply chain is only as strong as its weakest link and therefore in order to assure a sustainable business perspective this weakest link should be as closely aligned as possible with the other links in order to strengthen the entire chain and enable the premises of long-term development. Another downside of SCOR is the scarce integration of some key drivers of competitiveness especially important within car manufacturing companies such as human resources, training and quality assurance. Quality is undoubtedly the key pillar and requirement in the industry and it can only be enabled by properly qualified personnel who need to provide high productivity rates in daily activities. The SCOR hierarchical model is provided in figure 3.12.

3.3.2. Global Materials Management Operations Guidelines/ Logistics Evaluation (MMOG/LE)

Another reference tool used in the automotive industry is the Global Materials Management Operations Guidelines/Logistics Evaluation (Global MMOG/LE) developed by Groupement pour l'Amélioration des Liaisons dans l'Industrie Automobile (GALIA) association in order to assess a company's logistics capability. In Europe, GALIA is a member of two major bodies:

- Odette International (which mission, objectives and organization are similar to those of GALIA) welcomes representatives of the following countries: Germany, France, United Kingdom, Spain, Sweden, Czech Republic, Turkey, Romania and
- ENX Association (an association created in 2000 to set up a private, secure and high-speed automotive network based on the Internet technologies)

In France, GALIA is in connection with many professional federations and bodies, in particular with the automotive industry platform PFA (Plateforme de la Filière Automobile), the automotive industry supplier federation FIEV (Fédération des Industries des Équipementiers pour Véhicules), the French automotive manufacturers committee CCFA (Comité des Constructeurs Français d'Automobiles) or the regional automotive industry associations ARIA (Associations Régionales pour l'Industrie Automobile).

GALIA's mission is to establish standards and recommendations to accelerate both physical and informational flow exchange between automotive industry partners and enable these flows to be reliable and to reduce their associated costs [50].

The complexity and economic importance of automotive industry worldwide enables a challenging environment for car manufacturers and needs a more sophisticated approach towards assessing its supply chain management. One of the most challenging tasks for carmakers is to balance their own available resources with the customer's changing needs and desires. This is never an easy task as the whole process needs to be done within tight cost margins. In order for this process to be carried out effectively it is vital that managers know exactly which logistics processes are working properly and which are not.

The Global MMOG/LE tool is also among the most used standards for evaluating automotive industry supply chain processes, for internal assessments, company benchmarking and improving its supply chain performance.

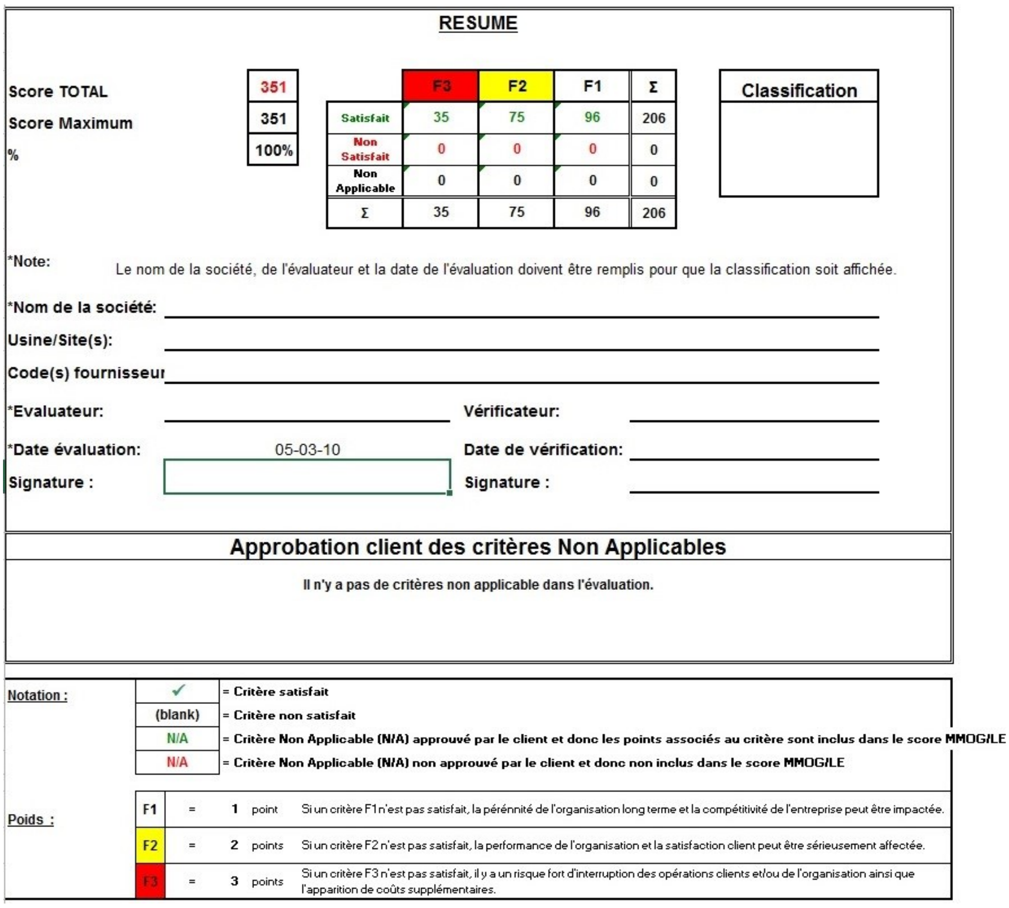
The Global Materials Management Operations Guidelines/Logistics Evaluation tool has around 200 criteria to assess logistics which in turn enables the organization's processes to be benchmarked against industry best practices. Logistics organizations are evaluated using the Global MMOG/LE tool and are rated simply as "A", "B" or "C", with "A" being the best possible rating and "C" being the least desirable outcome, whilst logistics system plans that meet customer demand or internal requirements are equally supported. The assessment tool assists carmakers and their suppliers to achieve cost reductions, reduce waste and workloads by improving and streamlining their operating procedures. The design of Global MMOG/LE's framework enables supply chain operations to be explained much easier to external customers or to demonstrate improvement possibilities to internal management.

The tool is aligned with the common goals of ISO/TS16949:2002, a quality standard applied throughout the automotive industry supply chain. The ISO/TS16949:2002 was developed by the International Automotive Task Force (IATF) and the ISO Technical Committee and refers to the design, development, production, installation and servicing of automotive-related products.

Since the MMOG/LE was first launched, it has been regularly updated to reflect both changes in supply chain practices and enhance the functionality of the tool with the 4th version being the newest as of 2014. One particularly interesting new feature of the 4th version is the "Basic" module which is aimed at smaller suppliers, those operating in developing markets or those whose main business may not necessarily be in the automotive sector. This "Basic" module is also more permissive than the classic version as it contains only a reduced number of criteria which focus on the core fundamentals of logistics best practices and provides an insight to compliance with the full MMOG/LE version.

The MMOG/LE is an audit and logistics assessment tool, internationally renowned and is structured in 6 chapters and a total of just 70 questions that address compliance with automotive industry accepted standards.

The six chapters focus on strategy and improvement, work organization, production capacity and planning, customer interface, product and process management and supplier interface. These chapters further refer to important aspect of the business organization process. Strategy and improvement address vision and strategy, objectives, metrics, analyses and action plans, continuous improvement and supply chain development. Work organization addresses organizational processes, organizational procedures, resource planning, work environment and human resources. Production capacity and planning addresses product development, capacity planning, production planning and system integration. Customer interface addresses communication, packaging and labeling, shipments, transport and customer satisfaction and returns. Product and process management address product identification, stock management, change management and traceability. Supplier interface addresses supplier selection, logistic protocol, communication, packaging and labeling, transport, reception and supplier assessment. An overview of the results provided by the MMOG/LE is provided in figure 3.13.


RESUME

Score TOTAL	351
Score Maximum	351
%	100%

	F3	F2	F1	Σ
Satisfait	35	75	96	206
Non Satisfait	0	0	0	0
Non Applicable	0	0	0	0
Σ	35	75	96	206

Classification

*Note: Le nom de la société, de l'évaluateur et la date de l'évaluation doivent être remplis pour que la classification soit affichée.

*Nom de la société:

Usine/Site(s):

Code(s) fournisseur

*Evaluateur: Vérificateur:

*Date évaluation: 05-03-10 Date de vérification:

Signature : Signature :

Approbation client des critères Non Applicables

Il n'y a pas de critères non applicable dans l'évaluation.

Notation :

✓	= Critère satisfait
(blank)	= Critère non satisfait
N/A	= Critère Non Applicable (N/A) approuvé par le client et donc les points associés au critère sont inclus dans le score MMOG/LE
N/A	= Critère Non Applicable (N/A) non approuvé par le client et donc non inclus dans le score MMOG/LE

Poids :

F1	=	1	point	Si un critère F1 n'est pas satisfait, la pérénnité de l'organisation long terme et la compétitivité de l'entreprise peut être impactée.
F2	=	2	points	Si un critère F2 n'est pas satisfait, la performance de l'organisation et la satisfaction client peut être sérieusement affectée.
F3	=	3	points	Si un critère F3 n'est pas satisfait, il y a un risque fort d'interruption des opérations clients et/ou de l'organisation ainsi que l'apparition de coûts supplémentaires.

Figure 3.13. MMOG/LE results overview

The reference model assesses an automotive industry company according to three different types of criteria (loss in performance and effectiveness for the concerned company, potential risk for the customer, major and immediate risk for the customer) and also provides a rating ("A", "B" or "C") and the degree of compliance (in percentage). It also describes the current state of the company in reference to the MMOG/LE requirements, points out the important differences and performance gaps and proposes targeted improvement suggestions.

Although it is of high practicality, the Global MMOG/LE is basically just an audit tool and only analyses if a company is compliant or not, without emphasizing the degree of compliance, which is also important in performance assessment. Also, one of the main problems with the reference model was the fact that in previous versions the fact that one criteria was not applicable meant is was not satisfied when considering end results, meaning in turn that it was considered as if it were non-compliant, which is not in accordance with the factual situation of the individual company.

It is important not only to know if you are compliant or not, but also the extent to which achieved performance and results meet previously established targets and objectives in order to allow the company to address and tailor the right degree of corrective measures and make changes in their business process management.

3.3.3. Business dashboards

According to the business dashboard platform Klipfolio [79], business dashboards are an information management tool that are used to track key performance indicators (KPIs), metrics and other key data which is both pertinent and relevant for a business entity, one of its departments or its specific processes (see figure 3.14). Through the use of data visualizations, these business dashboards enable the simplification of complex data sets in order to provide users with a quick and effective overview on current performance.

The term dashboard originates from the common car dashboard where a driver has the most important information and warning signs and lights right in front of him which help him monitor the major functions at a glance via the instrument cluster during driving. Although there are many processes going on which affect the performance of the car while driving the dashboard summarizes these events using visualizations and informs the driver when something important is wrong or needs attention. This is pretty much the same in business entities where there is a need for lots of information, but only to a certain extent is that information really essential for decision-making and such dashboards help managers have a quick and clear image on probably the most relevant data to assist them in aligning performance.

Business dashboards generally provide a concentrated at-a-glance overview of KPIs (key performance indicators) which are relevant for an individual company on a global level or one of its departments on a more specific level (production, logistics, sales) [6]. Dashboards are very easy to understand and interpret as they give clear signs about a business and ultimately let the user know if something is wrong or something is right within just a couple of seconds.

The automotive industry has worked together to establish standards and best practices, but up to today the industry has not yet been able to provide an aggregate performance assessment tool, because the industry carmakers and their partners are still reluctant to sharing some sensitive information among each other. A common dashboard would typically provide an overview on data by using summaries, key trends, comparisons, and exceptions.

A good dashboard [60] usually has the following attributes:

- it is simple, in order to easily communicate results and to facilitate an accurate overview for the user
- it has minimum distractions as they may cause some forms of confusion for the user
- it provides meaningful and useful data in order to support business entities or their departments
- it presents data and information in a visual manner as to enable a quick and easy perception of results for the user

In management information systems, a dashboard is "an easy to read, often single page, real-time user interface, showing a graphical presentation of the current status (snapshot) and historical trends of an organization's key performance indicators (KPIs) to enable instantaneous and informed decisions to be made at a glance" [99]. There is also a strong conviction amongst the business environment that a well-designed dashboard is a remarkable information management tool which can provide support for better planning and forecasting of future developments.

Although dashboards seem as a primary performance assessment tool, they do not date that far back as they started being used only somewhere around the middle of the 1990s when the information age quickly increased its pace and enabled technology (as were the likes of data warehousing or online analytical processing) to facilitate the adequate functioning of these business dashboards.

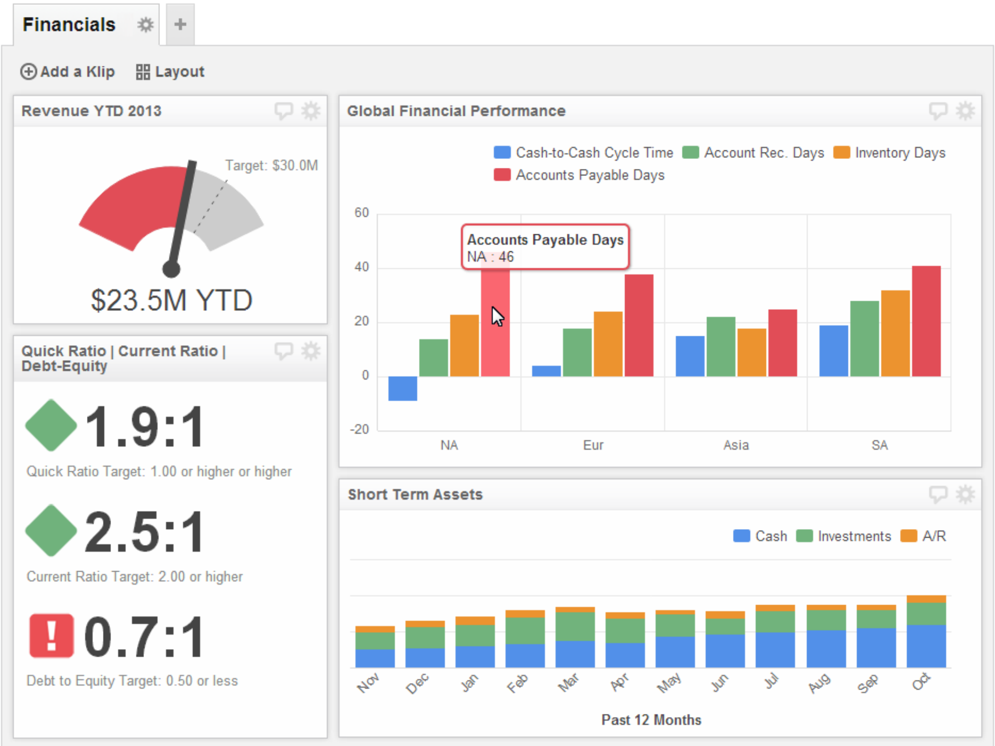


Figure 3.14. Example of business dashboard

The dashboard laid the ground for the rise of key performance indicators (KPIs) and was the perfect setting for the introduction of the Balanced Scorecard and has become today an important part of a company's Business Performance Management (BPM). Dashboards can fall within different categories (strategic, analytical, operational, etc.) and are a practical and useful tool to help managers better conduct their company's activities and improve performance with the help of some simply organized and visualized data.

Strategic dashboards provide a quick overview that enable managers to make better decisions for their companies as they have the possibility to thoroughly monitor business performance and seize business opportunities. Strategic dashboards offer a more static snapshot (usually after a period of time: weekly, monthly, quarterly, etc.) of relevant and pertinent data and help guide managers in measuring performance, assessing compliance with previously set objectives and forecasts and improving the future business activity.

Analytical dashboards usually include more information on the approached issues such as context, comparisons or even history and also have a more in-depth assessment of the importance of details. Operational dashboards for monitoring operations are different from strategic or analytical dashboards as they are usually intended for monitoring activities and events that are currently underway and may change within a short period of time thus requiring a more constant attention and a quicker response time.

Dashboards may have different user designs as they do not follow a standard pattern and may encompass different ways of presenting data. Dashboard designs are usually company tailored as to match as closely as possible the way that particular company wants to have its relevant data presented and how it wants to overview its main decision-making criteria. There are general guidelines when initially developing such an assessment tool that targets to improve certain performance metrics, but it is essential to note that what may work for one business entity may not work for another, therefore there is the need to tailor the dashboard in accordance to specific company needs. A user-friendly design and a clear overview of data is of high importance for the quality of communicating key information and making supporting information easily accessible [9].

3.3.4. Conclusions

Performance analysis is one of the most important activities within automotive industry, the harsh competition and challenging nature of the industry and its accelerated development in the last decade have imposed rigorous standards for carmakers and their supply chain partners in order to be able to cope with the high competitiveness level on the market.

This has helped companies and their supply chains develop more in-depth collaborations in order to strengthen their competitive position on the market and render their whole network of activities more efficient and reliable. Performance analysis can be performed in different ways and its target should be to objectively assess a company's level of performance and provide insights on the areas which need improving.

Although there are some performance analysis tools available on the specific car market, some may be more appropriate than others and the main idea is to know exactly what a company wants to find out after the assessment, what are the areas it wants to measure and assess for effectiveness, because by setting a clear and measurable target, the company can compare actual performance to the pre-established levels of desired performance and can thereafter tailor more pertinent solutions to help improve both on certain target levels or on an overall level.

SCOR, MMOG/LE and business dashboards are good tools and can provide valuable insights for a company if used properly and with a clear overview of the desired areas that are to be measured, but each of them have certain features which lack a better consistency of the obtained results, therefore there is still room for improvement in this domain and new and innovative performance analysis tools may be developed to better assess a car manufacturer's activity.

4. DESIGNING A PERFORMANCE ANALYSIS TOOL FOR THE AUTOMOTIVE INDUSTRY

4.1. Presentation of the proposed performance analysis tool

Automotive industry has always been preoccupied with analyzing its performance. However as the industry is very complex and each carmaker and its supply chain partner network have their own specific way of doing business, so do their methods of analyzing performance.

Within the last couple of years car manufacturers have started delivering company reports, group reports or CSR reports which focus on analyzing the company's activity and also provide some KPI's the carmakers consider relevant. Usually carmaker companies also develop these activity assessments every year differently, which means they either contain more information from year to year or that the information provided sometimes changes in order to better meet certain internal or external criteria. Although this approach is very praiseworthy, the fact that these reports tend to be rather inconsistent makes them rather difficult to use in order to compare the activity of the same carmaker within consecutive years or a given timespan.

After carefully analyzing the automotive industry throughout the last couple of years, studying reports, conducting company visits and having extensive discussions with industry managers the author has summed up the main indicators of the automotive industry which are especially relevant for car manufacturers but can also be applied to their first or second tier suppliers. These indicators will provide an in-depth analysis and a consistent overview of a carmaker's performance throughout a given year and can prove a useful tool for their managers in decision making and goal setting. The performance assessment tool can be used both internally and externally to show results and highlights the best functioning areas of the company as well as the least best ones.

The performance analysis tool contains 81 key performance indicators (KPIs) which are grouped into 3 categories: logistics, management and internal performance as shown in figures 4.1, 4.2 and 4.3 below. Given the nature of the aspects which the 3 indicator categories address, they could also be grouped into the classic sustainable development categories: economic, social and environment, but the chosen categories are much broader and better synthetize the content of the indicators.

The resulting indicators within the 3 categories are then divided into strategic, tactical and operational indicators according to the aim and timespan of each indicator. An operational indicator will produce effects for the company within a short upcoming time span of up to 4 months, a tactical indicator between 4 months and one and a half years, whereas strategic indicators will usually produce an effect in the long-term, which will arise after one a half years or more.

KEY PERFORMANCE INDICATOR INTRODUCTION AND CALCULATION

	STRATEGIC	actual	
1	Perfect Order Fulfillment	0.941	Perfect Order Fulfillment = Total Perfect Orders / Total Number of Orders
2	Process Integration/Cooperation	0.6	Process Integration/Cooperation = total amount of processes, procedures and reports shared with suppliers / total amount of relevant
3	Innovative Product Development Cycle	0.84	Innovative Product Development Cycle = 1 - (number of weeks to bring a new product to the market / 100)
4	Lead Time	0.82	Lead Time = 0,7 + [(13 - average number of weeks for an Order Fulfillment) / 13] * 0,3
5	Green Products Index	0.71	Green Products Index = Number of manufactured cars which enable the use of greener technology / Total Number of cars manufacture
6	Supply Chain Cycle Time	0.65	Supply Chain Cycle time = 1 - [(Average Number of weeks to Fulfill an Order (if Inventory levels were zero) - 13) / 13]
7	Clean Production Techniques Usage	0.79	Clean Production Techniques Usage = Amount of Clean Techniques Used / Total Amount of Techniques Used
8	Energy Consumption Reduction	0.88	Energy Consumption Reduction = Achieved Energy Consumption Results / Targeted Energy Consumption Results
9	Waste Reduction	0.92	Waste Reduction = Achieved Waste Reduction Results / Targeted Waste Reduction Results
10	Carbon Emissions per Vehicle	0.56	Carbon Emission per Vehicle = 0,5 + (130 - Average Carbon Emissions per Manufactured Vehicle [g/km] / 70)
11	Reuse Used Products	0.85	Reuse Used Products = number of Reused Products / Total Products
12	Recycle Used Products	0.31	Recycle Used Products = number of Recycled Products / Total Products
	Overall Average	0.7393	
	TACTICAL	actual	
13	Upside SC Flexibility	0	Upside Supply Chain Flexibility (average time needed to support an unexpected 20% increase in delivered quantities) = 1 - (number of
14	Upside SC Adaptability	0.1625	Upside Supply Chain Adaptability = (maximum possible increase in delivered quantities for 30 days / average monthly scheduled produ
15	Downside SC Adaptability	0.925	Downside Supply Chain Adaptability = 0,5 + decrease in ordered quantities that can be sustained with no inventory or cost penalties [%
16	Flexibility of Service Systems	0.66	Flexibility of Service Systems = number of fulfilled particular customer needs / number of requests to meet particular customer needs
17	Delivery Balancing	0.86	Delivery Balancing = measures the extent of the reliability of the schedule for planned deliveries, number of arrivals [%] / 100
18	Delivery Schedule Planning	0.78	Delivery Schedule Planning = extent to which deliveries arrive on time and according to schedule [%] / 100
19	Buy-Back Policy	0.25	Buy-Back Policy = extent to which the company has a plan to buy-back its older models from its customers and provide incentives to pu
	Overall Average	0.5196	
	OPERATIONAL	actual	
20	Departure Accuracy	0.81	Departure Accuracy = number of On-Time Departures / Total number of Departures
21	Urgent Delivery Responsiveness	0.85	Urgent Delivery Responsiveness = Urgent Delivery Requests met / Total Amount of Urgent Requests
22	Delivery Performance Cycle Time	0.769	Delivery Performance Cycle Time = 0,7 + [(4 - average number of weeks for a Delivery) / 4] * 0,3
23	Transport Service Rate	0.98	Transport Service Rate = number of Perfect Deliveries / Total number of Deliveries
24	Data Interchange Delivery	0.77	Data Interchange Delivery = measures the degree of reliability, rapidity and accuracy of records being transferred between Supplier an
25	Customer Order Taking	0.96	Customer Order Taking = extent to which a customer order is being automatically processed [%] / 100
26	Supplier Performance Cycle Time	0.55	Supplier Performance Cycle Time = 1 - (average number of weeks for a Supply to arrive / maximum number of weeks for a supply to arr
27	Arrival Accuracy	0.82	Arrival Accuracy = number of On-Time Arrivals / Total number of Arrivals
28	Production Capacity Analysis	0.86	Production Capacity Analysis = extent to which actual capacity is known in real time and altered by random occurences [%] / 100
29	Total Production Cycle Time	0.5	Total Production Cycle Time = 1 - (average number of weeks for manufacturing a custom-tailored car / 13)
	Overall Average	0.7869	

LOGi | LOG | MANi | MAN | PERi | PER | LOGs | LOGm | LOGl | MANs | MANm | MANl | PERs | PERm | PERl | SUM | OVER

Figure 4.1. Logistics KPIs calculation

KEY PERFORMANCE INDICATOR INTRODUCTION AND CALCULATION

	STRATEGIC	actual	
1	Forecast Accuracy	0.9439	Forecast Accuracy = 1 - Forecast Error
2	Product's Risk Rating	0.54	Product's Risk Rating = extent to which such an analysis in carried out [%] / 100
3	Long-Term Supplier Agreement/Partnership	0.6	Long-Term Supplier Agreement/Partnership = number of Suppliers with early involvement in R&D and with which know-how is sha
4	SC Risk Management	0.66	Supply Chain Risk Management = extent to which such an analysis is carried out [%] / 100
5	Risk and Benefit Sharing	0.63	Risk and Benefit Sharing = extent to which Benefits and Risks are shared / Total Number of potential Benefits and Risks
6	Rate of Returned Cars	0.94	Rate of Returned Cars = 1 - (Number of Cars being Returned for several reasons / Total Number of Shipped Cars)
7	Profit Margin	0.195	Profit Margin = (Profit / Turnover) *10
8	Employee Added Value Generated	0.54	Employee Added Value Generated = (Average Selling Price - Outside Purchases) / Outside Purchases
9	Level of Perceived Value by Customers	0.76	Level of Perceived Value by Customers = extent to which a customer satisafaction analysis is carried out [%] / 100
10	Internal Market Share	0.058	Internal Market Share = Cars Sold on the Internal Market / Overall Sales
11	Supplier's Risk Rating	0.78	Supplier's Risk Rating = extent to which such an analysis is carried out [%] / 100
12	Customer's Risk Rating	0.58	Customer's Risk Rating = entent to which such an analysis is carried out [%] / 100
13	Model Strategy Plan	0.75	Model Strategy Plan = extent to which such a plan is carried out [%] / 100
	Overall Average	0.6136	
	TACTICAL	actual	
14	Safety Stock Planning	0.97	Safety Stock Planning = extent to which such an analysis is fundamented and carried out [%] / 100
15	Bottleneck Adaptation	0.998	Bottleneck Adaptation = Achieved Output of Bottleneck / Maximum Capacity Output of Bottleneck
16	Revenue Dynamic	0.23	Revenue Dynamic = [(Revenue in current year / Revenue in previous year) - 1] * 10
17	Annual Cost Reduction Policy	0.84	Annual Cost Reduction Policy = extent to which such a policy exists and is carried out thoroughly [%] / 100
18	Cost-Cutting Policy	0.92	Cost-Cutting Policy = extent to which the cost-cutting policy is sustainable and based on accurate data and a thorough analysis [%] /
19	Sales Export Share	0.942	Sales Export Share = Cars Sold on International Markets / Overall Sales
20	Inventory Turnover	0.55	Inventory Turnover = 0,5 + [(Sales or Cost of Goods Sold / Average Inventory) - 11] / 10
21	Cash to Cash Cycle Time	0.63	Cash to Cash Cycle Time = 1 - [(Average Materials payment days - Average Customer order payment days) / 90]
22	Average Employee Salary Levels	0.73	Average Employee Salary Levels = (Average Salary within the company / Average National Salary) -1
	Overall Average	0.7567	
	OPERATIONAL	actual	
23	Incident Informing Procedure	0.88	Incident Informing Procedure = extent to which such a procedure exists, is operational and is carried out effectively [%] / 100
24	Transportation Cost	0.971	Transportation Cost = 1 - (Average Cost of Transportation / Average Cost of Goods Transported)
25	Total Logistics Cost Contribution	0.968	Total Logistic Cost Contribution = 1 - (Average Logistics Cost / Average Cost of Goods Prepared)
26	Inventory Accuracy	0.9775	Inventory Accuracy = Physical Evidence of Inventory / Recorded Evidence of Inventory
27	ABC Analysis	0.74	ABC Analysis = extent to which the analysis is performed and up-to-date [%] / 100
28	Total Inventory Flows	0.82	Total Inventory Flows = extent to which the flow of inventory is known in real time between several workstations [%] / 100
29	Information Sharing	0.79	Information Sharing = extent to which relevant information is shared with Suppliers [%] / 100
	Overall Average	0.8781	

LOGi | LOG | MANi | MAN | PERi | PER | LOGs | LOGm | LOGl | MANs | MANm | MANl | PERs | PERm | PERl | SUM | OVER

Figure 4.2. Management KPIs calculation

The 81 KPIs are divided into 29 logistics and management performance assessment indicators and 23 internal performance ones. There are 34 strategic, 23 tactical and 24 operational indicators. Logistics has 12 strategic, 7 tactical and 10 operational relevant indicators, management uses 13 strategic, 9 tactical and 7 operational reference KPIS, whereas internal performance is being measured through 9 strategic indicators and 7 indicators for both tactical and operational level.

KEY PERFORMANCE INDICATOR INTRODUCTION AND CALCULATION

	STRATEGIC	actual	
1	Labor Productivity	0.968	Labor Productivity = Average Number of Cars manufactured / Total Factory Capacity
2	Absenteeism Rate	0.9812	Absenteeism Rate = 1 - (Number of Working Days lost due to Absenteeism / Total Number of Workign Days Available)
3	Employee Turnover Rate	0.991	Employee Turnover Rate = 1 - (Number of separations from workers / Average number of workers)
4	Work-Study Employment	0.98	Work-Study Employment = (Number of Students hired at the end of their internship / Total Number of Students taking part in company-
5	Ergonomic Rating in Workstations	0.71	Ergonomic Rating in Workstations = extent to which existing workstations provide at least satisfactory conditions for its employees [%] /
6	Profit/Employee	0.666	Profit/Employee = (Total profit / Number of Employees) / Price of Reference car model
7	Profit/Sold Car	0.21	Profit/Sold Car = (Total Profit / Number of cars sold)*10 [%]/ Price of Reference car model
8	Employee Improvement Suggestions	0.65	Employee Improvement Suggestions = Number of implemented improvement suggestions / Total Number of Improvement suggestions
9	GDP Contribution	0.28	GDP contribution = (company turnover / Gross Domestic Product) * 10
	Overall Average	**0.7151**	
	TACTICAL	**actual**	
10	New Hires Rate	0.995	New Hires Rate = 1 - (Number of New Hires / Total Number of Employees)
11	Women in Managing Positions	0.28	Women in Managing Positions = Number of Women in Managing Positions / Total number of Managing Positions
12	Employee Enablement	0.66	Employee Enablement = extent to which the company is able to create conditions that enable its employees to do their jobs as well as p
13	Internal Performance Index	1	Internal Performance Index = Achieved Output / Planned Output
14	Production Performance Rate	0.994	Production Performance Index = 1 - Defect Rate
15	Resource Utilization Index	0.998	Resource Utilization Index = Average Usage of all Technical Means within the factory [%] / 100
16	Employee Yearly Training Plan	0.59	Employee Yearly Training Plan = (yearly hours of training plan for its employees / number of employees) / 40
	Overall Average	**0.7881**	
	OPERATIONAL	**actual**	
17	Work Accidents Rate	0.954	Work Accidents Rate = number of work accidents requiring medical care outside of the company / million hours worked
18	Lost Time Accidents	0.974	Lost Time Accidents = number of lost-time work accidents / million hours worked
19	Occupational Illness Rate	0.9556	Occupational Illness Rate = [100 - (number of reported cases / 1,000 employees)] / 100
20	Disabled Employees	0.398	Disabled Employees = (Number of Disabled Employees / Total Number of Employees) * 10
21	Employee Motivation	0.72	Employee Motivation = extent to which the company is able to motivate its employees to provide their best while at work [%] / 100
22	Performance Alignment	0.834	Performance Alignment = extent to which current performance matches planned performance (both productivity and quality output equ
23	Job Satisfaction Measurement	0.88	Job Satisfaction Measurement = extent to which employees are satisfied with their jobs based on internal surveys [%] / 100
	Overall Average	**0.8165**	

LOGi | LOG | MANi | MAN | PERi | PER | LOGs | LOGm | LOGl | MANs | MANm | MANl | PERs | PERm | PERl | SUM | OVER

Figure 4.3. Internal performance KPIs calculation

The automotive industry is a very dynamic and complex industry and its specific features impose a very good work and schedule discipline where product quality, cost control and meeting deadlines are a must in order to ensure a consistent and reliable supply chain. This very detailed sense of care and attention helps automotive industry companies develop an anticipative feeling upon the impact of certain issues or events on their activity within the upcoming timespan. Some of the KPIs will more likely be reflected within costs and others less. This imposes a further classification of the indicators based on their impact on short, medium and long-term. The timespan of their impact however can be very variable and unsteady, however an indicator with a short-term impact will likely produce its effects within a couple of months on current activity. Evidence shows that these short-term impacts usually appear in 2-3 months or for specific cases they can produce heavy impacts even earlier in a time span of up to 4 months.

Similar to the indicators which enable a short-term impact, the impact of the medium-term indicators will generally produce noticeable effects for the company in a more distant timespan of 3-6 months, with the exact duration being subject to the indicator's specifics or to the perceived signs a particular indicator generates throughout its supposed time range. Consequently some indicators will present their impacts closer to the 3 month term, while others will more likely present their signs closer to the half year mark. Long-term impact is considered to be the impact an indicator generates after 6 months or more, with a maximum range of 12 months where the indicator would have already produced some sort of signs that it has had an effect of some kind on current activity.

The value of each indicator can range from 0 to 1, with 1 being the best possible value and 0 the least best. In order to assess the degree of compliance reference values have been established based on the author's experience, the relevance and nature of the indicator, benchmark indicator values and automotive industry specific information gathered. For indicators which have a short-term impact, regardless of them being strategic, tactical or operational, a reference value of 0.9 has been set (90% of the maximum possible value), for medium-term impact indicators 0.7 (70% of the maximum possible value) and a 0.5 value (50% of the maximum possible value) for the long-term impact indicators based on automotive industry relevant data, average performance rates and common target levels.

Targets set by companies are usually ambitious and even though sometimes they are met and even surpassed, there are cases when the actual results do not meet the set targets. In such cases it is important to assess the degree to which the indicator performed and whether it was just short of accomplishing the aim or whether it had an important lag. In order to establish the importance of not achieving the target value, a critical value was defined as two thirds of the reference value, which although does not comply with the original established target, it still shows that more than 66% has been achieved and enables a closer look on that specific performance area. This may arise certain features which may have prevented the company to achieve the target value or some circumstantial events that may have hindered its accomplishment. Regardless of these circumstances, an indicator value under the established reference and also under the critical value level is not acceptable and should immediately be addressed by the managers to understand the reasons for underperformance which may either be due to setting a non-realistic target value or to the failure of the company to achieve the desired outcome. This particular situation is likely to generate more issues and properly approaching the causes which lead to this deviation is imperative as the quality of the chosen solutions will be decisive in realigning company performance.

Based on the actual values the indicators achieve, the performance analysis tool generates three types of result summaries and interpretations. The first results focus on the first three categories (logistics, management and internal performance) and provide an overview of these indicators on strategic, tactical and operational level. Results are presented on a classic chart which also includes the reference line as to position the result in accordance to the initial set target values. The second part of the results shows a detailed assessment of the three categories with regard to the indicators' short, medium and long-term impact on company activity. Besides summing up the indicators based on their timespan impact, this part also averages out the indicators, shows the best performing and least best performing ones and generates a radar chart to graphically represent target values (reference values), critical levels, average rating of the category and actual values of the concerned indicators. This part therefore provides a more complete view on performance by using both the actual numerical values and their graphical representation through the radar chart.

The third and final representation of the results is in fact a summary of the overall results. This part does a quick recap of the previous section and generates an overall value for the three categories (logistics, management and internal performance) as well as for the overall short, medium and long-term impacts from all three categories. It also averages out the reference values (target values) and compares the actual average with the reference for an overall view of the different performance categories. Within this part the different performance categories are also ranked according to their results, the best and least best ones are highlighted, an overall average of the company's performance is generated as well as an overall radar graph which points out the performance gaps between actual results and target levels.

The proposed performance analysis tool is in fact a proper business dashboard, which is usually used to track key data as are key performance indicators (KPIs) or other similar metrics relevant to a specific business. Business dashboards provide useful data reorganization and visualizations, which simplify complex data categories and provide their users with at a glance awareness of the company's current performance on specific levels.

4.2. Comparative case study on the Renault Douai plant – Dacia Mioveni plant

The case study provides an interesting insight and an in-depth analysis of the two Renault Group car manufacturing sites, the Northern France Renault Douai production plant, one of the best in France in terms of quality and delivery times of the French car manufacturer which recently was assigned to handle the production of the losange brand's two new premium models, the New Espace and the Talisman beginning with 2016 and the Dacia Mioveni facility, part of the Renault Group, where the French carmaker builds its entry models and where its main low-cost or smart-buy brand Dacia has its major operations. Results are analyzed on the performance assessment tool which first examines the two company's performance in terms of overall activity on three levels: strategic, tactical and operational and then conducts a more in-depth analysis, based on three key and main areas within an automotive industry company: logistics, management and internal performance.

Renault has a very impressive overall record on its logistics KPIs, as it manages to almost match performance on all three major levels (strategic, tactical and operational) as is shown in figure 4.5. Strategic and operational logistics indicators score more than 0.83 each, with the tactical indicators at 0.82. This performance level is made possible as only 7 KPIs out of the 29 do not meet the reference targets. There are 3 strategic (out of 12), 3 tactical (out of 7) and 1 operational indicator (out of 10) that do not comply with the established target values.

Dacia on the other hand has only the operational part close to the French carmaker's performance with 0.78, whereas on strategic (0.73) and especially on tactical level (0.51), the Romanian brand lags behind the losange brand (see figure 4.4). Although on average Renault easily outperforms Dacia, the Romanian car manufacturer has only 10 logistics KPIs out of 29 that do not meet reference targets, one more for each category compared to the leading Renault Group brand. Thus the factory in Mioveni has 4 strategic (out of 12), 4 tactical (out of 7) and 2 operational indicators (out of 10) that do not comply with the pre-set reference targets.

	STRATEGIC	actual	*reference*
1	Perfect Order Fulfillment	*0.941*	0.9
2	Process Integration/Cooperation	*0.6*	0.9
3	Innovative Product Development Cycle	*0.84*	0.9
4	Lead Time	*0.82*	0.7
5	Green Products Index	*0.71*	0.7
6	Supply Chain Cycle Time	*0.65*	0.7
7	Clean Production Techniques Usage	*0.79*	0.7
8	Energy Consumption Reduction	*0.88*	0.5
9	Waste Reduction	*0.92*	0.5
10	Carbon Emission per Vehicle	*0.56*	0.5
11	Reuse Used Products	*0.85*	0.5
12	Recycle Used Products	*0.31*	0.5
	Overall Average	**0.7393**	

	TACTICAL	actual	*reference*
13	Upside SC Flexibility	*0*	0.9
14	Upside SC Adaptability	*0.1625*	0.9
15	Downside SC Adaptability	*0.925*	0.9
16	Flexibility of Service Systems	*0.66*	0.7
17	Delivery Balancing	*0.86*	0.7
18	Delivery Schedule Planning	*0.78*	0.7
19	Buy-Back Policy	*0.25*	0.5
	Overall Average	**0.5196**	

	OPERATIONAL	actual	*reference*
20	Departure Accuracy	0.81	0.9
21	Urgent Delivery Responsiveness	0.85	0.9
22	Delivery Performance Cycle Time	0.769	0.7
23	Transport Service Rate	0.98	0.7
24	Data Interchange Delivery	0.77	0.7
25	Customer Order Taking	0.96	0.5
26	Supplier Performance Cycle Time	0.55	0.5
27	Arrival Accuracy	0.82	0.5
28	Production Capacity Analysis	0.86	0.5
29	Total Production Cycle Time	0.5	0.5
	Overall Average	**0.7869**	

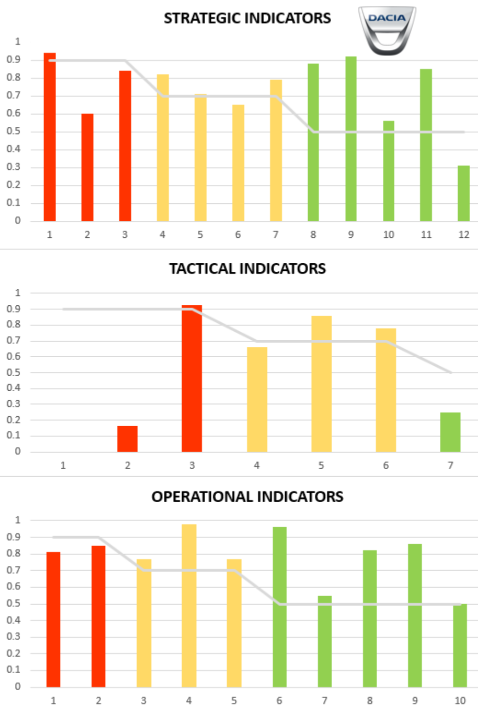


Figure 4.4. Dacia's logistics KPIs on strategic, tactical and operational level

	STRATEGIC	actual	*reference*
1	Perfect Order Fulfillment	*0.923*	0.9
2	Process Integration/Cooperation	*0.87*	0.9
3	Innovative Product Development Cycle	*0.86*	0.9
4	Lead Time	*0.896*	0.7
5	Green Products Index	*0.91*	0.7
6	Supply Chain Cycle Time	*0.76*	0.7
7	Clean Production Techniques Usage	*0.88*	0.7
8	Energy Consumption Reduction	*0.93*	0.5
9	Waste Reduction	*0.96*	0.5
10	Carbon Emission per Vehicle	*0.808*	0.5
11	Reuse Used Products	*0.95*	0.5
12	Recycle Used Products	*0.31*	0.5
	Overall Average	**0.8381**	

	TACTICAL	actual	*reference*
13	Upside SC Flexibility	*0.928*	0.9
14	Upside SC Adaptability	*0.875*	0.9
15	Downside SC Adaptability	*0.625*	0.9
16	Flexibility of Service Systems	*0.68*	0.7
17	Delivery Balancing	*0.89*	0.7
18	Delivery Schedule Planning	*0.83*	0.7
19	Buy-Back Policy	*0.94*	0.5
	Overall Average	**0.8240**	

	OPERATIONAL	actual	*reference*
20	Departure Accuracy	0.74	0.9
21	Urgent Delivery Responsiveness	0.93	0.9
22	Delivery Performance Cycle Time	0.805	0.7
23	Transport Service Rate	0.98	0.7
24	Data Interchange Delivery	0.93	0.7
25	Customer Order Taking	0.965	0.5
26	Supplier Performance Cycle Time	0.675	0.5
27	Arrival Accuracy	0.88	0.5
28	Production Capacity Analysis	0.92	0.5
29	Total Production Cycle Time	0.53	0.5
	Overall Average	**0.8355**	

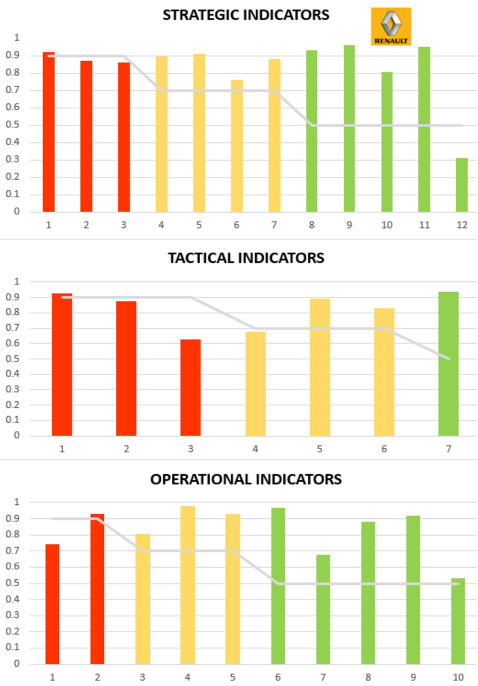


Figure 4.5. Renault's logistics KPIs on strategic, tactical and operational level

The differences for the management KPIs are tighter than in the previous category as Renault's operational average of 0.9 outperforms the other 2 levels (strategic with 0.71 and tactical with 0.7) by around 20 percentage points (see figure 4.7). Within this KPI category Renault has 10 KPIs out of 29 that do not meet the reference targets. There are 8 strategic (out of 13) and 2 tactical indicators (out of 9) that do not comply with the established target values, as all the 7 operational ones fall within established reference levels.

Interestingly Dacia, although on average values is behind Renault, has less non-compliant indicators as shown in figure 4.6. The 0.87 value for the operational level indicators is close to the French carmaker's average, the 0.75 value for the tactical indicators beats the losange brand's average, whereas strategically the Mioveni plant is 9 percentage points behind its French owner with a score of 0.61.

Nevertheless the Romanian car manufacturer has only 8 management KPIs out of 29 that do not meet reference targets, which is 2 indicators less than Renault. Dacia has 7 strategic (out of 13) and only one tactical (out of 9) that do not comply with targeted value levels, as all operational indicators achieve reference performance levels, similarly to the French company.

	STRATEGIC	actual	*reference*
1	Forecast Error	*0.9439*	0.9
2	Product's Risk Rating	*0.54*	0.9
3	Long-Term Supplier Agreement/Partnership	*0.6*	0.9
4	SC Risk Management	*0.66*	0.9
5	Risk and Benefit Sharing	*0.63*	0.9
6	Rate of Returned Cars	*0.94*	0.9
7	Profit Margin	*0.195*	0.7
8	Employee Added Value Generated	*0.54*	0.7
9	Level of Perceived Value by Customer	*0.76*	0.7
10	Internal Market Share	*0.058*	0.7
11	Supplier's Risk Rating	*0.78*	0.5
12	Customer's Risk Rating	*0.58*	0.5
13	Model Strategy Plan	*0.75*	0.5
	Overall Average	**0.6136**	

	TACTICAL	actual	*reference*
14	Safety Stock Planning	*0.97*	0.9
15	Bottleneck Adaptation	*0.998*	0.9
16	Revenue Dynamic	*0.23*	0.7
17	Annual Cost Reduction Policy	*0.84*	0.7
18	Cost-Cutting Policy	*0.92*	0.7
19	Sales Export Share	*0.942*	0.7
20	Inventory Turnover	*0.55*	0.5
21	Cash to Cash Cycle Time	*0.63*	0.5
22	Average Employee Salary Levels	*0.73*	0.5
	Overall Average	**0.7567**	

	OPERATIONAL	actual	*reference*
23	Incident Informing Procedure	*0.88*	0.9
24	Transportation Cost	*0.971*	0.7
25	Total Logistic Cost Contribution	*0.968*	0.7
26	Inventory Accuracy	*0.9775*	0.5
27	ABC Analysis	*0.74*	0.5
28	Total Inventory Flows	*0.82*	0.5
29	Information Sharing	*0.79*	0.5
	Overall Average	**0.8781**	

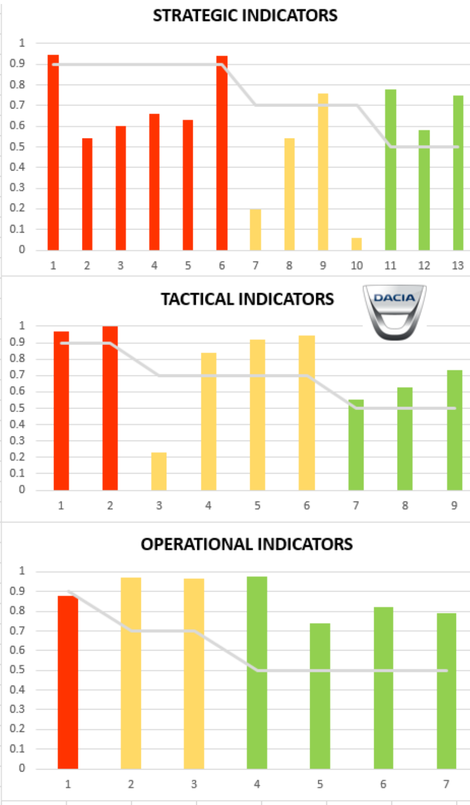


Figure 4.6. Dacia's management KPIs on strategic, tactical and operational level

	STRATEGIC	actual	reference
1	Forecast Error	0.88	0.9
2	Product's Risk Rating	0.7	0.9
3	Long-Term Supplier Agreement/Partnership	0.71	0.9
4	SC Risk Management	0.85	0.9
5	Risk and Benefit Sharing	0.78	0.9
6	Rate of Returned Cars	0.9	0.9
7	Profit Margin	0.4866	0.7
8	Employee Added Value Generated	0.68	0.7
9	Level of Perceived Value by Customer	0.79	0.7
10	Internal Market Share	0.2129	0.7
11	Supplier's Risk Rating	0.9	0.5
12	Customer's Risk Rating	0.63	0.5
13	Model Strategy Plan	0.8	0.5
	Overall Average	**0.7169**	

	TACTICAL	actual	reference
14	Safety Stock Planning	0.94	0.9
15	Bottleneck Adaptation	0.978	0.9
16	Revenue Dynamic	0.3	0.7
17	Annual Cost Reduction Policy	0.85	0.7
18	Cost-Cutting Policy	0.96	0.7
19	Sales Export Share	0.7871	0.7
20	Inventory Turnover	0.65	0.5
21	Cash to Cash Cycle Time	0.37	0.5
22	Average Employee Salary Levels	0.53	0.5
	Overall Average	**0.7072**	

	OPERATIONAL	actual	reference
23	Incident Informing Procedure	0.92	0.9
24	Transportation Cost	0.984	0.7
25	Total Logistic Cost Contribution	0.981	0.7
26	Inventory Accuracy	0.9875	0.5
27	ABC Analysis	0.68	0.5
28	Total Inventory Flows	0.84	0.5
29	Information Sharing	0.91	0.5
	Overall Average	**0.9004**	

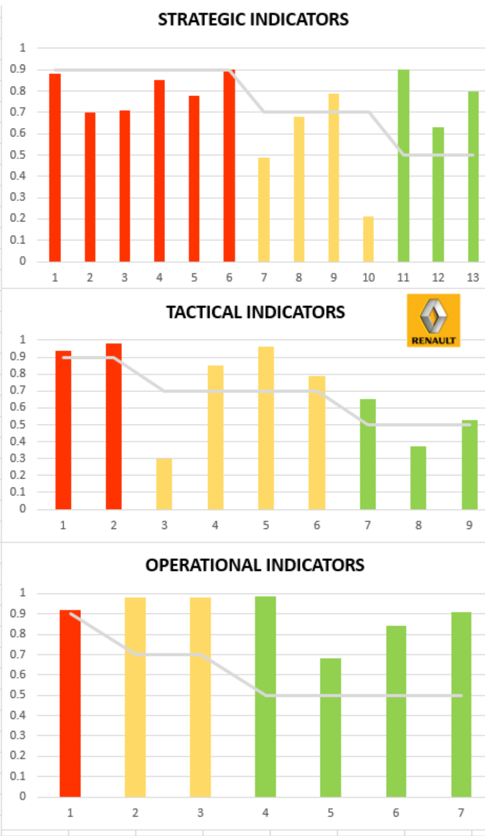


Figure 4.7. Renault's management KPIs on strategic, tactical and operational level

Internal performance is where Dacia outperforms the Douai factory, with a 0.81 value on operational level and 0.78 and 0.71 for indicators on tactical and strategic level as is shown in figure 4.8 below. This performance level is supported by the fact that only 6 KPIs out of the 23 do not meet the reference targets. There are 3 strategic (out of 9), 2 tactical (out of 7) and 1 operational indicator (out of 7) that do not comply with the established target values.

Renault on the other hand is only a 3 percentage point difference away from the Romanian brand's performance with 0.78 for the operational level and 0.68 for the strategic one, with the tactical level being almost 17 percentage points behind at 0.61 (see figure 4.9). Although Renault is easily outperformed by Dacia within this KPI category, the French carmaker has only 7 internal performance KPIs out of 23 that do not meet reference targets, only one more than its outperforming group brand. Thus the Douai facility has 3 strategic (out of 9), 3 tactical (out of 7) and 1 operational indicators (out of 7) that do not comply with the pre-set reference targets.

	STRATEGIC	actual	reference
1	Labor Productivity	0.968	0.9
2	Absenteeism Rate	0.9812	0.9
3	Employee Turnover Rate	0.991	0.9
4	Work-Study Employment	0.98	0.9
5	Ergonomic Rating in Workstations	0.71	0.7
6	Profit/Employee	0.666	0.7
7	Profit/Sold Car	0.21	0.7
8	Employee Improvement Suggestions	0.65	0.5
9	GDP Contribution	0.28	0.5
	Overall Average	0.7151	

	TACTICAL	actual	reference
10	New Hires Rate	0.995	0.9
11	Women in Managing Positions	0.28	0.7
12	Employee Enablement	0.66	0.7
13	Internal Performance Index	1	0.5
14	Production Performance Rate	0.994	0.5
15	Resource Utilization Index	0.998	0.5
16	Employee Yearly Training Plan	0.59	0.5
	Overall Average	0.7881	

	OPERATIONAL	actual	reference
17	Work accidents rate	0.954	0.9
18	Lost Time Accidents	0.974	0.9
19	Occupational illness rate	0.9556	0.7
20	Performance Alignment	0.834	0.7
21	Disabled Employees	0.398	0.5
22	Employee Motivation	0.72	0.5
23	Job Satisfaction Measurement	0.88	0.5
	Overall Average	0.8165	

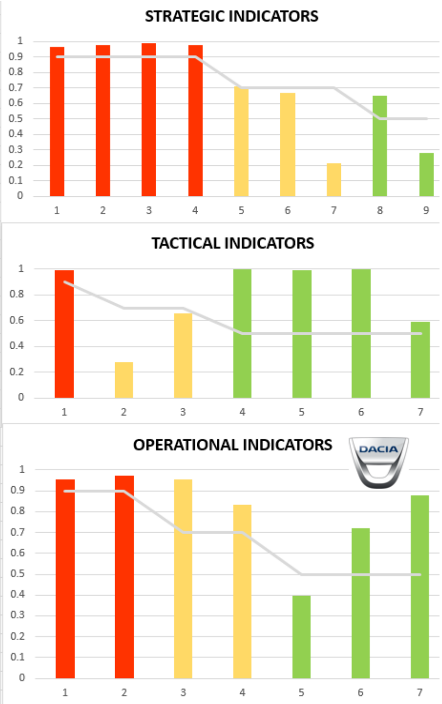


Figure 4.8. Dacia's internal performance KPIs on strategic, tactical and operational level

	STRATEGIC	actual	reference
1	Labor Productivity	0.36	0.9
2	Absenteeism Rate	0.9703	0.9
3	Employee Turnover Rate	0.93	0.9
4	Work-Study Employment	0.95	0.9
5	Ergonomic Rating in Workstations	0.73	0.7
6	Profit/Employee	0.75	0.7
7	Profit/Sold Car	0.42	0.7
8	Employee Improvement Suggestions	0.87	0.5
9	GDP Contribution	0.19	0.5
	Overall Average	0.6856	

	TACTICAL	actual	reference
10	New Hires Rate	0.916	0.9
11	Women in Managing Positions	0.22	0.7
12	Employee Enablement	0.66	0.7
13	Internal Performance Index	0.545	0.5
14	Production Performance Rate	0.997	0.5
15	Resource Utilization Index	0.41	0.5
16	Employee Yearly Training Plan	0.59	0.5
	Overall Average	0.6197	

	OPERATIONAL	actual	reference
17	Work accidents rate	0.954	0.9
18	Lost Time Accidents	0.974	0.9
19	Occupational illness rate	0.9556	0.7
20	Performance Alignment	0.6636	0.7
21	Disabled Employees	0.398	0.5
22	Employee Motivation	0.72	0.5
23	Job Satisfaction Measurement	0.82	0.5
	Overall Average	0.7836	

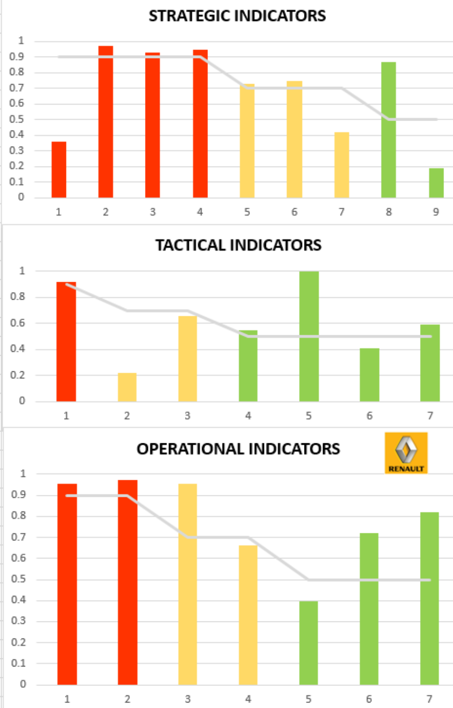


Figure 4.9. Renault's internal performance KPIs on strategic, tactical and operational level

Summarizing results, one can observe that on a strategic level, Renault perform better in logistics and management, with Dacia having an improved operational performance. Tactically the Romanian brand has the edge over the French carmaker in management and internal performance, whereas Renault has superior logistics performance. On operational level, Dacia outperforms Renault in internal performance, but the losange brand surpasses Dacia in logistics and management, as was the case on strategic level.

4.2.1. Logistics performance analysis

The logistics KPIs with short-term impact generate the largest gap between the performance of the two companies, as Renault average a score of 0.84, whereas Dacia are 20 percentage points back with 0.64 as is shown in figure 4.10 and 4.11 below. This important gap is mainly due to the extent to which the two plants in Douai and Mioveni are currently working, to their place within the Renault-Nissan strategy and to their different support from their logistics infrastructure.

The main KPIs that contribute to this gap are Upside Supply Chain Flexibility and Upside Supply Chain Adaptability. The facility in Mioveni currently has a productivity level of almost 97% which in turn creates scarce space for fulfilling unexpected customer demand as would be required by a 20% increase in customer demand. This situation however had already occurred for Dacia after first launching the Duster model in 2010, when customer demand had surpassed estimates and waiting times reached six months for the current top model of the brand. Even today with a reserve of only 11,000 vehicles from maximum capacity the plant would still need half a year to fulfill an extra 20% of the current 28,250 cars monthly average generated by workers at Dacia.

Similarly to the rigid flexibility of the plant, the upside adaptability of the factory in Romania is also limited, as within current activity the plant is able to achieve only a 3.25% increase in monthly output, which is much below the possibilities the Douai factory can achieve. This is also due to the fact that the Renault plant from Northern France is currently running under capacity with a productivity level of under 40%. Although recent plans from the Renault-Nissan Alliance will significantly raise productivity levels of the site, today its low output and activity level allow it to easily sustain a possible flexibility challenge of increasing production by 20% within just 4 working days or being able to adapt to a monthly increase in output of 17.5% without any form of extra cost incurrences.

This also explains the 8 percentage point difference in Urgent Delivery Responsiveness between the two factories, which also indirectly shows the capacity of Dacia plant to cope quite well with current activity volumes and assure an effective performance display. This is remarkable also when considering the fact that the Romanian plant’s process integration and cooperation with its suppliers is significantly lower than that of the Renault plant in Douai (0.6 as opposed to 0.87). Interestingly the factory in Mioveni has a better customer service level, with almost 2 percentage points higher than Renault in Perfect Order Fulfillment, as well as better departure accuracy (0.81 as opposed to 0.74).

The constant high volumes generated by Dacia allow it to outperform the Douai factory in Downside Supply Chain Adaptability with 30 percentage points as the Romanian facility can support a 17% decrease in ordered quantities from its suppliers that can be sustained with no inventory or cost penalties, whereas in France, the Renault site can only impose a 5% increase.

CATEGORY SUMMARY		
	Category	LOGISTICS
	Impact	short-term

LOGISTICS	actual	*reference*
1 Perfect Order Fulfillment	0.941	0.9
6 Process Integration/Cooperation	0.6	0.9
4 Innovative Product Development Cycle	0.84	0.9
8 Upside SC Flexibility	0	0.9
7 Upside SC Adaptability	0.1625	0.9
2 Downside SC Adaptability	0.925	0.9
5 Departure Accuracy	0.81	0.9
3 Urgent Delivery Responsiveness	0.85	0.9
Overall Average	0.6411	

LOGISTICS	actual	reference	average	critical
1 Perfect Order Fulfillment	0.941	0.9	0.641	0.6
2 Downside SC Adaptability	0.925	0.9	0.641	0.6
3 Urgent Delivery Responsiveness	0.85	0.9	0.641	0.6
4 Innovative Product Development Cycle	0.84	0.9	0.641	0.6
5 Departure Accuracy	0.81	0.9	0.641	0.6
6 Process Integration/Cooperation	0.6	0.9	0.641	0.6
7 Upside SC Adaptability	0.163	0.9	0.641	0.6
8 Upside SC Flexibility	0	0.9	0.641	0.6

OVERALL AVERAGE		
	Target value	0.9
	Critical level	0.6
0.6411	Result status and interpretation	
	if objective is achieved	✓
	if objective **needs revising**	!
	if objective is failed	✗

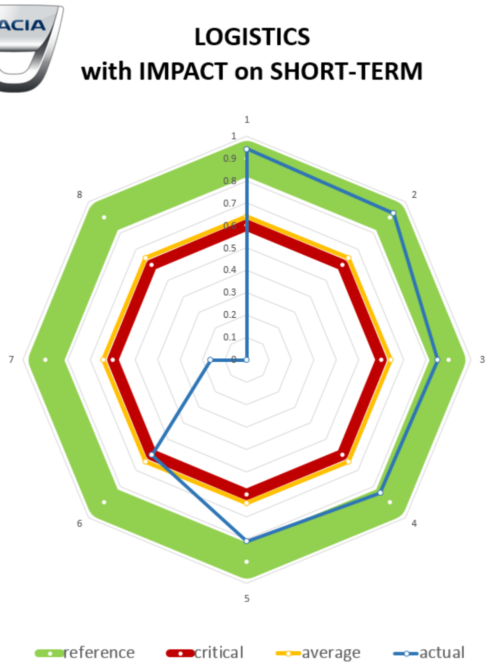


Figure 4.10. Dacia's logistics KPIs with short-term impact

CATEGORY SUMMARY		
	Category	LOGISTICS
	Impact	short-term

LOGISTICS	actual	*reference*
3 Perfect Order Fulfillment	0.923	0.9
5 Process Integration/Cooperation	0.87	0.9
6 Innovative Product Development Cycle	0.86	0.9
2 Upside SC Flexibility	0.928	0.9
4 Upside SC Adaptability	0.875	0.9
8 Downside SC Adaptability	0.625	0.9
7 Departure Accuracy	0.74	0.9
1 Urgent Delivery Responsiveness	0.93	0.9
Overall Average	0.8439	

LOGISTICS	actual	reference	average	critical
1 Urgent Delivery Responsiveness	0.93	0.9	0.844	0.6
2 Upside SC Flexibility	0.928	0.9	0.844	0.6
3 Perfect Order Fulfillment	0.923	0.9	0.844	0.6
4 Upside SC Adaptability	0.875	0.9	0.844	0.6
5 Process Integration/Cooperation	0.87	0.9	0.844	0.6
6 Innovative Product Development Cycle	0.86	0.9	0.844	0.6
7 Departure Accuracy	0.74	0.9	0.844	0.6
8 Downside SC Adaptability	0.625	0.9	0.844	0.6

OVERALL AVERAGE		
	Target value	0.9
	Critical level	0.6
0.8439	Result status and interpretation	
	if objective is achieved	✓
	if objective **needs revising**	!
	if objective is failed	✗

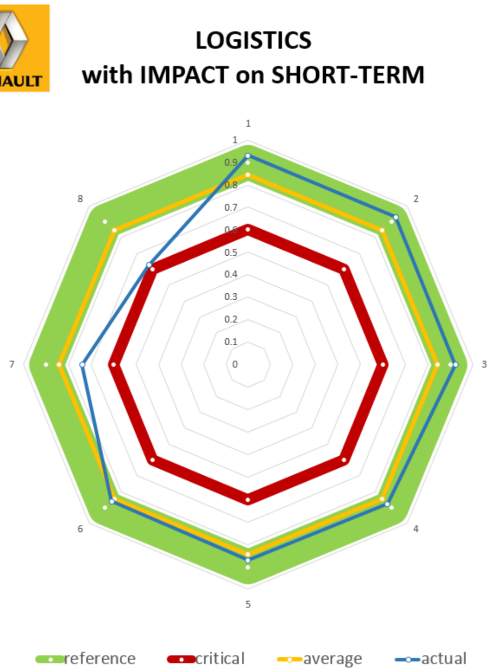


Figure 4.11. Renault's logistics KPIs with short-term impact

The logistics KPIs with medium-term impact also work in favor of Renault as the French carmaker outperforms Dacia by 8 percentage points with a performance average of 0.85 as opposed to 0.77 for this category (see figure 4.12 and 4.13 below). Within this category the difference between the two manufacturers is made by four out of the ten indicators, where the plant in Douai has better performance: Green Products Index, Clean Production Techniques Usage, Supply Chain Cycle Time and Data Interchange Delivery.

Renault is the European car manufacturer with the widest range of environmentally friendly vehicles with the electric Zoe and Twizy or its Zero Emissions versions of the Fluence and Kangoo which are part of the losange brand's development strategy and contribute to the 0.91 score achieved for this indicator. The Dacia brand however, although part of the Group, does not yet focus on this type of vehicles and has only some eco-friendly versions of the classic model range and improved environmental care within the manufacturing process. The Logan and Sandero models can be purchased in an eco2 version with lower CO_2 emissions, 95% of the vehicle mass that can be recycled and with at least 7% of the plastic material to be made from recycled material. With the aid of the French Group's environmental policy, Dacia scores 0.71 for the Green Products Index. In this regard Clean Production Techniques Usage is also applied to a different extent by the two factories as in Douai the indicator achieves a value of 0.88, whereas in Mioveni it is 9 percentage points lower, due to the high amount of manual labor which is still performed at the Romanian plant, where currently only 5% of production is automatized.

Renault has a lead time of 4-5 weeks for the Clio, Scenic and Megane models, whilst Dacia has an average lead time of 7-8 weeks for its brand models. This generates a difference of almost 8 percentage points, the same as the overall average for this category as Renault scores 0.89 compared to Dacia's 0.82. The Supply Chain Cycle Time further broadens the differences between the two companies as the Renault factory in Douai scores 0.76, 11 percentage points more than the facility in Mioveni, due to the fact that the French factory would need only an extra 3 weeks to fulfill an order if inventory levels were zero, whereas the Romanian plant would need one and a half weeks more than Renault Douai.

The French car manufacturer also has a better Data Interchange Delivery system which allows for faster and more reliable communication with its suppliers and scores 0.93 as opposed to Dacia which scores a 16 percentage point lower 0.77, mainly due to structure and networking differences of its supply chain. The two brands score very similar scores for Flexibility of Service Systems, Delivery Balancing, Delivery Schedule Planning and for the Transport Service Rate, which is somehow normal as they both are part of the Renault Group and integrate a common modus operandi in certain areas. Delivery Performance Cycle Time values are also very close one to the other, but this is mainly due to the fact that some Renault models have longer than average waiting times (as the Captur or the electric vehicles) which may even reach 16 weeks or more and thus reduce the difference in performance between the two carmakers.

CATEGORY SUMMARY	Category	LOGISTICS
	Impact	medium-term

	LOGISTICS	actual	reference
3	Lead Time	0.82	0.7
8	Green Products Index	0.71	0.7
10	Supply Chain Cycle Time	0.65	0.7
4	Clean Production Techniques Usage	0.79	0.7
9	Flexibility of Service Systems	0.66	0.7
2	Delivery Balancing	0.86	0.7
5	Delivery Schedule Planning	0.78	0.7
7	Delivery Performance Cycle Time	0.769	0.7
1	Transport Service Rate	0.98	0.7
6	Data Interchange Delivery	0.77	0.7
	Overall Average	0.7789	

	LOGISTICS	actual	reference	average	critical
1	Transport Service Rate	0.98	0.7	0.779	0.47
2	Delivery Balancing	0.86	0.7	0.779	0.47
3	Lead Time	0.82	0.7	0.779	0.47
4	Clean Production Techniques Usage	0.79	0.7	0.779	0.47
5	Delivery Schedule Planning	0.78	0.7	0.779	0.47
6	Data Interchange Delivery	0.77	0.7	0.779	0.47
7	Delivery Performance Cycle Time	0.769	0.7	0.779	0.47
8	Green Products Index	0.71	0.7	0.779	0.47
9	Flexibility of Service Systems	0.66	0.7	0.779	0.47
10	Supply Chain Cycle Time	0.65	0.7	0.779	0.47

OVERALL AVERAGE	Target value	0.7
	Critical level	0.466666667
0.7789	Result status and interpretation	
	if objective is achieved	
	if objective needs revising	
	if objective is failed	

DACIA

LOGISTICS
with IMPACT on MEDIUM-TERM

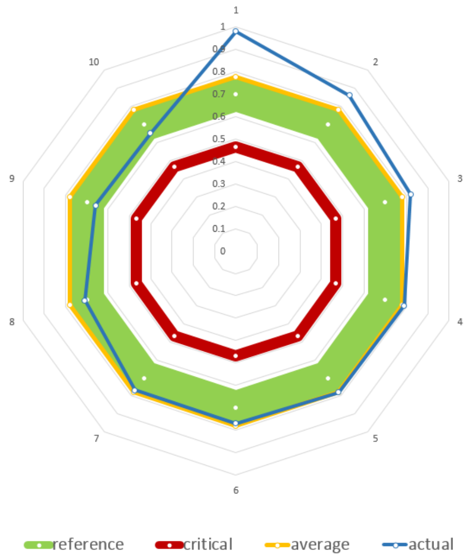


Figure 4.12. Dacia's logistics KPIs with medium-term impact

CATEGORY SUMMARY	Category	LOGISTICS
	Impact	medium-term

	LOGISTICS	actual	reference
4	Lead Time	0.896	0.7
3	Green Products Index	0.91	0.7
9	Supply Chain Cycle Time	0.76	0.7
6	Clean Production Techniques Usage	0.88	0.7
10	Flexibility of Service Systems	0.68	0.7
5	Delivery Balancing	0.89	0.7
7	Delivery Schedule Planning	0.83	0.7
8	Delivery Performance Cycle Time	0.805	0.7
1	Transport Service Rate	0.98	0.7
2	Data Interchange Delivery	0.93	0.7
	Overall Average	0.8561	

	LOGISTICS	actual	reference	average	critical
1	Transport Service Rate	0.98	0.7	0.856	0.47
2	Data Interchange Delivery	0.93	0.7	0.856	0.47
3	Green Products Index	0.91	0.7	0.856	0.47
4	Lead Time	0.896	0.7	0.856	0.47
5	Delivery Balancing	0.89	0.7	0.856	0.47
6	Clean Production Techniques Usage	0.88	0.7	0.856	0.47
7	Delivery Schedule Planning	0.83	0.7	0.856	0.47
8	Delivery Performance Cycle Time	0.805	0.7	0.856	0.47
9	Supply Chain Cycle Time	0.76	0.7	0.856	0.47
10	Flexibility of Service Systems	0.68	0.7	0.856	0.47

OVERALL AVERAGE	Target value	0.7
	Critical level	0.466666667
0.8561	Result status and interpretation	
	if objective is achieved	
	if objective needs revising	
	if objective is failed	

RENAULT

LOGISTICS
with IMPACT on MEDIUM-TERM

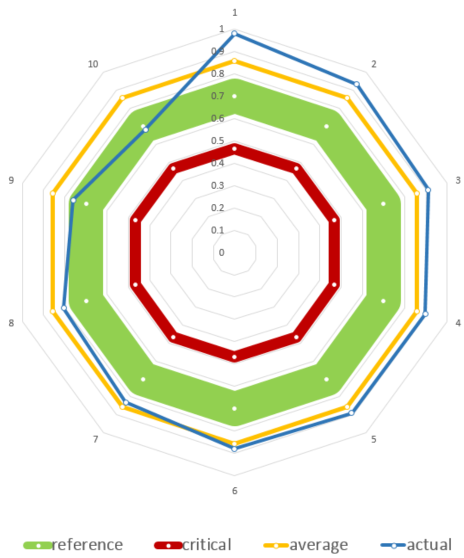


Figure 4.13. Renault's logistics KPIs with medium-term impact

The logistics KPIs with long-term impact of Renault are again performing overall better than those of Dacia by just under 13 percentage points, as the losange brand scores 0.80, as shown in figures 4.14 and 4.15, compared to the Romanian brand's 0.67. In this category Renault outperforms Dacia in every indicator, but the French carmaker manages to achieve this mainly due to four of the 11 indicators in question: Carbon Emissions per Vehicle, Reuse Used Products, Buy-Back Policy and Supplier Performance Cycle Time.

In this category the first important difference is brought about by the average carbon emissions generated by the Renault models, which is of only 108.4 g/km as opposed to Dacia's average of only 125.8 g/km. This brings about the difference of 24 percentage points between the two brands and also shows Renault's commitment towards the environment as the French manufacturer easily fulfills the EU's 2015 emissions criteria and is close to meeting even the 2020 environmental target of 95 g/km. In 2014 the average carbon emissions of new cars were 124.6 g/km, almost 5% better than this year's target of 130 g/km, but which is still 20% lower than those of all cars actually driving in traffic (156,6 g/km). Renault also uses 10% more of its products from the Douai plant than the Mioveni facility and also has an improved Buy-Back Policy. In France customers are keen on selling their old cars to a dealer for a price reduction on a new car as part of the deal, which allows for a more practical disposal of the vehicle, an important reduction in the purchase price and a faster process than that of independently selling the used car and dealing with associated formalities.

This allows for time savings as well and is preferred by the majority of the French customers as offers are competitive, although the independent sales are also picking up within recent years. In Romania however such policies are scarce and are limited in their extent as the vast majority of customers prefer to sell their cars independently or postpone changing their cars after the introduction of the mandatory environmental stamp which has put a further barrier to the dynamics of the national car market. The only incentive which proves helpful is the Rabla program, which encourages scrapping used vehicles and provides a voucher of almost 1.500 euros for those who want to purchase a new car. The Supplier Performance Cycle Time indicator of Renault is also 12 percentage points better than that of Dacia (0.67 compared to 0.55) as the Douai plant usually gets its supplies in an average 1.3 weeks, whereas Mioveni in around 1.8 weeks, which is normal when considering the supply chain network, collaboration and integration differences and the associated infrastructure.

CATEGORY SUMMARY

Category	LOGISTICS
Impact	long-term

#	LOGISTICS	actual	*reference*
3	Energy Consumption Reduction	*0.88*	0.5
2	Waste Reduction	*0.92*	0.5
7	Carbon Emission per Vehicle	*0.56*	0.5
5	Reuse Used Products	*0.85*	0.5
10	Recycle Used Products	*0.31*	0.5
11	Buy-Back Policy	*0.25*	0.5
1	Customer Order Taking	*0.96*	0.5
8	Supplier Performance Cycle Time	*0.55*	0.5
6	Arrival Accuracy	*0.82*	0.5
4	Production Capacity Analysis	*0.86*	0.5
9	Total Production Cycle Time	*0.5*	0.5
	Overall Average	**0.6782**	

#	LOGISTICS	actual	reference	average	critical
1	Customer Order Taking	0.96	0.5	0.678	0.33
2	Waste Reduction	0.92	0.5	0.678	0.33
3	Energy Consumption Reduction	0.88	0.5	0.678	0.33
4	Production Capacity Analysis	0.86	0.5	0.678	0.33
5	Reuse Used Products	0.85	0.5	0.678	0.33
6	Arrival Accuracy	0.82	0.5	0.678	0.33
7	Carbon Emission per Vehicle	0.56	0.5	0.678	0.33
8	Supplier Performance Cycle Time	0.55	0.5	0.678	0.33
9	Total Production Cycle Time	0.5	0.5	0.678	0.33
10	Recycle Used Products	0.31	0.5	0.678	0.33
11	Buy-Back Policy	0.25	0.5	0.678	0.33

OVERALL AVERAGE		
✓ **0.6782**	*Target value*	*0.5*
	Critical level	*0.333333333*
	Result status and interpretation	
	if objective is **achieved**	✓
	if objective **needs revising**	!
	if objective is **failed**	✗

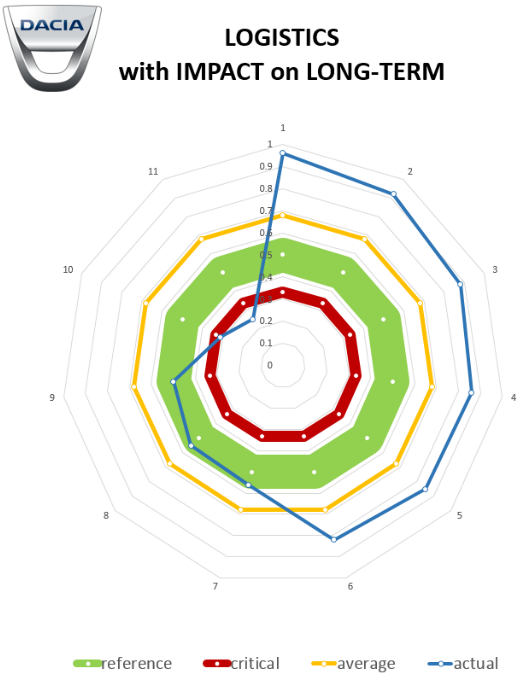


Figure 4.14. Dacia's logistics KPIs with long-term impact

CATEGORY SUMMARY

Category	LOGISTICS
Impact	long-term

#	LOGISTICS	actual	*reference*
5	Energy Consumption Reduction	*0.93*	0.5
2	Waste Reduction	*0.96*	0.5
8	Carbon Emission per Vehicle	*0.808*	0.5
3	Reuse Used Products	*0.95*	0.5
11	Recycle Used Products	*0.31*	0.5
4	Buy-Back Policy	*0.94*	0.5
1	Customer Order Taking	*0.965*	0.5
9	Supplier Performance Cycle Time	*0.675*	0.5
7	Arrival Accuracy	*0.88*	0.5
6	Production Capacity Analysis	*0.92*	0.5
10	Total Production Cycle Time	*0.53*	0.5
	Overall Average	**0.8062**	

#	LOGISTICS	actual	reference	average	critical
1	Customer Order Taking	0.965	0.5	0.806	0.33
2	Waste Reduction	0.96	0.5	0.806	0.33
3	Reuse Used Products	0.95	0.5	0.806	0.33
4	Buy-Back Policy	0.94	0.5	0.806	0.33
5	Energy Consumption Reduction	0.93	0.5	0.806	0.33
6	Production Capacity Analysis	0.92	0.5	0.806	0.33
7	Arrival Accuracy	0.88	0.5	0.806	0.33
8	Carbon Emission per Vehicle	0.808	0.5	0.806	0.33
9	Supplier Performance Cycle Time	0.675	0.5	0.806	0.33
10	Total Production Cycle Time	0.53	0.5	0.806	0.33
11	Recycle Used Products	0.31	0.5	0.806	0.33

OVERALL AVERAGE		
✓ **0.8062**	*Target value*	*0.5*
	Critical level	*0.333333333*
	Result status and interpretation	
	if objective is **achieved**	✓
	if objective **needs revising**	!
	if objective is **failed**	✗

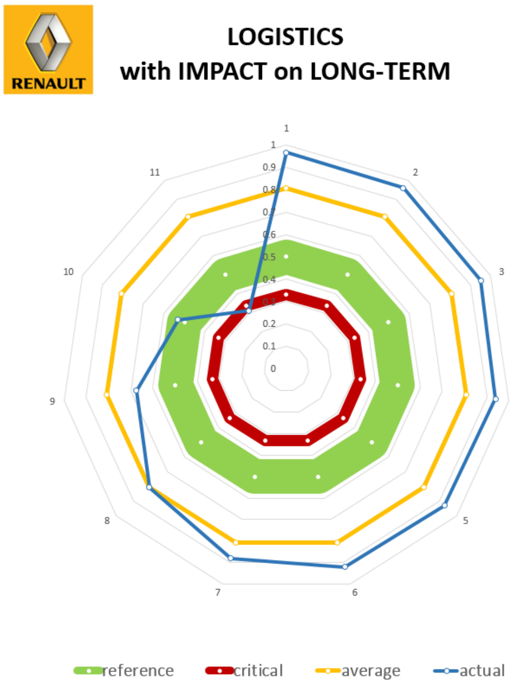


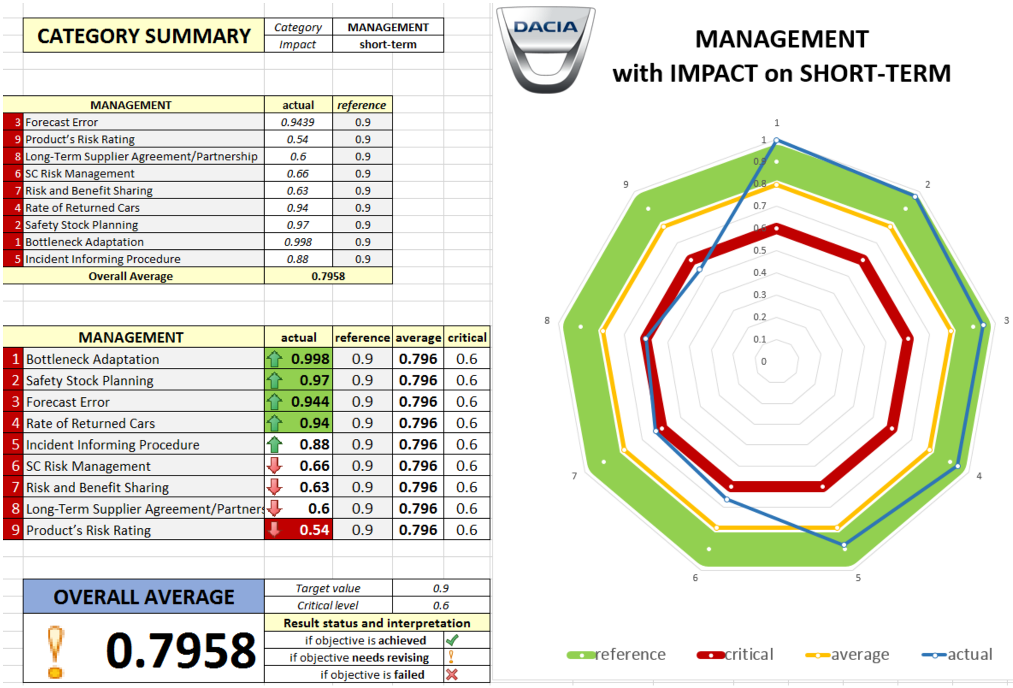
Figure 4.15. Renault's logistics KPIs with long-term impact

4.2.2. Management performance analysis

The management KPIs category is where both Renault and Dacia start to perform almost evenly with only minor differences. As opposed to the logistics category, the management KPIs with short-term impact of Renault are on average just under 5 percentage points better than Dacia, with less obvious differences than those before (see figures 4.16 and 4.17).

Renault outperforms Dacia in Supply Chain Risk Management, Product Risk Rating, Long-Term Supplier Agreement/Partnership and Risk and Benefit Sharing. Being the leading brand of the Renault Group, the French car manufacturer is also in charge of the strategies it decides to follow for the group's brands and gives more consideration to having a sound risk management plan for its manufacturing plants than to those of Dacia as shown by the 19 percentage point difference (0.85 compared to 0.66). This approach is also extended to the Product Risk Rating, where there is a 16 percentage point difference when analyzing the Renault models product risk rating to those of Dacia (0.7 compared to 0.54). This is also due to the fact that the Dacia brand models are still a forerunner in the car industry as there are still scarce competitors on the low-cost or smart-buy segment, which makes Dacia a yet unchallenged leader. However neglecting a risk analysis even in this stage can provide detrimental to the brand and a more careful analysis should be carried out in order to assess whether this approach is reasonable or whether it needs to be evened out.

The supply chain network and its structure also bring a further gap in performance, as the Long-Term Supplier Agreement/Partnership indicator for Renault scores 11 percentage points more than the one from Dacia (0.71 as opposed to 0.6). This is mainly due to the fact that Renault involves its suppliers more into research and development activities and know-how sharing than Dacia does through its quality standards and specifications. This also translates into a different scale in Risk and Benefit Sharing, where Douai outperforms Mioveni by 15 percentage points (0.78 compared to 0.63), which is an important tool in order to strengthen collaboration and the stability of business partners.



CATEGORY SUMMARY

Category	MANAGEMENT
Impact	short-term

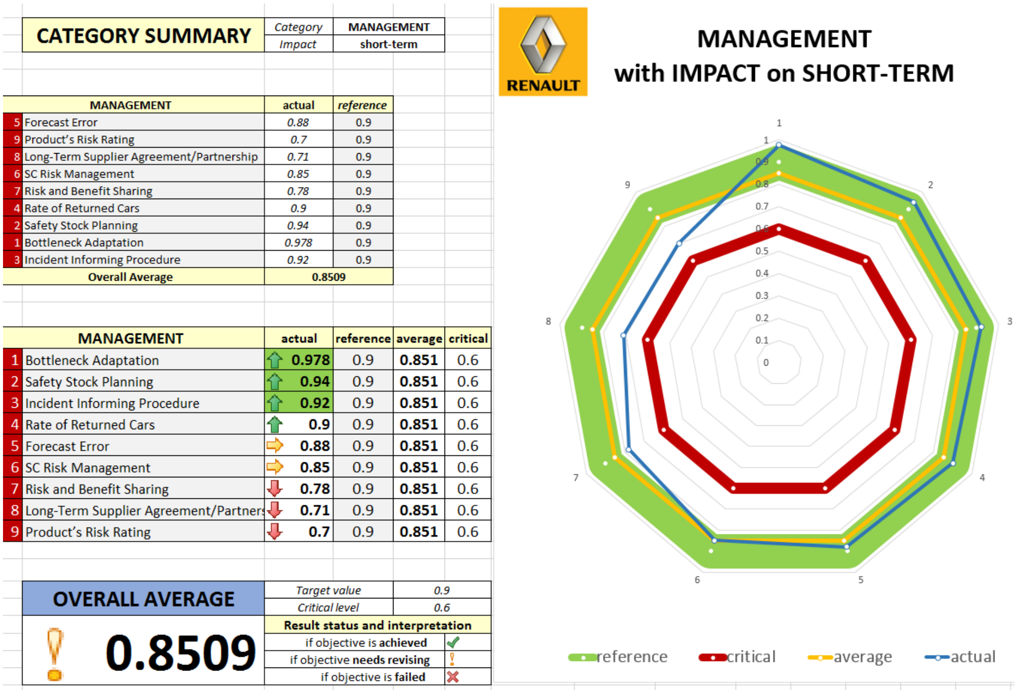
	MANAGEMENT	actual	reference
3	Forecast Error	0.9439	0.9
9	Product's Risk Rating	0.54	0.9
8	Long-Term Supplier Agreement/Partnership	0.6	0.9
6	SC Risk Management	0.66	0.9
7	Risk and Benefit Sharing	0.63	0.9
4	Rate of Returned Cars	0.94	0.9
2	Safety Stock Planning	0.97	0.9
1	Bottleneck Adaptation	0.998	0.9
5	Incident Informing Procedure	0.88	0.9
	Overall Average	0.7958	

	MANAGEMENT	actual	reference	average	critical
1	Bottleneck Adaptation	0.998	0.9	0.796	0.6
2	Safety Stock Planning	0.97	0.9	0.796	0.6
3	Forecast Error	0.944	0.9	0.796	0.6
4	Rate of Returned Cars	0.94	0.9	0.796	0.6
5	Incident Informing Procedure	0.88	0.9	0.796	0.6
6	SC Risk Management	0.66	0.9	0.796	0.6
7	Risk and Benefit Sharing	0.63	0.9	0.796	0.6
8	Long-Term Supplier Agreement/Partners	0.6	0.9	0.796	0.6
9	Product's Risk Rating	0.54	0.9	0.796	0.6

OVERALL AVERAGE 0.7958

Target value	0.9
Critical level	0.6
Result status and interpretation	
if objective is achieved	
if objective needs revising	
if objective is failed	

Figure 4.16. Dacia's management KPIs with short-term impact



CATEGORY SUMMARY

Category	MANAGEMENT
Impact	short-term

	MANAGEMENT	actual	reference
5	Forecast Error	0.88	0.9
9	Product's Risk Rating	0.7	0.9
8	Long-Term Supplier Agreement/Partnership	0.71	0.9
6	SC Risk Management	0.85	0.9
7	Risk and Benefit Sharing	0.78	0.9
4	Rate of Returned Cars	0.9	0.9
2	Safety Stock Planning	0.94	0.9
1	Bottleneck Adaptation	0.978	0.9
3	Incident Informing Procedure	0.92	0.9
	Overall Average	0.8509	

	MANAGEMENT	actual	reference	average	critical
1	Bottleneck Adaptation	0.978	0.9	0.851	0.6
2	Safety Stock Planning	0.94	0.9	0.851	0.6
3	Incident Informing Procedure	0.92	0.9	0.851	0.6
4	Rate of Returned Cars	0.9	0.9	0.851	0.6
5	Forecast Error	0.88	0.9	0.851	0.6
6	SC Risk Management	0.85	0.9	0.851	0.6
7	Risk and Benefit Sharing	0.78	0.9	0.851	0.6
8	Long-Term Supplier Agreement/Partners	0.71	0.9	0.851	0.6
9	Product's Risk Rating	0.7	0.9	0.851	0.6

OVERALL AVERAGE 0.8509

Target value	0.9
Critical level	0.6
Result status and interpretation	
if objective is achieved	
if objective needs revising	
if objective is failed	

Figure 4.17. Renault's management KPIs with short-term impact

The management KPIs with medium-term impact also work in favor of the Renault Douai factory which averages a 0.70 as shown in figures 4.18 and 4.19 below, 6 percentage points better within this category than the Mioveni plant.

Last year Renault managed a 3% sales increase, whereas Dacia increased its revenues by 2.3%, both manufacturers having good results at the end of the year. This brought about a 4.8% Profit Margin for the French carmaker, two and a half times more than its Romanian brand, which only accounted for a 1.9% margin in benefits. This is however obvious as the losange brand sells more expensive cars as Dacia, which have more added value and thus generate more benefits per unit than its low-cost group brand. The cheapest Renault models have a starting price of over 10,000 euros and can reach or even go over 40,000 euros, with an average selling price of around 22,500 euros. On the other hand, Dacia's models start at around 7,700 euros and the top model of the brand, the Duster, has a maximum selling price of around 18,500 euros with the standard version at 10,500 euros. The more expensive and better equipped models are usually sold on the foreign market, whereas locally Dacia mainly sells its models with close to average extras, the average selling price of the Romanian brand in the country being under the 10,000 euro level.

These price differences also account for the Added Value Generated by the manufacturers' Employees, as Renault scores 14 percentage points more than Dacia with 0.68 for this indicator compared to 0.54. The difference is however tightened due to the fact that the Dacia plant in Mioveni has a better overall performance and productivity than the Douai facility currently produces. When analyzing sales distribution, there is also an interesting difference between the two brands, as Renault sells more than one in five vehicles on the French market (21.2%), whereas Dacia only averages slightly over one in 20 cars (5.8%). This is rather a sensitive issue, because when a local market loses too much of its potential, it may become subject to relocation of the facility as it may no longer prove effective for the future strategy of the brand. This is not the case of the Mioveni facility, because it is of strategic importance for the Renault Group from a production, logistics and know-how point of view, but future development should be carefully analyzed to strengthen the position of the plant and maintain its competitiveness.

The balance is then reversed as Renault sells just under 80% on international markets, whereas Dacia almost reaches 95% of its half a million cars to be sold on other foreign and international markets, which has an important effect for the country's export figures and helps generate economic growth. Interestingly however the Level of Perceived Value by the Customers is quite close, as Dacia scores an impressive 0.76, only 3 percentage points lower than its French owner, which is nevertheless a subjective opinion due to customer's high expectations of the Renault brand, which sometimes may not meet their rigorous expectations, whereas with Dacia, being a cheap car, their expectations are not as high, which allows for occasional positive surprises of reliability and practicality often translating into customer value.

The other indicators within this category (Annual Cost Reduction Policy, Cost-Cutting Policy, Transportation Cost and Total Logistics Cost Contribution) have very similar values as both factories in Douai, France and Mioveni, Romania are part of the Renault Group and have the same policies when conducting regular activity. These indicators usually refer to supplier-buyer requirements of improving efficiency by reducing the price of provided materials and parts by 5% yearly, implementing lean production techniques to improve effectiveness, providing a reliable service rate, keeping a high level of the transport rate or decreasing logistics and transportation costs under the 2% target.

CATEGORY SUMMARY	Category	MANAGEMENT
	Impact	medium-term

	MANAGEMENT	actual	reference
9	Profit Margin	0.195	0.7
7	Employee Added Value Generated	0.54	0.7
6	Level of Perceived Value by Customer	0.76	0.7
10	Internal Market Share	0.058	0.7
8	Revenue Dynamic	0.23	0.7
5	Annual Cost Reduction Policy	0.84	0.7
4	Cost-Cutting Policy	0.92	0.7
3	Sales Export Share	0.942	0.7
1	Transportation Cost	0.971	0.7
2	Total Logistic Cost Contribution	0.968	0.7
	Overall Average	0.6424	

	MANAGEMENT	actual	reference	average	critical
1	Transportation Cost	0.971	0.7	0.642	0.47
2	Total Logistic Cost Contribution	0.968	0.7	0.642	0.47
3	Sales Export Share	0.942	0.7	0.642	0.47
4	Cost-Cutting Policy	0.92	0.7	0.642	0.47
5	Annual Cost Reduction Policy	0.84	0.7	0.642	0.47
6	Level of Perceived Value by Customer	0.76	0.7	0.642	0.47
7	Employee Added Value Generated	0.54	0.7	0.642	0.47
8	Revenue Dynamic	0.23	0.7	0.642	0.47
9	Profit Margin	0.195	0.7	0.642	0.47
10	Internal Market Share	0.058	0.7	0.642	0.47

OVERALL AVERAGE	Target value	0.7
	Critical level	0.466666667
0.6424	Result status and interpretation	
	if objective is achieved	✓
	if objective needs revising	!
	if objective is failed	✗

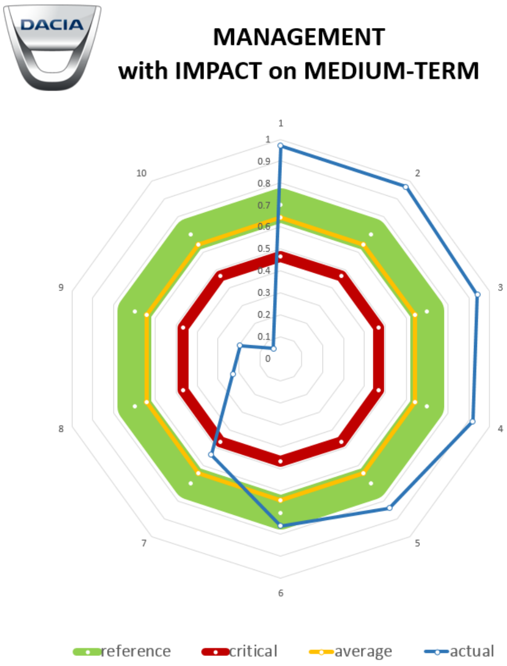


Figure 4.18. Dacia's management KPIs with medium-term impact

CATEGORY SUMMARY	Category	MANAGEMENT
	Impact	medium-term

	MANAGEMENT	actual	reference
8	Profit Margin	0.4866	0.7
7	Employee Added Value Generated	0.68	0.7
5	Level of Perceived Value by Customer	0.79	0.7
10	Internal Market Share	0.2129	0.7
9	Revenue Dynamic	0.3	0.7
4	Annual Cost Reduction Policy	0.85	0.7
3	Cost-Cutting Policy	0.96	0.7
6	Sales Export Share	0.7871	0.7
1	Transportation Cost	0.984	0.7
2	Total Logistic Cost Contribution	0.981	0.7
	Overall Average	0.7032	

	MANAGEMENT	actual	reference	average	critical
1	Transportation Cost	0.984	0.7	0.703	0.47
2	Total Logistic Cost Contribution	0.981	0.7	0.703	0.47
3	Cost-Cutting Policy	0.96	0.7	0.703	0.47
4	Annual Cost Reduction Policy	0.85	0.7	0.703	0.47
5	Level of Perceived Value by Customer	0.79	0.7	0.703	0.47
6	Sales Export Share	0.787	0.7	0.703	0.47
7	Employee Added Value Generated	0.68	0.7	0.703	0.47
8	Profit Margin	0.487	0.7	0.703	0.47
9	Revenue Dynamic	0.3	0.7	0.703	0.47
10	Internal Market Share	0.213	0.7	0.703	0.47

OVERALL AVERAGE	Target value	0.7
	Critical level	0.466666667
0.7032	Result status and interpretation	
	if objective is achieved	✓
	if objective needs revising	!
	if objective is failed	✗

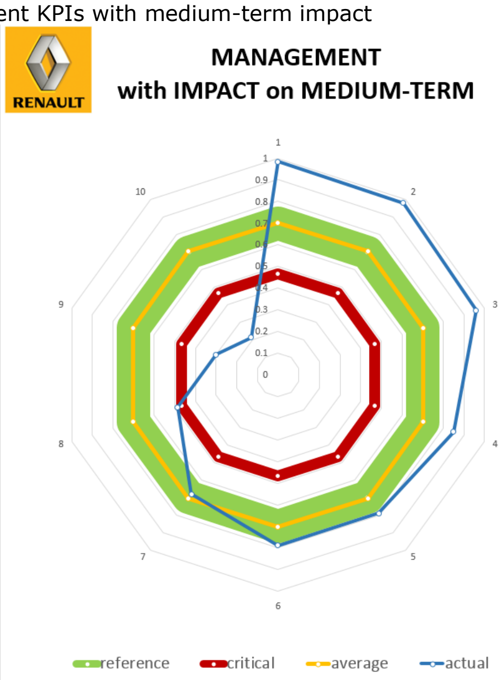


Figure 4.19. Renault's management KPIs with medium-term impact

The long-term impact management KPIs average out better overall results for Dacia than for Renault, as the Mioveni plant outperforms its French homologue from Douai by more than half a percentage point (0.73 compared to 0.72) according to figures 4.20 and 4.21.

Although Renault scores better than Dacia in four indicators, the Romanian brand compensates with two other very important indicators and thanks to the efficiency of the Mioveni plant, manages to score a better average than the leading Renault Group brand.

Renault has a better and a more in-depth collaboration and integration policy with its suppliers that enable it to achieve 12 percentage points more than Mioveni on the Supplier Risk Rating indicator (0.9 compared to 0.78). This also contributes to the better extent to which Douai conducts Information Sharing with its leading suppliers, where again 12 percentage points go in favour of the Douai facility, 0.91 as opposed to Mioveni only scoring 0.79. The fact that Renault has within the last couple of year continuously renewed and enlarged its model range shows a very keen preoccupation for meeting the automobile customer demand which allow the losange brand to score an overall 10 percentage points more than Dacia for Customer Risk Rating (0.63) and Model Strategy Plan (0.8) and also enable the same difference for Inventory Turnover, where Douai scores 0.65 as opposed to Mioveni's 0.55.

The Romanian factory however compensates for these indicators with the Cash-to-Cash Cycle Time, where surprisingly Renault has a very bad reputation of delaying payments towards its suppliers, whereas Dacia is one of the best in this regard. Although the automotive industry cycle time has considerably reduced its average within the last 15 years from nearly 60 days to around 35 days today (40% reduction), Renault delays payments towards suppliers and only averages 56 days, whereas Dacia perform better than average with 33 days.

This difference is also justified by the fact that volumes at Dacia are continuously rising, which brings cash-flow, whereas business at Renault is rather steady and sometimes liquidities may be prioritized towards other expenses. Nevertheless this state of fact gives Dacia a 26 percentage point advantage over Douai and a further 20 percentage points arise from the competitiveness of Salary Levels when compared to the national average salary. The net average salary at Dacia is at almost 3,300 lei (equivalent of 750 euros), which is almost double the national average, whereas Renault Douai has an average of 3,255 euros, which is only 50% above the French economy average of 2,128 euros. This translates into an indicator value of 0.73 for Mioveni and 0.53 for Douai.

Dacia also has more practical approach towards the ABC analysis for categorizing the importance of its stocks (0.74 indicator value) and enable a further advance of 6 percentage points which also explains the efficiency of the Romanian factory when referring to Inventory Accuracy and Total Inventory Flows, where although it has to deal with close to full capacity production, it is just one and two percentage points behind a plant operating at under 40% capacity, which is remarkable.

CATEGORY SUMMARY	Category	MANAGEMENT
	Impact	long-term

	MANAGEMENT	actual	reference
4	Supplier's Risk Rating	0.78	0.5
9	Customer's Risk Rating	0.58	0.5
5	Model Strategy Plan	0.75	0.5
10	Inventory Turnover	0.55	0.5
8	Cash to Cash Cycle Time	0.63	0.5
7	Average Employee Salary Levels	0.73	0.5
1	Inventory Accuracy	0.9775	0.5
6	ABC Analysis	0.74	0.5
2	Total Inventory Flows	0.82	0.5
3	Information Sharing	0.79	0.5
	Overall Average	0.7348	

	MANAGEMENT	actual	reference	average	critical
1	Inventory Accuracy	0.978	0.5	0.735	0.33
2	Total Inventory Flows	0.82	0.5	0.735	0.33
3	Information Sharing	0.79	0.5	0.735	0.33
4	Supplier's Risk Rating	0.78	0.5	0.735	0.33
5	Model Strategy Plan	0.75	0.5	0.735	0.33
6	ABC Analysis	0.74	0.5	0.735	0.33
7	Average Employee Salary Levels	0.73	0.5	0.735	0.33
8	Cash to Cash Cycle Time	0.63	0.5	0.735	0.33
9	Customer's Risk Rating	0.58	0.5	0.735	0.33
10	Inventory Turnover	0.55	0.5	0.735	0.33

OVERALL AVERAGE	Target value	0.5
0.7348	Critical level	0.333333333
	Result status and interpretation	
	if objective is achieved	✓
	if objective needs revising	!
	if objective is failed	✗

MANAGEMENT with IMPACT on LONG-TERM

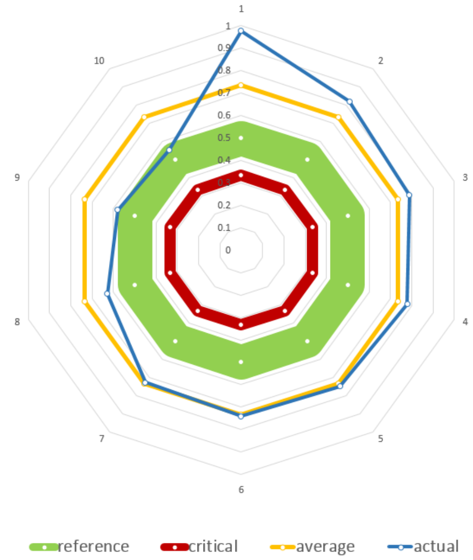


Figure 4.20. Dacia's management KPIs with long-term impact

CATEGORY SUMMARY	Category	MANAGEMENT
	Impact	long-term

	MANAGEMENT	actual	reference
3	Supplier's Risk Rating	0.9	0.5
8	Customer's Risk Rating	0.63	0.5
5	Model Strategy Plan	0.8	0.5
7	Inventory Turnover	0.65	0.5
10	Cash to Cash Cycle Time	0.37	0.5
9	Average Employee Salary Levels	0.53	0.5
1	Inventory Accuracy	0.9875	0.5
6	ABC Analysis	0.68	0.5
4	Total Inventory Flows	0.84	0.5
2	Information Sharing	0.91	0.5
	Overall Average	0.7298	

	MANAGEMENT	actual	reference	average	critical
1	Inventory Accuracy	0.988	0.5	0.73	0.33
2	Information Sharing	0.91	0.5	0.73	0.33
3	Supplier's Risk Rating	0.9	0.5	0.73	0.33
4	Total Inventory Flows	0.84	0.5	0.73	0.33
5	Model Strategy Plan	0.8	0.5	0.73	0.33
6	ABC Analysis	0.68	0.5	0.73	0.33
7	Inventory Turnover	0.65	0.5	0.73	0.33
8	Customer's Risk Rating	0.63	0.5	0.73	0.33
9	Average Employee Salary Levels	0.53	0.5	0.73	0.33
10	Cash to Cash Cycle Time	0.37	0.5	0.73	0.33

OVERALL AVERAGE	Target value	0.5
0.7298	Critical level	0.333333333
	Result status and interpretation	
	if objective is achieved	✓
	if objective needs revising	!
	if objective is failed	✗

RENAULT

MANAGEMENT with IMPACT on LONG-TERM

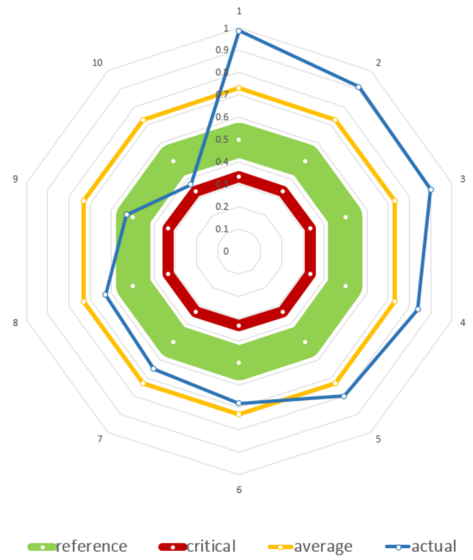


Figure 4.21. Renault's management KPIs with long-term impact

4.2.3. Internal performance analysis

The internal performance KPIs with short-term impact are the first category of indicators where Dacia considerably outperforms Renault, as the Romanian brand scores 11 percentage points more than the French carmaker (0.97 as opposed to 0.86), highlighted by figures 4.22 and 4.23.

This difference is mainly made up by the Labor Productivity indicator, where there is a massive difference between the two Renault Group factories, as the plant in Mioveni scores 60 percentage points more than the site in Douai. This is because last year Dacia produced 339,000 vehicles in Romania, just 11,000 short of full capacity, meaning a productivity rate of almost 97%, one of the most efficient manufacturing sites in the world. In Douai in turn things are somewhat different as the factory is currently running under capacity, last year only 109,121 left the factory, which only goes over one third of total capacity (36%). Starting 2016, the plant in Douai will however receive two new Renault models which will certainly boost production figures and help the factory get closer to the break-even mark. In order for a factory to prove efficient it should run at about 75% capacity, with a 60-70% level still being in certain conditions acceptable, but when going over 90% the factory produces a lot of benefits which is only possible if it is operated effectively.

Dacia also scores better than Renault when the Absenteeism Rate is considered as in Mioveni absenteeism is over one percent lower than in Douai (1.88% compared to 2.97%), which also affects the Turnover Rate of the workers. After Renault announced it would fire 7,500 employees by 2016 in France, absenteeism rose to 8% and turnover increased to 7%, whereas at Mioveni, although there were rumors of another strike, turnover was under 1% last year and the plant only employed 61 new people in 2014. This accounts for a further 3 percentage point advance of Dacia (0.99) over Renault where the new hires rate was at 8.4% last year according to the Group’s statements.

Work-Study Employment is where Renault leaps in front of Dacia with around 5% of all students taking part in internships being employed as Dacia only contracted 2% of its trainees. The other two indicators of this category are balanced out for both Renault and Dacia (Work Accidents Rate and Lost Time due to Accidents), which is also remarkable given the fact that in Douai 84% of production is automatized, whereas in Dacia automatisation is practically scarce compared to Northern France at around 5%.

CATEGORY SUMMARY

Category	PERFORMANCE
Impact	short-term

DACIA — PERFORMANCE with IMPACT on SHORT-TERM

	PERFORMANCE	actual	reference
6	Labor Productivity	0.968	0.9
3	Absenteeism Rate	0.9812	0.9
2	Employee Turnover Rate	0.991	0.9
4	Work-Study Employment	0.98	0.9
1	New Hires Rate	0.995	0.9
7	Work accidents rate	0.954	0.9
5	Lost Time Accidents	0.974	0.9
	Overall Average	0.9776	

	PERFORMANCE	actual	reference	average	critical
1	New Hires Rate	0.995	0.9	0.978	0.6
2	Employee Turnover Rate	0.991	0.9	0.978	0.6
3	Absenteeism Rate	0.981	0.9	0.978	0.6
4	Work-Study Employment	0.98	0.9	0.978	0.6
5	Lost Time Accidents	0.974	0.9	0.978	0.6
6	Labor Productivity	0.968	0.9	0.978	0.6
7	Work accidents rate	0.954	0.9	0.978	0.6

OVERALL AVERAGE

0.9776

Target value	0.9
Critical level	0.6
Result status and interpretation	
if objective is **achieved**	✓
if objective **needs revising**	!
if objective is **failed**	✗

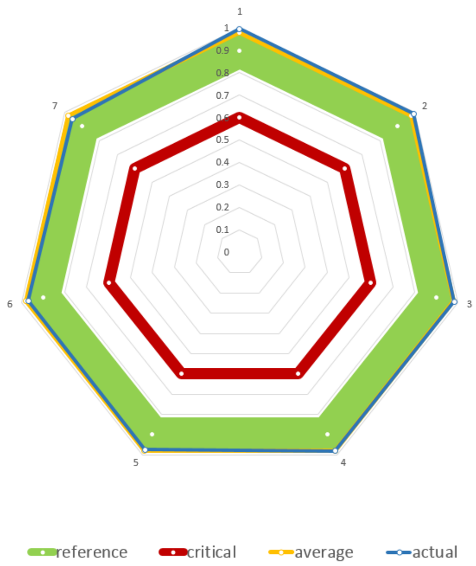


Figure 4.22. Dacia's internal performance KPIs with short-term impact

CATEGORY SUMMARY

Category	PERFORMANCE
Impact	short-term

RENAULT — PERFORMANCE with IMPACT on SHORT-TERM

	PERFORMANCE	actual	reference
7	Labor Productivity	0.36	0.9
2	Absenteeism Rate	0.9703	0.9
5	Employee Turnover Rate	0.93	0.9
4	Work-Study Employment	0.95	0.9
6	New Hires Rate	0.916	0.9
3	Work accidents rate	0.954	0.9
1	Lost Time Accidents	0.974	0.9
	Overall Average	0.8649	

	PERFORMANCE	actual	reference	average	critical
1	Lost Time Accidents	0.974	0.9	0.865	0.6
2	Absenteeism Rate	0.97	0.9	0.865	0.6
3	Work accidents rate	0.954	0.9	0.865	0.6
4	Work-Study Employment	0.95	0.9	0.865	0.6
5	Employee Turnover Rate	0.93	0.9	0.865	0.6
6	New Hires Rate	0.916	0.9	0.865	0.6
7	Labor Productivity	0.36	0.9	0.865	0.6

OVERALL AVERAGE

0.8649

Target value	0.9
Critical level	0.6
Result status and interpretation	
if objective is **achieved**	✓
if objective **needs revising**	!
if objective is **failed**	✗

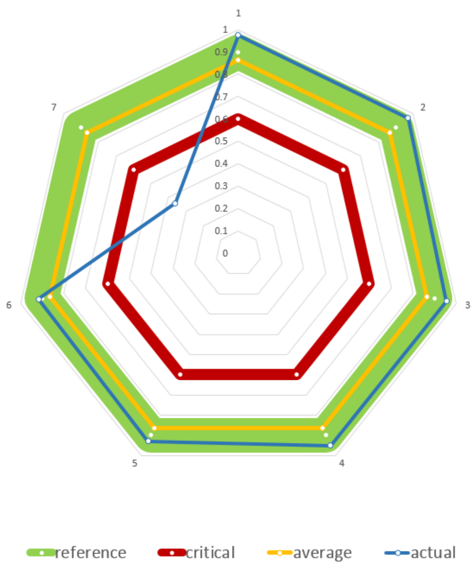


Figure 4.23. Renault's internal performance KPIs with short-term impact

The medium-term impact internal performance KPIs show only a slight overall better performance for the Renault Douai site, as it averages just 1 percentage point more than Dacia in Mioveni (0.62 as opposed to 0.61). The difference here is made by the financial performance differences brought about by the different segment in which the two car brands compete (see figures 4.24 and 4.25).

Renault scores almost 9 percentage points better than Dacia with its Profit per Employee indicator (0.75) and the indicator value of 0.42 for Profit per Sold Car means it is double that of its Romanian brand, adding a further 21 percentage points to its favor.

The Mioveni plant is however almost 17 percentage points better than the French site in Douai, as it scores 0.83 for the Performance Alignment indicator compared to Renault's 0.66. Although the French brand has significantly improved its quality compliance and reduced the gap towards the German quality standards from Mercedes from 25% to only 3%, it still underperforms in productivity, an issue which should be solved by the beginning of 2016 with the production of the New Espace and Talisman premium models in Northern France. The Romanian factory also has more Women in Managing Positions, with 28% of these positions being held by women, which is more than 20% the Renault Group average.

Interestingly the Ergonomic Rating in Workstations is only 2 percentage points lower in Mioveni than in Douai, which at a first glance may seem improbable given the totally opposite automatisation levels, but the investments Renault made in the Mioveni facility throughout the last 15 years have brought the plant to a very good performance and productivity level, which could not have been achieved without providing proper working conditions for Dacia's employees. This also accounts for Dacia balancing out Renault in Employee Enablement and for the two factories being within the Group's average performance level when referring to the Occupational Illness Rate indicator.

CATEGORY SUMMARY	Category	PERFORMANCE
	Impact	medium-term

PERFORMANCE		actual	reference
3	Ergonomic Rating in Workstations	0.71	0.7
4	Profit/Employee	0.666	0.7
7	Profit/Sold Car	0.21	0.7
6	Women in Managing Positions	0.28	0.7
5	Employee Enablement	0.66	0.7
1	Occupational illness rate	0.9556	0.7
2	Performance Alignment	0.834	0.7
	Overall Average	0.6165	

	PERFORMANCE	actual	reference	average	critical
1	Occupational illness rate	0.956	0.7	0.617	0.47
2	Performance Alignment	0.834	0.7	0.617	0.47
3	Ergonomic Rating in Workstations	0.71	0.7	0.617	0.47
4	Profit/Employee	0.666	0.7	0.617	0.47
5	Employee Enablement	0.66	0.7	0.617	0.47
6	Women in Managing Positions	0.28	0.7	0.617	0.47
7	Profit/Sold Car	0.21	0.7	0.617	0.47

OVERALL AVERAGE	Target value	0.7
	Critical level	0.466666667
0.6165	Result status and interpretation	
	if objective is achieved	✔
	if objective needs revising	!
	if objective is failed	✘

PERFORMANCE with IMPACT on MEDIUM-TERM

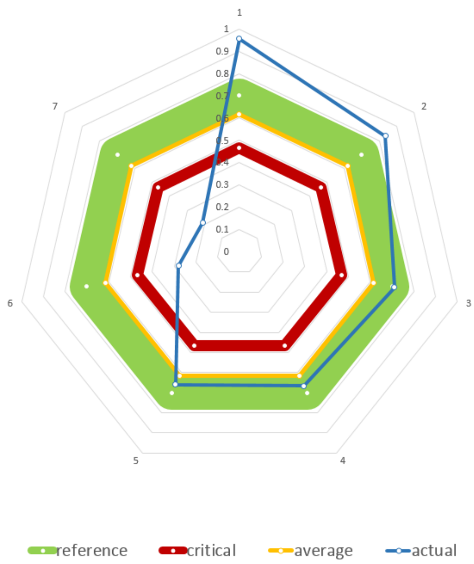


Figure 4.24. Dacia's internal performance KPIs with medium-term impact

CATEGORY SUMMARY	Category	PERFORMANCE
	Impact	medium-term

PERFORMANCE		actual	reference
3	Ergonomic Rating in Workstations	0.73	0.7
2	Profit/Employee	0.75	0.7
6	Profit/Sold Car	0.42	0.7
7	Women in Managing Positions	0.22	0.7
5	Employee Enablement	0.66	0.7
1	Occupational illness rate	0.9556	0.7
4	Performance Alignment	0.6636	0.7
	Overall Average	0.6285	

	PERFORMANCE	actual	reference	average	critical
1	Occupational illness rate	0.956	0.7	0.628	0.47
2	Profit/Employee	0.75	0.7	0.628	0.47
3	Ergonomic Rating in Workstations	0.73	0.7	0.628	0.47
4	Performance Alignment	0.664	0.7	0.628	0.47
5	Employee Enablement	0.66	0.7	0.628	0.47
6	Profit/Sold Car	0.42	0.7	0.628	0.47
7	Women in Managing Positions	0.22	0.7	0.628	0.47

OVERALL AVERAGE	Target value	0.7
	Critical level	0.466666667
0.6285	Result status and interpretation	
	if objective is achieved	✔
	if objective needs revising	!
	if objective is failed	✘

RENAULT

PERFORMANCE with IMPACT on MEDIUM-TERM

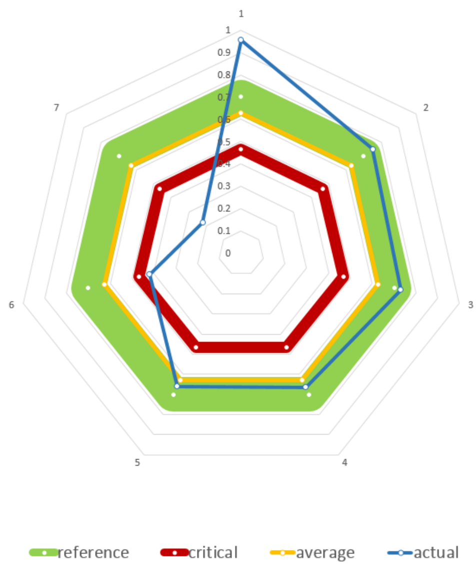


Figure 4.25. Renault's internal performance KPIs with medium-term impact

The internal performance KPIs with long-term impact is another category where Dacia performs better than the leading Renault Group brand, as it manages to achieve 11 percentage points more than the French carmaker (see figures 4.26 and 4.27).

Internal performance is where Dacia could probably compete and outperform almost any car manufacturing facility, as the plant in Mioveni has an Internal Performance Index of 1, as it not only managed to match the Planned Output for 2014, but also managed to surpass it by more than 6%. Dacia planned to make around 310-320,000 vehicles last year, but the actual output of the factory was 339,000 cars, which again shows the extent of the productivity in the Romanian plant. On the other hand with an output of around 110,000 vehicles in Douai, the plant was way below its initial set target for last year of 200,000 cars, just slightly managing to go beyond 50%. This difference also brought about a different Resource Utilization Index where Mioveni have an impressive 99,8%, whereas Douai could only achieve 41% due to its reduced volume of activity in 2014.

Dacia has a more important contribution to GDP in Romania than Renault in France, as it accounts for a 2.8% share, with the French brand lagging just 1 percent behind in the Hexagon. Surprisingly or not, Employee Motivation and Job Satisfaction Measurement are also 2 indicators where Dacia outperforms Renault, by 17 percentage points in motivation (0.83) and 6 percentage points in job satisfaction (0.88). Nevertheless Renault wins important points back as its Employee Improvement Suggestions indicator (0.87) overtakes Dacia by not less than 22 percentage points.

The factory in Douai also has a better Production Performance Index, with a Defect Rate of just 0.3%, twice as low as the one Dacia has in Mioveni of 0,6%, whereas the Employee Yearly Training Plan and the Disabled Employee indicator are average out for the entire Renault Group.

CATEGORY SUMMARY	*Category*	PERFORMANCE
	Impact	long-term

	PERFORMANCE	actual	*reference*
6	Employee Improvement Suggestions	*0.65*	0.5
9	GDP Contribution	*0.28*	0.5
1	Internal Performance Index	*1*	0.5
3	Production Performance Rate	*0.994*	0.5
2	Resource Utilization Index	*0.998*	0.5
7	Employee Yearly Training Plan	*0.59*	0.5
8	Disabled Employees	*0.398*	0.5
5	Employee Motivation	*0.72*	0.5
4	Job Satisfaction Measurement	*0.88*	0.5
	Overall Average	**0.7233**	

	PERFORMANCE	actual	reference	average	critical
1	Internal Performance Index	1	0.5	**0.723**	0.33
2	Resource Utilization Index	0.998	0.5	**0.723**	0.33
3	Production Performance Rate	0.994	0.5	**0.723**	0.33
4	Job Satisfaction Measurement	0.88	0.5	**0.723**	0.33
5	Employee Motivation	0.72	0.5	**0.723**	0.33
6	Employee Improvement Suggestions	0.65	0.5	**0.723**	0.33
7	Employee Yearly Training Plan	0.59	0.5	**0.723**	0.33
8	Disabled Employees	0.398	0.5	**0.723**	0.33
9	GDP Contribution	0.28	0.5	**0.723**	0.33

OVERALL AVERAGE	*Target value*	*0.5*
	Critical level	*0.333333333*
0.7233	**Result status and interpretation**	
	if objective is **achieved**	✓
	if objective **needs revising**	!
	if objective is **failed**	✗

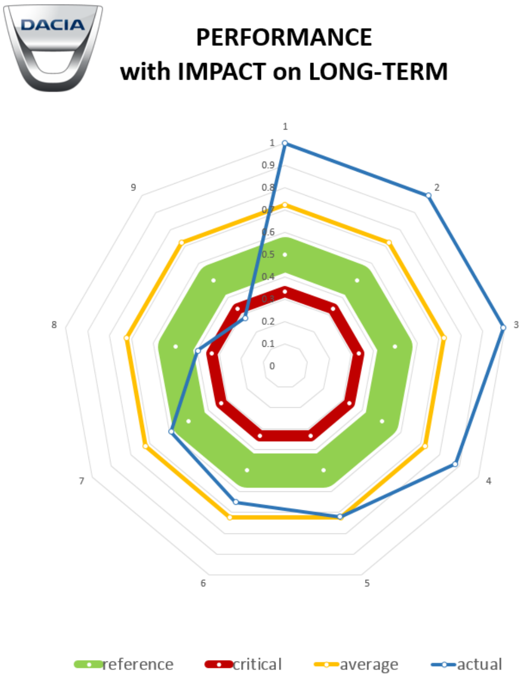


Figure 4.26. Dacia's internal performance KPIs with long-term impact

CATEGORY SUMMARY	*Category*	PERFORMANCE
	Impact	long-term

	PERFORMANCE	actual	*reference*
2	Employee Improvement Suggestions	*0.87*	0.5
9	GDP Contribution	*0.19*	0.5
6	Internal Performance Index	*0.545*	0.5
1	Production Performance Rate	*0.997*	0.5
7	Resource Utilization Index	*0.41*	0.5
5	Employee Yearly Training Plan	*0.59*	0.5
8	Disabled Employees	*0.398*	0.5
4	Employee Motivation	*0.72*	0.5
3	Job Satisfaction Measurement	*0.82*	0.5
	Overall Average	**0.6156**	

	PERFORMANCE	actual	reference	average	critical
1	Production Performance Rate	0.997	0.5	**0.616**	0.33
2	Employee Improvement Suggestions	0.87	0.5	**0.616**	0.33
3	Job Satisfaction Measurement	0.82	0.5	**0.616**	0.33
4	Employee Motivation	0.72	0.5	**0.616**	0.33
5	Employee Yearly Training Plan	0.59	0.5	**0.616**	0.33
6	Internal Performance Index	0.545	0.5	**0.616**	0.33
7	Resource Utilization Index	0.41	0.5	**0.616**	0.33
8	Disabled Employees	0.398	0.5	**0.616**	0.33
9	GDP Contribution	0.19	0.5	**0.616**	0.33

OVERALL AVERAGE	*Target value*	*0.5*
	Critical level	*0.333333333*
0.6156	**Result status and interpretation**	
	if objective is **achieved**	✓
	if objective **needs revising**	!
	if objective is **failed**	✗

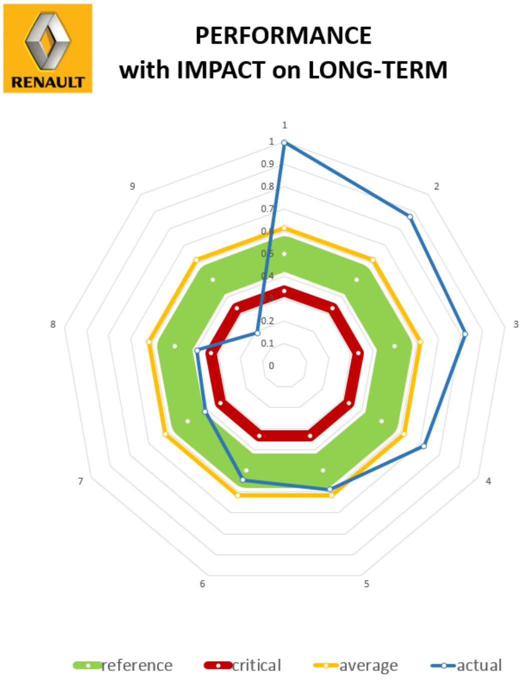


Figure 4.27. Renault's internal performance KPIs with long-term impact

The performance analysis tool then provides a summary of the results for each category on a numerical level, emphasizing overall logistics, management and internal performance assessment as well as an overview of performance on short-, medium- and long-term for both car manufacturers. Renault outperforms Dacia on short- and medium-term overall indicator impact by 6 percentage points, but Dacia has overall better indicator performance on long-term impacted KPIs. Renault has better short-term performance in logistics and management, with internal performance being the asset of Dacia on the more immediate impacted indicators. Medium-term performance is where Renault beats Dacia overall, with all 3 categories being better within the losange plant in Douai than within the Romanian plant in Mioveni, although the internal performance difference between the two facilities is of just 1 percentage point. On the long-term impacted indicators, Dacia outperforms Renault in management and internal performance with logistics being the asset of the French carmaker. These results are highlighted in figures 4.28 and 4.29 above.

To summarize the results of the performance analysis (see figures 4.30 and 4.31), Renault has a higher degree of achieving target values for the logistics indicators (0.83 compared to 0.70 for Dacia), the management KPIs are rather balanced as Dacia's overall score of 0.72 is only 3 percentage points behind the leading Renault Group brand, whereas the Romanian carmaker outperforms the losange brand in overall internal performance by 7 percentage points (0.76 as opposed to 0.69).

Both the Renault factory in Douai and the Dacia plant in Mioveni manage to fulfill established targets for 5 out of the 9 categories, but in a slightly different manner. Renault achieves planned results for 2 of the 3 logistics and management KPI categories and for only one internal performance KPI category, with 5 of its category averages being over the 80% level.

Dacia on the other hand has only one indicator category which performs over the 80% level (the internal performance indicators with short-term impact), but it is at the same time the only indicator category which is fulfilled of those with short-term impact (0.97) and 3 others are close to the 80% level. Dacia thus achieves planned results for 2 of the 3 logistics and internal performance KPI categories and for only one management performance KPI category.
The two brands also account for best overall average results for their KPI categories with short-term impact, whereas those with medium- and long-term impact have similar averages, 10-12 percentage points behind the short-term one.

PERFORMANCE ANALYSIS SUMMARY									DACIA
	AGGREGATED INDICATORS	short-term		medium-term		long-term		OVERALL AVERAGE
		actual	reference	actual	reference	actual	reference	
1	LOGISTICS	0.6411	0.9	0.7789	0.7	0.6782	0.5	0.7027
2	MANAGEMENT	0.7958	0.9	0.6424	0.7	0.7348	0.5	0.7218
3	PERFORMANCE	0.9776	0.9	0.6165	0.7	0.7233	0.5	0.7682
	AVERAGE RATING	0.7972		0.6862		0.7106		AVERAGE RATING

	AGGREGATED INDICATORS	short-term		medium-term		long-term		OVERALL AVERAGE
		actual	average reference	actual	average reference	actual	average reference	
1	LOGISTICS	0.6411	0.6793	0.7789	0.6793	0.6782	0.6793	0.7027
2	MANAGEMENT	0.7958	0.6931	0.6424	0.6931	0.7348	0.6931	0.7218
3	PERFORMANCE	0.9776	0.6826	0.6165	0.6826	0.7233	0.6826	0.7682
	AVERAGE RATING	0.7972		0.6862		0.7106		AVERAGE RATING

Figure 4.28. Dacia's performance analysis summary

PERFORMANCE ANALYSIS SUMMARY									RENAULT
	AGGREGATED INDICATORS	short-term		medium-term		long-term		OVERALL AVERAGE
		actual	reference	actual	reference	actual	reference	
1	LOGISTICS	0.8439	0.9	0.8561	0.7	0.8062	0.5	0.8338
2	MANAGEMENT	0.8509	0.9	0.7032	0.7	0.7298	0.5	0.7582
3	PERFORMANCE	0.8649	0.9	0.6285	0.7	0.6156	0.5	0.6954
	AVERAGE RATING	0.8526		0.7404		0.7235		AVERAGE RATING

	AGGREGATED INDICATORS	short-term		medium-term		long-term		OVERALL AVERAGE
		actual	average reference	actual	average reference	actual	average reference	
1	LOGISTICS	0.8439	0.6793	0.8561	0.6793	0.8062	0.6793	0.8338
2	MANAGEMENT	0.8509	0.6931	0.7032	0.6931	0.7298	0.6931	0.7582
3	PERFORMANCE	0.8649	0.6826	0.6285	0.6826	0.6156	0.6826	0.6954
	AVERAGE RATING	0.8526		0.7404		0.7235		AVERAGE RATING

Figure 4.29. Renault's performance analysis summary

CATEGORY OVERVIEW		RENAULT			

	PERFORMANCE	actual	reference	department	department average
4	Logistics / short-term impact	0.8439	0.9	0.8338	0.8338
2	Logistics / medium-term impact	0.8561	0.7	0.8338	
5	Logistics / long-term impact	0.8062	0.5	0.8338	
3	Management / short-term impact	0.8509	0.9	0.7582	0.7582
7	Management / medium-term impact	0.7032	0.7	0.7582	
6	Management / long-term impact	0.7298	0.5	0.7582	
1	Performance / short-term impact	0.8649	0.9	0.6954	0.6954
8	Performance / medium-term impact	0.6285	0.7	0.6954	
9	Performance / long-term impact	0.6156	0.5	0.6954	
	Overall Reference	0.6852			
	Overall Average	0.7674			

	PERFORMANCE	actual	reference	overall average	critical
1	Performance / short-term impact	✓ 0.8649	0.6852	0.7674	0.4568
2	Logistics / medium-term impact	✓ 0.8561	0.6852	0.7674	0.4568
3	Management / short-term impact	✓ 0.8509	0.6852	0.7674	0.4568
4	Logistics / short-term impact	✓ 0.8439	0.6852	0.7674	0.4568
5	Logistics / long-term impact	✓ 0.8062	0.6852	0.7674	0.4568
6	Management / long-term impact	✓ 0.7298	0.6852	0.7674	0.4568
7	Management / medium-term impact	✓ 0.7032	0.6852	0.7674	0.4568
8	Performance / medium-term impact	! 0.6285	0.6852	0.7674	0.4568
9	Performance / long-term impact	! 0.6156	0.6852	0.7674	0.4568

OVERALL AVERAGE		
✓ 0.7674	Target value	0.6852
	Critical level	0.4568
	Result status and interpretation	
	if objective is achieved	✓
	if objective needs revising	!
	if objective is failed	✗

OVERALL PERFORMANCE OVERVIEW

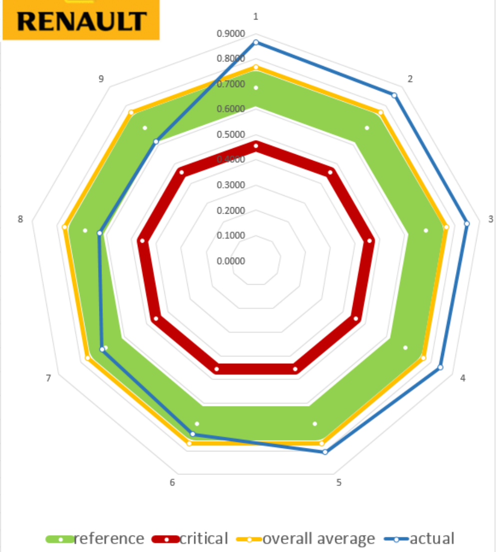


Figure 4.30. Renault's overall performance overview and best performing categories

CATEGORY OVERVIEW		DACIA			

	PERFORMANCE	actual	reference	department	department average
8	Logistics / short-term impact	0.6411	0.9	0.7027	0.7027
3	Logistics / medium-term impact	0.7789	0.7	0.7027	
6	Logistics / long-term impact	0.6782	0.5	0.7027	
2	Management / short-term impact	0.7958	0.9	0.7218	0.7218
7	Management / medium-term impact	0.6424	0.7	0.7218	
4	Management / long-term impact	0.7348	0.5	0.7218	
1	Performance / short-term impact	0.9776	0.9	0.7682	0.7682
9	Performance / medium-term impact	0.6165	0.7	0.7682	
5	Performance / long-term impact	0.7233	0.5	0.7682	
	Overall Reference	0.6852			
	Overall Average	0.7281			

	PERFORMANCE	actual	reference	overall average	critical
1	Performance / short-term impact	✓ 0.9776	0.6852	0.7281	0.4568
2	Management / short-term impact	✓ 0.7958	0.6852	0.7281	0.4568
3	Logistics / medium-term impact	✓ 0.7789	0.6852	0.7281	0.4568
4	Management / long-term impact	✓ 0.7348	0.6852	0.7281	0.4568
5	Performance / long-term impact	✓ 0.7233	0.6852	0.7281	0.4568
6	Logistics / long-term impact	! 0.6782	0.6852	0.7281	0.4568
7	Management / medium-term impact	! 0.6424	0.6852	0.7281	0.4568
8	Logistics / short-term impact	! 0.6411	0.6852	0.7281	0.4568
9	Performance / medium-term impact	! 0.6165	0.6852	0.7281	0.4568

OVERALL AVERAGE		
✓ 0.7281	Target value	0.6852
	Critical level	0.4568
	Result status and interpretation	
	if objective is achieved	✓
	if objective needs revising	!
	if objective is failed	✗

OVERALL PERFORMANCE OVERVIEW

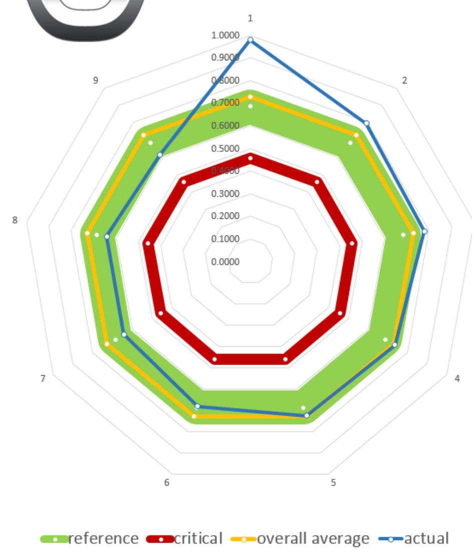


Figure 4.31. Dacia's overall performance overview and best performing categories

The overview of the results for the two carmakers shows Renault being 4 percentage points better on overall than Dacia, with 0.76 compared to 0.72, with both manufacturers managing to surpass the average reference of 0.68, which means their overall activity is good as it has met and even exceeded the set targets on average. Renault has only 2 indicator categories below the average reference values, which are the internal performance indicators with medium- and long-term impact. Interestingly however, Renault's best indicator category is the internal performance KPI with short-term impact. Dacia on the other hand has 4 indicator categories which do not meet the set reference average, two logistics indicator categories (with short- and long-term impact) and the medium-term impact management and internal performance indicator categories. Dacia's best indicator results also come from the internal performance KPIs with short-term impact, as this is the overall best score of all categories with a rating of 0.97, 17 percentage points more than the next best indicator category.

The performance analysis tool thus provides interesting insights and a more in-depth assessment and comparison of the two car manufacturers on three important levels: logistics, management and internal performance and points out each of the two carmakers' strengths and weaknesses with a more oriented target for improvement measures. Overall results are good, but in order for the two carmakers to maintain their competitive position on the car market they need to continue improvement efforts that will enable them to achieve long-term sustainable development in the automotive industry.

4.3. Conceiving a specific corporate social responsibility (CSR) indicator for the automotive industry

Automotive industry is one of the most important industries worldwide as the large variety of car manufacturers' and brands account not only for an important amount of jobs within their own plants and facilities but also within their entire supply chain partners.

The recent economic crisis has hampered its development and has put pressure on car manufacturers to be more efficient. Thus reorganizing activities, cutting costs or laying off workforce have been some of the decisions made in order to balance overall performance. This setback has made carmakers rethink their strategy based on a more sustainable approach [113].

Sustainable development can enable decision making as an ultimate value system and be seen as a framework for companies to transform their CSR policy into a business practice that serves the entire community [81].

The automotive industry is an energy intensive industry where car manufacturers heavily invest in new technologies and strategies to address the complex CSR and sustainability challenges: alternative production techniques to reduce carbon footprint, recycling procedures or the use of renewable energies throughout the production process. Carmakers have also developed innovative technologies, as are zero-emission electric or hybrid-driven cars in order to sustain and improve their economic and social benefits while reducing the environmental footprint of their products, services and production facilities and become more environmentally friendly [158].

4.3.1. Methodological approach to conceiving a global CSR indicator

CSR is a long-term commitment and efforts have to be made to implement it as results and benefits may not always be immediate. The main idea that should guide CSR is not so much whether a cause is worthy or not, but whether it presents an opportunity to enable a win-win relationship and create shared value by providing a meaningful benefit to society that is in the meantime also valuable to the business [119].

Although the CSR concept is somewhat familiar to most businesses, especially to multinational companies, its actual integration in the organizational culture is still rather new and mostly low in Romania. The paper analyzes the capacity of local car manufacturer Dacia to integrate CSR concerns into its operations and core strategy in collaboration with its stakeholders. The research also points out if sustainability throughout the entire value chain and its underlying processes can provide the expected benefits for the involved companies [153].

The proposed methodological approach assumes a two-step comparison of economic, social and environmental indicators which are considered relevant in identifying CSR evolution within a company.

The first step of analysis is to calculate aggregate indicators for every one of the three analysis directions proposed. Data reported by Dacia between the years 2004 - 2013 was processed using linear interpolation, analyzing six indicators for the economic performance, three for social concern and six for environmental awareness. Thus, by being able to compare data, we obtain a high level of accuracy for the analysis. The yearly utilities for each individual sustainability indicator are calculated by using the following formulas:

$$u_{ij} = \frac{a_{ij} - min\ a_{ij}}{max\ a_{ij} - min\ a_{ij}} \quad (1)$$

for the economic and social indicator category, where a_{ij} is the corresponding value for each indicator;

$$u_{ij} = \frac{a_{ij} - max\ a_{ij}}{min\ a_{ij} - max\ a_{ij}} \quad (2)$$

for the environment indicator category, where a_{ij} is the corresponding value for each indicator;

In the next step of analysis we consider the results identified for each period of time, these are being summed up in order to obtain a global CSR indicator for every year since 2004 where the initial aggregated elements from step one are equally weighted.

4.3.2. CSR policy implementation at the Dacia plant in Mioveni

The economic indicators considered in table 4.1 are the net turnover (NTO), net profit (NPR), internal production (IP), global sales (GS), exports (EXP) and turnover to Gross Domestic Product ratio (% GDP) within a time span of 10 years (2004-2013). Data was retrieved from the annual balance sheets available on the website of the Ministry of Finance, press releases provided by Dacia, data obtained from the National Institute of Statistics and from written articles in business magazines.

Table 4.1. Economic indicators

indicator	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
NTO [mil.lei]	2402,1	4367,6	5554,4	6936	7642,3	9004,4	11403,3	13177,8	12742,1	18402,5
NPR [mil.lei]	296,6	298,3	377,3	442,3	222	230,3	300	275,1	277,2	337,4
IP [units]	94720	170000	183958	222808	242415	296010	341299	327620	307152	342610
GS [units]	95296	163899	196708	230473	257594	311282	348723	343233	359822	429540
EXP [units]	15283	50623	88931	128411	172886	269420	311000	312000	337674	404000
% GDP [%]	0,83	1,26	1,62	1,71	1,48	1,79	2,18	2,36	2,09	2,92

By using formula (1) we obtain the following yearly utilities for the economic indicators (see table 4.2):

Table 4.2. Utilities for economic indicators

indicator	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
NTO	0,00	0,12	0,20	0,28	0,33	0,41	0,56	0,67	0,65	1,00
NPR	0,34	0,35	0,70	1,00	0,00	0,04	0,35	0,24	0,25	0,52
IP	0,00	0,30	0,36	0,52	0,60	0,81	0,99	0,94	0,86	1,00
GS	0,00	0,21	0,30	0,40	0,49	0,65	0,76	0,74	0,79	1,00
EXP	0,00	0,09	0,19	0,29	0,41	0,65	0,76	0,76	0,83	1,00
% GDP	0,00	0,21	0,38	0,42	0,31	0,46	0,65	0,73	0,60	1,00
Economic	**0,06**	**0,21**	**0,36**	**0,49**	**0,35**	**0,50**	**0,68**	**0,68**	**0,66**	**0,92**

The aggregate economic indicator shows an impressive progress throughout the last decade as the Romanian car manufacturer has managed to constantly improve its performance and achieve a peak in the year 2013.

The aggregate economic indicator shows a growth of 38 percent in the last year and it has increased 16 times since the year 2004. This strong development is due to investments made within the factory that have allowed Dacia to work at maximum capacity and attain production figures nearly four times higher than the ones from 2004 in order to sustain the boost in global sales recorded by the Renault brand. With a 19 percent increase in sales and a total of 429,540 vehicles sold in 2013, Dacia currently sells almost five times more cars than it did 10 years ago.

Accordingly turnover has risen by 44 percent only in the last year and is almost eight times the size of that in 2004 whilst the brand is among the few to have recorded profits even throughout the crisis and having achieved an important 21 percent increase in 2013.

Moreover Dacia currently exports 93 percent of its production. In 2013 more than 400,000 vehicles of the Romanian car manufacturer went to foreign markets, 26 times more than a decade ago, an impressive development for the brand which makes it one of the most important contributors to the country's GDP, where its share has risen almost four times since 2004.

The social indicators considered in table 4.3 are the average number of employees, net average salary and the amount of investments.

Table 4.3. Social indicators

indicator	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Employees	7921	11554	11423	11486	13274	12698	13823	13652	13640	14002
Salary [lei]	729	892	1055	1328	1580	1880	2288	2548	2781	3154
Investments [mil.euros]	350	350	142	200	300	200	90	300	250	120

By applying formula (1) we obtain the following yearly utilities for the social indicators (see table 4.4 below):

Table 4.4. Utilities for social indicators

indicator	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Employees	0,00	0,60	0,58	0,59	0,88	0,79	0,97	0,94	0,94	1,00
Salary	0,00	0,07	0,13	0,25	0,35	0,47	0,64	0,75	0,85	1,00
Investments	1,00	1,00	0,20	0,42	0,81	0,42	0,00	0,81	0,62	0,12
Social	**0,33**	**0,55**	**0,30**	**0,42**	**0,68**	**0,56**	**0,54**	**0,83**	**0,80**	**0,71**

The aggregate social indicator has a cyclical trend, but throughout the last decade it has more than doubled, showing a consistent onward trend in line with Dacia's development policy: constant investments, better working conditions for employees and higher wages.

The company's success throughout the last decade is also due to its employee policy. The investments in the factory meant reorganizing activity was needed and jobs would be restructured in order to meet company objectives. After a few hectic years employment became stable and the average number of employees began to follow Dacia's success abroad. Last year the company employed around 14,000 people, 362 more than in 2012. Meanwhile the average salary has also kept up the pace with the company's development and with increases amounting up to 25 percent in 2007, the average salary is today more than four times higher than 10 years ago and almost twice as much as the national average salary.

Investments have been constant at Dacia since being bought by Renault and the results of the financial efforts started to pay off by 2004 when the Romanian car manufacturer began to obtain profits and has since become more competitive on the market, especially abroad. Constant investment is a very good sign for the development of a company and it is a good indicator for employees that shows management is thinking ahead and planning for the future, which means their jobs are assured as long as the company is competitive on the market.

Education and training is another area where Dacia has started giving attention: since 2008 the company offers scholarships for students in the master's degree of the University in Pitesti studying Logistics Management with a six month internship in France as well as the "Drive your Future" program launched in 2012 which allows bachelor students to apply for a three to six month paid internship within the company in several departments with specific project themes as well as the possibility to work on their bachelor thesis as part of their internship. Although the programs are quite new, results were more than satisfactory and those who distinguished themselves even had the chance to become full-time employees at Dacia following their internship projects.

Moreover one of three employees is a woman and while in 2005 this meant just over 3,900 employees, today 4,700 women work at Dacia (19 percent more than 10 years ago) of the 5,555 female employees within the Renault group in Romania.

The environmental indicators considered are cumulated vehicle consumption and a set of unitary indicators: CO_2 emissions, volatile organic compound (VOC) emissions, energy consumption, water consumption and waste generation.

Table 4.5. Environmental indicators

indicator	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Consumption	20,9	20,9	20,9	20,90	22	22	22	22	18,5	18,5
CO_2/vehicle	166	166	166	166	165	165	165	165	137	137
COV/vehicle	3,86	3,86	3,86	1,90	1,90	1,90	1,90	1,30	1,30	1,30
Energy/vehicle	8,15	8,15	8,15	2,11	2,11	2,11	2,11	1,60	1,60	1,60
Water/vehicle	114,38	114,38	114,38	14,40	14,40	14,40	14,40	3,90	3,90	3,90
Waste/vehicle	513,11	513,11	513,11	274	274	274	274	220	220	220

By using formula (2) we obtain the following yearly utilities for the environmental indicators, as shown in table 4.6 below:

Table 4.6. Utilities for environmental indicators

indicator	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
consumption	0,31	0,31	0,31	0,31	0,00	0,00	0,00	0,00	1,00	1,00
CO_2/vehicle	0,00	0,00	0,00	0,00	0,03	0,03	0,03	0,03	1,00	1,00
COV/vehicle	0,00	0,00	0,00	0,77	0,77	0,77	0,77	1,00	1,00	1,00
Energy/vehicle	0,00	0,00	0,00	0,92	0,92	0,92	0,92	1,00	1,00	1,00
Water/vehicle	0,00	0,00	0,00	0,90	0,90	0,90	0,90	1,00	1,00	1,00
Waste/vehicle	0,00	0,00	0,00	0,82	0,82	0,82	0,82	1,00	1,00	1,00
Environment	**0,06**	**0,06**	**0,06**	**0,58**	**0,53**	**0,53**	**0,53**	**0,61**	**1,00**	**1,00**

The aggregate environmental indicator is certainly the most impressive as the efforts made by the Romanian car manufacturer have reached their peak starting 2012 and the improvement trend is bound to continue within the following years.

Within the last decade the general tendency has been to reduce fuel consumption and to make smaller yet more efficient engines without a drop in performance. Thus Dacia has shifted from 1400 to 1600cc engines in 2004 to 1200 to 1600cc engines in 2008 and to 900 to 1500cc engines in 2012. They develop the same amount or even more horsepower, but the fuel consumption has been improved by almost 16 percent. In addition, the carmaker has improved its average CO_2 emissions by 17.5 percent for the Logan model and is in line with the EU policy to reduce emissions to an upper limit of 130g/km by 2015.

Meanwhile progress has also been made within other areas in the last decade: VOC emissions have been reduced by around 66 percent, energy consumption by more than 80 percent, water consumption by 96.5 percent while the amount of generated waste has been cut down by more than 57 percent thereby rendering considerable efficiency improvements as a result of the company's environmental investments.

Table 4.7. Utilities for aggregate CSR indicators

indicator	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Economic	0,06	0,21	0,36	0,49	0,35	0,50	0,68	0,68	0,66	0,92
Social	0,33	0,55	0,30	0,42	0,68	0,56	0,54	0,83	0,80	0,71
Environment	0,06	0,06	0,06	0,58	0,53	0,53	0,53	0,61	1,00	1,00
CSR	**0,15**	**0,28**	**0,24**	**0,50**	**0,52**	**0,53**	**0,58**	**0,71**	**0,82**	**0,88**

Finally in order to have a general image of Dacia's overall development a global CSR indicator has been developed based on the yearly values of the economic, social and environmental indicators considered (see table 4.7), all of them being considered equally important and thus being weighted accordingly.

Results show an impressive overall development of the global CSR indicator as its value has doubled twice within the first four years and by 2007 the indicator's value is more than three times the value in 2004. During the economic crisis however progress had slowdown but by 2010 an increase of 16 percent was to be achieved during the harsh timespan. Within the next three years results would pick up and last year a 51 percent increase is noticed since 2010 showing a clear revival of the indicator.

These results are mainly sustained by the solid environmental performance (63 percent increase since 2012) and the current economic results (39 percent increase in 2013). Nevertheless progress made on social level is also remarkable as it has increased by over 31 percent since the year 2010. Excepting the year 2006, the global CSR indicator has continuously grown and by last year it has increased nearly six times since 2004 resulting in constant profits, even throughout the recent crisis.

4.3.3. Conclusions

The important growth trend of the global CSR indicator for Dacia is due in similar proportions to the economic, social and environmental performance of the company.

The constant investments in the factory have allowed the Romanian car manufacturer to produce competitive vehicles and provided an impressive boost in production and sales during the last couple of years, especially towards foreign markets, bringing profits.

Dacia is among the few industry players which have managed to improve their position on the car market by sales growth, market share and visibility. The investments have also improved working conditions and employees have benefited from salary raises during this period making their wages above the national average. The manufacturer is also dedicated to producing low emission cars with more efficient engines that use less petrol and has introduced a model with more eco-friendly features.

The paper reveals that the recent success of the national car manufacturer Dacia is closely linked with the brands' continuous development plans and CSR policy.

Economic, social and environmental performance have a strong impact on creating a positive image whilst increasing brand value and adds an extra asset to a company and provides it with a sustainable organizational culture to assure its current and future competitiveness.

Thus by integrating CSR concerns into its operations and core strategy, Dacia is an example of how sustainability throughout the entire value chain can provide consistent benefits for all stakeholders on a long-term basis.

Ultimately, CSR must be viewed from a strategic standpoint, within a broader understanding of the relationship between a company and society which implies that both business decisions and social policies benefit both sides.

A healthy society ultimately creates expanding demand for business, as more human needs are met and aspirations grow, therefore CSR can be much more than a charitable deed, a constraint or a cost; it can be a source of opportunity, innovation, and competitive advantage.

5. CONCLUSIONS, PERSONAL CONTRIBUTIONS AND PERSPECTIVES FOR THE FURTHER DEVELOPMENT OF THE RESEARCH

This chapter summarizes the intermediate conclusions of the previously presented chapters and presents the overview of the thesis by emphasizing the personal contributions and future research perspectives.

5.1. Thesis summary

Chapter 1 is an introduction to automotive industry where the author underlines the main characteristics and challenges of the car industry and its role throughout the last century in society. The chapter defines the automotive industry, provides an insight to the history and major events that have marked the automobile and the industry around it, as well as the changing structures that have shaped the car business environment and its economic contribution and relevance.

The chapter also provides an analysis on the manufacturing philosophies that have revolutionized car making throughout the world, Fordism and Toyotism, their distinctive features and characteristics which are emphasized on a case study of the Romanian car brand Dacia.

Lean management is currently one of the most important principles leading companies working in the automotive industry, whether they are assemblers, original equipment manufacturers (OEMs) or tier suppliers for the industry. The production philosophy is explained within this chapter with its component concepts as well as the importance of their interrelated connections and effects on productivity improvement.

Finally the chapter also underlines the importance of the support for automotive industry provided by road infrastructure and the synergic effect of car industry and motorway network enlargement for supporting a sustainable long-term development.

Chapter 2 presents two of the three Renault Group brand, namely the French company Renault, the leading brand of the group, and Dacia, the Romanian carmaker with the most impressive development in the automotive industry in the last decade.

The chapter presents a short history of Renault, its innovations which have brought about important changes in the automotive industry, the benchmark alliance with Nissan established 15 years ago as well as the French carmaker's 30 production sites throughout the world and a summary of their level of activity.

The Dacia brand's history is also summarized as well as its most important events throughout the last 50 years for the Romanian carmaker and there is a short description of its 2 production facilities. The chapter also integrates the Renault Group brands in the context of the international car market and provides case studies on two current topics in the automotive world: the low-cost segment created by Renault in 2004 with the Dacia Logan, a project which failed in its initial version, but which was then adapted and is now a benchmark business strategy in automotive industry and the more strategic issue of relocation in automotive industry towards more cost-competitive countries with the example of the newly built Dacia plant in Tanger, Morocco, which is an example of how important market dynamics, infrastructure features and corporate costs are in choosing the location of a future car manufacturing facility.

Chapter 3 provides an in-depth analysis on performance assessment issues in the automotive industry which mainly focus on production, management, supplier-buyer collaboration and supply chain development. Production features manufacturing flexibility, factory productivity through standardization, investments and training as well as an integrated supply chain approach through specific Lean management tools. Management features aspects of the business environment (corporate tax, incentives, workforce, infrastructure, market access, utility rates), quality management challenges, production scheduling to better meet customer demands, working capital and risk management and organizational culture. Collaboration features strengthening supplier-buyer relationships through information sharing, enabling reliable logistics, focusing on innovation and value added activities as well as promoting an overall win-win strategy. Supply chain features addressing specific competitiveness challenges as are cost-effective structures and policies, reliable delivery times, managing the Just-in-Time system, the quality management and the lean management techniques to achieve a high degree of effectiveness. The chapter also provides a case study on improving forecasting in the European automotive industry based on exponential smoothing and provides an overview on the existing performance analysis tools SCOR, MMOG/LE and business dashboards, their most important features and limitations.

Chapter 4 describes 81 relevant key performance indicators (KPIs) and highlights the proposed performance analysis tool and its main features and provides a case research on two manufacturing sites of the Renault Group. The Renault plant in Douai, France and the Dacia factory in Mioveni, Romania are compared regarding their logistic, management and internal performance on strategic, tactical and operational level as well as judging their impact on short-, medium- and long-term. Results show the Douai plant outperform Mioveni in logistics as the Dacia facility has better results than Renault in internal performance, with the management category being slightly in favor of the French car manufacturer. Research shows that both factories have their strengths and weaknesses in the main categories and although overall results show Renault performs to a small degree better than Dacia, the minor difference indicates that it is fair to say that the 2 factories are almost balanced out in overall performance. Complementary to the performance analysis tool a corporate social responsibility (CSR) indicator has been developed to assess a company's efforts and involvement on economic, social and environmental level as a means for sustainable development and competitive advantage.

5.2. Propositions for future research

Automotive industry is a very complex, challenging and competitive business environment and due to the multitude and complexity of factors which can affect the industry as well as individual car manufacturers the presented performance analysis tool should be considered a departure point for a more practical and relevant assessment of the overall effectiveness of a car manufacturing facility. Based on experience the author proposes the following additional research topics which can further broaden understanding the drivers of performance in automotive industry as well as the pertinence of the obtained results:

1. The present configuration of the 81 KPIs can be adjusted according to a carmaker's own appreciation and view on the level where an indicator should be placed within the overall importance (strategic, tactical or operational) as well as within the timespan of generating an effect or impact on its overall activity level (short-term, medium-term or long-term)

2. The performance analysis tool can further be extended and the indicator range enlarged according to a carmakers view on the relevance of certain more specific KPIs that may better assess and describe the characteristics of the business entity

3. The performance analysis tool could also be improved by providing besides the more operational and technical indicators a marketing pertinent component (a couple of additional indicators) which could better explain and quantify the value perceived by customers to a much greater extent and their motivation in choosing a certain brand over another within the current highly competitive car market structure

4. The tool can further prove interesting in analyzing and comparing the performance of production sites belonging to the same manufacturer for benchmarking purposes which can help the car manufacturer better tailor its decision-making, tactical plans and overall strategy

5. As well as comparing multiple production sites of a single car manufacturer of car group, the performance analysis tool may also be employed to compare two or more car manufacturing sites of different brands to make an assessment which ranges beyond internal decision-making and strategy-tailoring purposes and provides an innovative benchmark comparison

5.3. Personal contributions within the thesis

The author's main contributions presented throughout the present thesis are as follows:

1. providing an own definition on the automotive industry
2. making a synthesis on the key events that have shaped the automotive industry throughout the last century and highlighting its economic contribution and importance
3. delivering a comparative analysis on Fordism and Toyotism based on an analytic overview on production principles, organizational culture and supply chain characteristics
4. conducting a case research on Fordism and Toyotism and their distinctive features within Romanian car manufacturer Dacia
5. summarizing the main Japanese organization concepts which shape the Lean management production philosophy and explaining their individual relevance
6. developing a systemic model to underline the importance of an integrated approach towards the Japanese organization concepts which enables the Lean management philosophy

7. elaborating a conceptual model of a sustainable economic development through the construction of motorways to support the automotive industry (Chapter 1)
8. presenting a synthesis with the key moments of Renault, its leading role in innovation and its benchmark alliance with Nissan
9. presenting a synthesis with the key moments of Dacia and its remarkable development within the last decade
10. compiling an overview of Renault's worldwide production facilities and summarizing their level of activity with key figures
11. presenting Dacia's current production facilities, its development and logistic center in Romania and their level of activity with key figures
12. integrating Renault, Dacia as well as the Renault Group's key figures within the international car market context and underlining their contribution
13. conducting a thorough case study on Renault's 5,000 euro car project, the Dacia Logan
14. providing an extensive strategic management decision-making framework to address (re)locating car manufacturing facilities
15. proposing a market dynamics and perspectives (MDP) indicator to analyze the results of a carmaker in a given year and help provide an indication on possible future development (Chapter 2)
16. summarizing the main performance assessment issues of the automotive industry presented within the research literature
17. testing a forecasting model which enables a sensible improvement of the planning accuracy by reducing the error to under 10%
18. giving an overview on the existing performance analysis tools, their features and limitations (Chapter 3)
19. elaborating an own performance analysis tool to assess a car manufacturer's logistic, management and internal performance through 81 key performance indicators relevant for the automotive industry
20. conducting a comparative case research on two production facilities (Renault Douai, France and Dacia Mioveni, Romania) to highlight the features of the performance tool
21. developing a complementary corporate social responsibility (CSR) indicator to assess a company's sustainable development policy on economic, social and environmental level (Chapter 4)

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