Professional MBA
Automotive Industry

# Low cost car segment.
# Trends on local and global markets

A Master's Thesis submitted for the degree of
"Master of Business Administration"

supervised by

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# Affidavit

I, **CORNELIU-CICERONE ANTONOVICI**, hereby declare

1. that I am the sole author of the present Master's Thesis, "LOW COST CAR SEGMENT. TRENDS ON LOCAL AND GLOBAL MARKETS", 71 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted this Master's Thesis as an examination paper in any form in Austria or abroad.

Vienna, 08.11.2016

Signature

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# List of abbreviations:

| | |
|---|---|
| CAGR | Compound Annual Growth Rate |
| NHTSA | National Highway Traffic Safety Administration |
| SA | Société Anonyme |
| Euro NCAP | European New Car Assessment Programme |
| FIA | Fédération Internationale de l'Automobile |
| TELCO | Tata Engineering and Locomotive Company Limited |
| ECU | Engine Control Unit |
| R&D | Research and Development |
| ANCAP | Australasian New Car Assessment Program |
| NASVA | National Agency for Automotive Safety & Victim's Aid |
| ESC | Electronic Stability Control |
| ESP | Electronic Stability Program |
| MMI | Man Machine Interface |
| E/E-System | Electrical and Electronic System |
| CRM | Cause-related marketing |
| EV | Electric Vehicle |
| HEV | Hybrid Electric Vehicle |
| OEM | Original Equipment Manufacturer |
| ADAS | Advanced Driver Assistance System |
| GFEI | Global Fuel Economy Initiative |
| ICE | Internal Combustion Engine |
| LPG | Liquefied Petroleum Gas |
| IEA | International Energy Agency |

# Abstract

The automotive world is changing. New technologies, new driving assistance functions, autonomous driving. Electrical car seems to be the future. But are all these things really necessary if we only need to go from one point to another? Many years ago Mr. Henry Ford made a bet: to offer mobility and freedom to everybody. Is this need still valid today? When you think about modern stories of Dacia or Tata Nano, the answer may be yes. Ford Model T was replaced in our times by the affordable car, also known as the low cost car.

We will present in this thesis the premises of the low cost car introduction, the low cost car market specifics as well as the most famous examples of low cost cars that are already milestones in the history of automotive industry. We will define and analyze the most influencing factors of the car buyers' decision in three different scenarios in order to find the answer to one question: is there any future for the low cost car market in a medium term? And moreover, taking into account the current changes within urban mobility sector? Until 2025 many changes will happen that will shape our mobility perspectives.

Starting with the first chapter, we will take a brief look at the automotive sector in order to find out the most favorable market for the low cost and ultra-low cost cars. How affordable must be an affordable car in term of price and for which category of customers? We have already a couple of examples with models that defined the modern low cost car concept: Dacia from Renault and Nano from Tata. In the second chapter we will see their path from design to manufacturing, their specifications and we will find out if they have been successful or not. It is now time to check the future perspectives of this car segment. But how it will be the future? As it is getting harder to predict it, we will analyze the trend taking into consideration three evolution scenarios based on the so called "megatrends" that are shaping the automotive industry's future. Each and every scenario (High Tech, Budget and Sustainable) has its own implications in the industry, starting with the markets, customers, products or business models and finishing with the business organizations and their employees. Next step would be to identify the factors that are influencing car buyers' decision in general and to define which factors have an impact on the potential low cost car customers. Finally, we will have the elements that predict the future of the segment, by combining the evolution of the most impacting factors in all three future evolution scenarios.

# 1. Introduction to the low cost market

## 1.1. Beginnings of low cost

Beginning of 20th century, only reach people afforded to own an automobile. Most of the available models were complex machines and usually required to have a chauffeur accustomed with their mechanics in order to be able to drive them. The first that had the determination to produce a simple, reliable and most importantly affordable vehicle for the average American worker was Henry Ford. As a result of his efforts, the Model T emerged and also the first serial assembly line. These two innovations have revolutionized the American society of that time and also influenced greatly the whole world until nowadays. [1]

Henry Ford's major accomplishment was not inventing the car, but being able to produce a vehicle that the average American could afford to purchase. At the time, other producers preferred to have as target market rich people but Ford worked on an innovative design and brand new method of manufacturing that continuously reduced the cost of its Model T. [1]

**Figure 1. Henry Ford and his first car, the Quadricycle, built in 1896** [2]

Thanks to its strategy to constantly lower the price of the car instead of taking advantage of the profits, Ford Motors was able to sell more and more cars and constantly increased its earnings while bringing the automobile from a luxury product to a common presence on the American streets. The first affordable car for the masses was a low cost car.

The Ford Model T was launched in 1908 with a starting price of 825$. In the first year on the market, approximately 10.000 vehicles were sold, therefore establishing a new sales record. Over the next four years the price was reduced to 575$, causing the sales figures to increase even more rapid, bringing Ford the possibility to have already a 48 percent of the automobile market. [2]

A very important factor that enabled Ford to produce an affordable car was the design of the assembly line which brought its valuable contribution by increasing the efficiency of the manufacturing process and therefore decreasing its cost. Ford did not actually invented the assembly line concept, but he improved it and put it into work with success. Before introducing the assembly line, the vehicles were individually crafted by teams of trained and skilled workers which was a slow and expensive process. Basically the assembly line inversed the usual manufacturing activity, because instead of the workers to go and work around the car, the car was the one to come to the worker who now was performing the same tasks for each and every car. With this standardization and perfection of the process, the time needed to build a Model T vehicle was reduced from 12.5 hours to only 6 hours. [3]

## 1.2. Low cost markets in the world

The world's passenger car market is now experiencing a revolution. The purchasing power of people in many emerging countries is rising as the economies of these countries progress. During the years to come a large number of people will want to be mobile and have the financial capabilities to do so. According to [4], the number of vehicles sold by 2020 in the low end segment should reach 16 million vehicles yearly, which would generate a 24 percent annual growth rate – see figure 2. The main markets for low and ultra-low cost cars will be most probably represented by India and various markets within South-East Asia. In the meantime, markets in China and Russia have moved past the ultra-low cost vehicles. As the income figures in these countries have appreciated, it is expected that the compact and medium vehicle class segments to have higher growth rates in comparison with low and ultra-low cost segments.

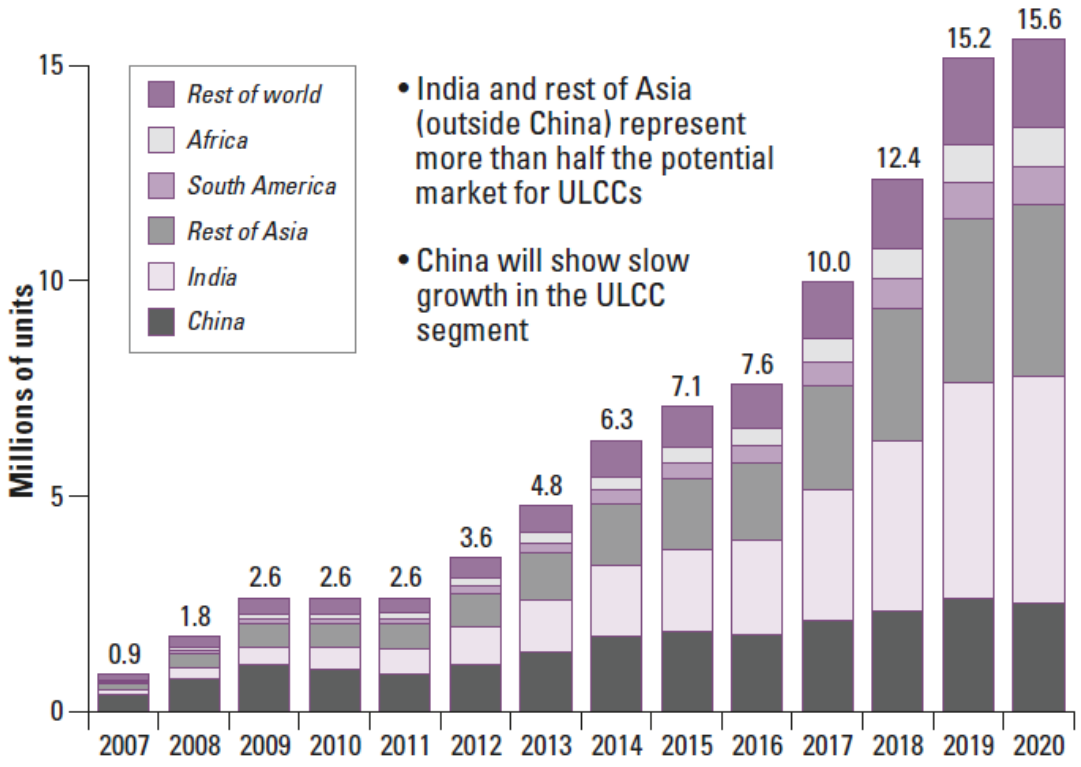


**Figure 2: Global sales forecast for low cost vehicles** [4, P2]

## 1.3. The customers for low cost

The automotive industry can experience an increase in number of generations of potential car buyers over the next few decades mainly in emerging countries like India, Algeria, etc. In the case of India, in 2005 there were approximately 208 million people which had incomes that in theory would enable them to spend anything between 2500 USD and 5000 USD for a new car. However by 2020 this figure will be more than double, reaching 439 million people (see figure 3).

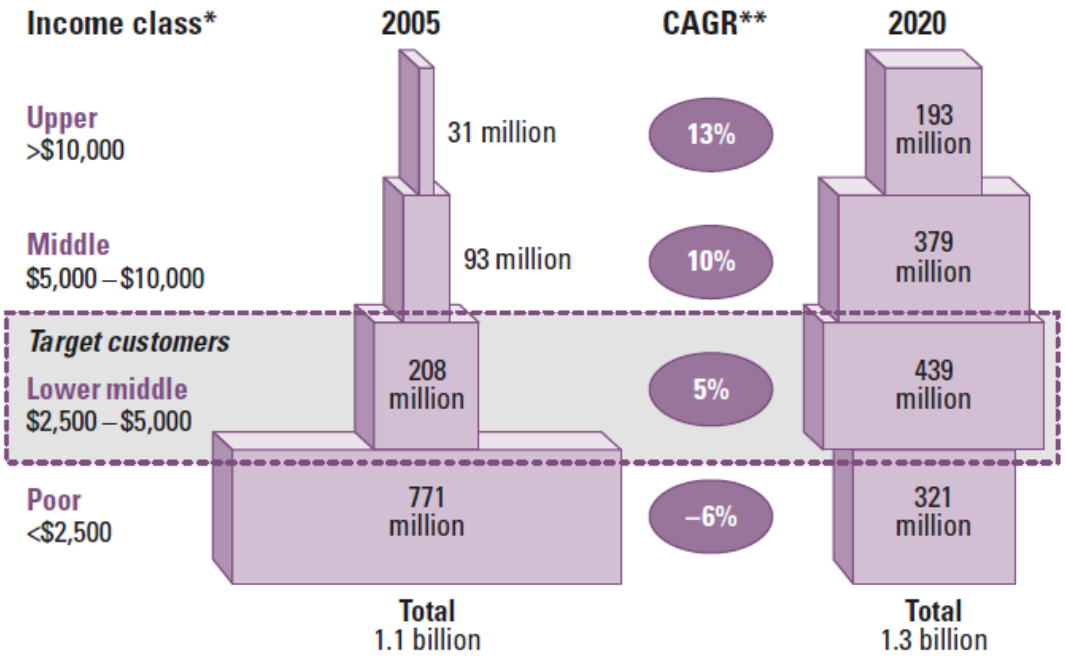


**Figure 3: Population in India by income range, 2005 - 2020** [4, P2]

**Income figures are based on purchasing power by applying an exchange rate which equalizes purchasing power of various currencies in their respective countries for a given shopping basket.*
***see abbreviation list*

For the vast majority of these people this will be their first opportunity to afford buying a new vehicle. The ideal car would be solid, mostly oriented to functionality, would contain basic equipment and should feature fairly simple design so the owner could be able to perform basic repair and maintenance of the vehicle himself.

Beside the cost to utilize a car – which in its biggest proportion is consisted by the cost of fuel, the retail price can represent a decisive purchasing factor. Car producers that will be able to bring on the market an ultra-low cost vehicle at a price of 2000 USD to 4000 USD will take the most advantage of this new market's growth (see figure 4). The amount of potential new buyers is strongly depending on the entry price level.

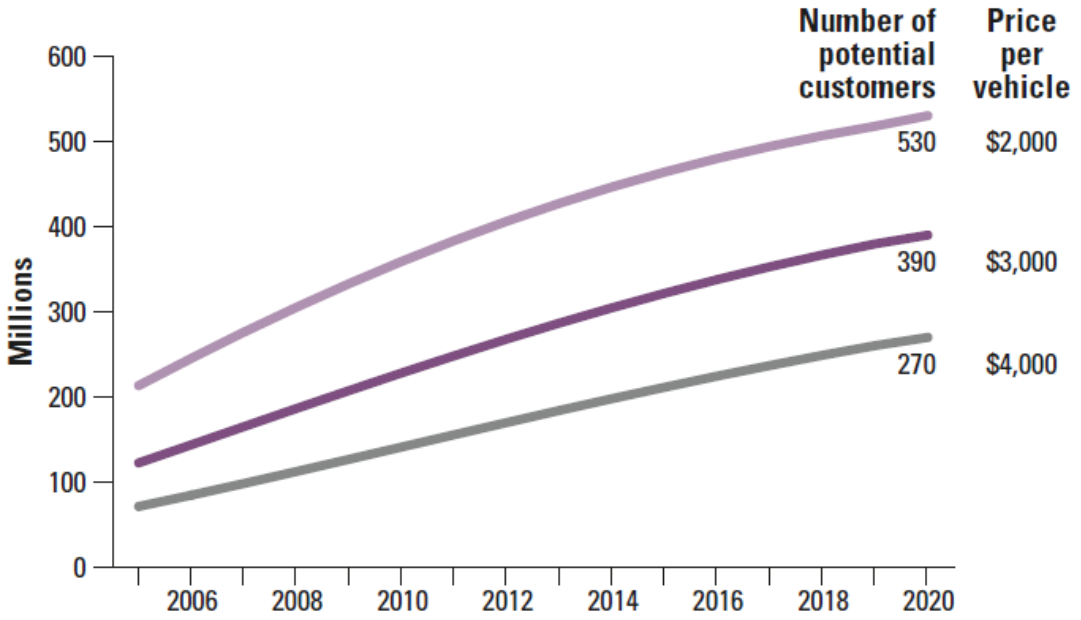


**Figure 4: Number of potential Ultra-Low-Cost-Cars customers by vehicle price** [4, P3]

Using Indian market as a reference, the analysis shows that if the cars will have an entry price of 4000 USD approximately 270 million people will represent the potential customer base in 2020. If the entry price will be 3000 USD, the potential customer market grows to 390 million, which represents roughly 50 percent increase of the potential buyers. While the entry price would go down to 2000 USD, the expected number of buyers which will afford an ultra-low cost vehicle increases to 530 million people. [4, P2]

Within the fast increasing ultra-low cost vehicles market segment, local car producers in emerging countries own currently an important strategic advantage over the established manufacturers thanks to their superior knowledge over the local markets. The main reason for this fact is that specific market particularities amid the different developing and industrializing countries vary greatly in contrast to those within developed countries where the generalist manufacturers are more familiarized with the requirements and because having the buyer's needs at the base of designing and marketing ultra-low cost cars is vital premise for success.

It happens usually that local manufacturers have a clear advantage over established producers mainly thanks to their better knowledge of the realistic selling prices and key purchasing criteria in the same local markets. These

manufacturers start by designing their entire product with the ultra-low cost concept in mind. They develop products that are cheap to produce, assemble and sell in comparison to the products that the established manufacturers design, which mainly consists of trimming down their already existing vehicles in a struggle to bring costs and prices as low as possible. The registered sales volume confirms the success of the local manufacturers. Between 2004 and 2008 the average sales growth rate of the established global producers was around 4 percent while the sales within all segments of the emerging players grew with roughly 8 percent. [4, P2]

## 1.4. The concept behind low cost vehicles

In the ultra-low cost car segment it is more than obvious for the car manufacturers that a successful path involves more than having sustainable products. In the majority of cases, the whole business model is assessed and rearranged as it is necessary. In the case of established manufacturers, that intend to enter in the ultra-low cost vehicles market, launching a separate new brand especially for their ultra-low cost cars would assure a clear distinction from already existing brands. Renault adopted such a strategy after acquiring the Romanian car maker Dacia and holding the same brand to bring on the market a new low end car situated below its previous vehicle portfolio in Europe.

In order to keep the manufacturing complexity as low as possible and by consequence also the production costs, the possible configuration of ultra-low cost vehicles is standardized and limited as much as possible. Additionally, the vehicles are built preferably with low labor cost in low cost countries like India, Romania, Serbia or Morocco. In case of the established big producers, it means setting up production plants especially for manufacturing these vehicles in the respective target regions. One can expect that manufacturers set up only one relatively high productivity production plant per region from where the finished vehicles will be shipped to a certain number of regional distribution hub.

Regarding the dealer network solution, a regular large and equally costly network is neither necessary nor affordable. Instead, the usual version of the ultra-low cost car is most probably going to be sold via a reduced number of localized regional centers where the future owner comes to the vehicle rather than the vehicle

going to the final customer. This approach has already been registered in different other areas characterized by low cost commodities. For example, in the furniture industry the usual small showroom is being more and more replaced by big centers like Kika where customers try, pick-up the desired product and take it home by themselves.

A rather innovative alternative solution for a sales channel for ultra-low cost cars could be also represented by internet based services. Following an online order, customers can take the standard finished car from a distribution center. In this way the producer is not obliged to cover any additional maybe also expensive services. Only exception would be for maintenance and repairs authorized workshops. As the ultra-low cost cars can be so designed and produced that they can be easily maintained and repaired even by the actual owner or local affordable mechanics, even this cost could also be greatly limited and reduced.

Thanks to the rather specific functional centric expectations of the new customer group – ultra low cost car customers – it is expected that these vehicles will be marketed mainly as three door saloons and station wagons but also as pickup trucks on specific markets.

Slowly but increasingly gaining importance in emerging markets are the safety issues of the vehicles in general. Actually, the chairman of Tata Motors, Mr. Ratan Tata, said one of the reasons he began to work on ultra-low cost cars is the safety. “I saw families of three or four riding on scooters,” says Mr. Tata. [5] Later he learned that death cases on two wheelers were a mere three to four times that of cars. Safety characteristics of ultra-low cost vehicles is expected to conform according to local standard requirements, for example those issued by the Unites States NHTSA or the European Enhanced Vehicle Safety Committee.

Regarding the pollution and environmental standards, namely fuel consumption and $CO_2$ emissions, it was expected that at the launch time the cars would comply the international standards Euro III or even Euro IV. In case of Tata Nano for example the exhaust emissions overcome regulatory emission requirements, having lower emission levels than two wheelers being sold in India at the respective time. Additionally the Nano is capable to achieve a specific fuel consumption rate of 4.7 liters/100km. The standard engine was expected to be a

three or even two cylinder engine working on gasoline, displacement of only 450 cubic centimeters featuring an output of around 33 horsepower linked to a manual four speed gear box. According to the Economic Times, Tata was planning also electric, hybrid and hydrogen powered vehicles for the market, while start of production was initially planned for 2011. [4, P4]

Car costs would greatly vary with additional equipment, features and trim introduced to personalize the vehicles to specific targeted markets. The interior of basic variants would feature simple instrument indicators and seat belts. For Indian market and other Asian countries the projection of 2020 market characteristics is based on the latest vehicle configuration calculated with the premises of minimum costs reaching 3200 USD. For Africa the lowest cost estimation is slightly reduced at 3100 USD, while for Russia and China estimation are 3370 USD and 3680 respectively. The mentioned values include a distribution premium as well as a marketing premium in total of around 15 percent of all production costs. [4, P4]

Regarding pricing strategy and margins, it is worth mentioning that traditionally known figures of roughly 25 percent of the production costs in order to assure coverage only for marketing expenses cannot be reached in the particular market of ultra-low cost cars. Replacing a regular model with two levels, wholesale and retail, companies may introduce a sort of direct sales approach in which the organization is comprised of a reduced number of sales and distribution centers that are operated and owned by the producer himself. Such a lean distribution concept would enable manufacturers to peak a 10 percent gross sales margin level. This margin can be further improved by means of selling accessories and spare parts over the internet and of course through existing retailers at distribution centers.

Financing possibilities represents also most of the time a matter of interest for potential new car customers. Considering how important mobility is for a complete family, it can be anticipated that a lot of families will raise together the money needed to acquire a car that otherwise a single individual would not afford to buy. However this “family sourced” cannot be reliable enough and the need for new and innovative financing strategy will still be present. Solutions for financing can be represented by one of the following models: “Grameen model” is a sort of micro financing specially adjusted to suit local requirements and needs and a so called “mobility model” in which the vehicle remains in the ownership of the manufacturer

while he is charging specific fees to the ones sharing the car. Both of these models are seen by micro enterprise lending programs as highly powerful means to poor people to have access to products and services that otherwise they would not be able to use.

The ultra-low cost car segment will experience rapid growth between present moment and 2020. Although local producers are currently enjoying clear competitive advantage over the established manufacturers thanks to their better and detailed knowledge of particularities of local low cost markets, the latter ones will do everything in order to maximize position on this market segment because annual growth rates of 24 percent are too important to be ignored or missed. Established automakers are already learning and adapting to develop new low cost strategies that would enable them to become and remain competitive in their established segments.

In order to be able to achieve success within operation in this market segment, the vast majority of established producers are moving towards cooperation with local manufacturers with the scope of developing certain low cost products from scratch. If producers are successful in innovating product design, determining the most appropriate business model and in implementing the design-to-cost principle it is almost assured the feasibility of achieving acceptable rates of return from selling ultra-low cost vehicles. Moreover, if they are able to assure absolute no compromise regarding safety and environment standards the long term success is most probably also assured.

# 2. Research low cost vehicles

## 2.1. Renault and X90 project short history

Beginning with 1990, Renault was incorporated as Renault SA. This represents the first step in the privatization of the company. It started also to increase and expand its international presence by establishing new production plants and by starting cooperation agreements with companies from various countries like China, Turkey, Czech Republic, Russia but also some countries from Latin America. [6, P4]

In the early 1990s, Renault has launched different successful vehicle models like Clio, which was a replacement for Renault 5 model, the second generation of Espace, Twingo, Laguna and finally Renault 19. Beginning with 1995, the new launched Renault Megane replaced Renault 19 model and was the first vehicle ever to receive the 4 star rating (highest possible rating at that time) in the Euro NCAP crash test for passenger safety. In the following years, Megane range developed to include hatchback, estate, saloon, coupe and cabriolet variants. In the first half of 1990s, Renault registered also quite a big success in FIA's Formula One racing as well. [6, P4]

Unfortunately, starting with 1996, Renault began to register losses primarily due to the relatively extended recession installed in Europe but also as a result of the increased competition within the global automotive industry. The French government understood that Renault's privatization would be to the company's benefit so it lowered its shares from 80 percent to 45 percent during the same year.

In 1999, Renault formed a cross-holding alliance with Nissan Motors from Japan and purchased 36.8 percent equity stakes for 3.5 billion USD and therefore gained effective control over the company, according to Japanese law. In turn, Nissan acquired 15 percent non-voting stakes of Renault Company. Carlos Ghosh, who was at the time Renault Vice President, was appointed to turn around Nissan and furthermore, in 2002, Renault increased its stake over Nissan to 44.4 percent. [6, P4]

Also in 1999, Renault bought the Romanian automaker Dacia too for 50 million USD. This acquisition was followed in September 2000 by acquiring of 70

percent stake over Samsung Motors, a South Korean automotive manufacturer for a mere 512 million USD. [6, P4]

During the early 2000s, Renault has created itself a good reputation within the global automotive industry especially for its design innovation and safety. At that time, all its new models were awarded the highest 5 star safety rating at Euro NCAP, except the Renault Trafic. Renault vehicles performed well also at the European Car Of The Year awards, the Clio model being even the only car to receive the award twice since it was introduced in 1964. [6, P4]

In 2005, Carlos Ghosn, who was CEO of Nissan, took over additionally from Louis Schweitzer the CEO position of Renault. Louis Schweitzer was CEO of Renault since 1992 and he continued as Chairman. Carlos Ghosn announced in February 2006 the “Renault Contrat 2009” whose scope would have been to bring Renault and keep it in the position of the most profitable volume automotive maker in Europe. The plan stated three strategic objectives in order to achieve the goal:

- Sell additionally 800.000 units in 2009 compared to 2005
- Achieve an operating margin of 6 percent in 2009
- Make the new Laguna, supposed to be launched in 2007, one among the three best cars in its category regarding product quality and service.

Mid 2006 it was reported that Renault-Nissan Alliance was negotiating with a possible further alliance with General Motors Corp. but the talks fell through eventually. In the yearly fiscal result from December 2006, Renault declared a net income of 2.8 billion Euro on revenues in total of 41.5 billion Euro. [6, P4]

The Renault-Nissan alliance was in 2006 both as production figures and as sales figures the fourth largest automobile production group in the world after General Motors, Toyota Corporation and Ford Motor. The France Government owned at that time 15.7 percent of the company. Additionally to the cross alliance holding with Nissan and ownership of Dacia and Samsung Motors, Renault owned also a 20 percent share of the Volvo Group, while Volvo passenger vehicles division was owned by Ford. [6, P5]

Around mid of the 1990s, under the coordination of CEO and chairman of the board Louis Schweitzer, Renault put the basis of the strategy to expand its

presence on markets outside of the Western Europe. The plan was to achieve by 2010 a sales figure of four million cars across the entire group but without Nissan – meaning Renault, Dacia and Samsung Motors. In order to accomplish this goal, the company realized that they would need to exploit the potential existing in developing regions, as the three biggest automobile markets of the world were almost saturated – Unites States, Japan and Western Europe. Following this strategy, Renault decided it's time to explore this possibility by developing a low price vehicle in order to meet the various specific needs in developing countries. As target price for the new car they set the 5000 Euro goal. [6, P5]

When Renault bought Dacia in 1999, the new project gained some momentous. Dacia was a known and established brand in Romania, even if somewhat outdated. Following the acquisition, Renault received the ownership of the Dacia production plant in Mioveni, south-central part of Romania. The state of the plant was obsolete and needed upgrade so Renault invested over the next 6 years, from 1999 to 2005, approximately 650 million Euro. As a result, the plant was brought to a level of quality and efficiency comparable to other Renault manufacturing sites. [7]

The location of Dacia production plant offered a strategic advantage because the region assured easy access to both markets in central as well as Eastern Europe. Renault started its activity within the premises of Dacia plant by starting to develop a range of low cost cars designated for markets in Central and Eastern Europe under the project name coded X90. At the time Renault was trying to achieve a similar success story as Volkswagen did by developing a low cost car under its subsidiary Skoda in Czech Republic. Renault decided to put Jean-Marie Hurtiger in charge of the X90 project started in 1999. The first vehicle to be launch within this project was intended to be a mid-size passenger saloon.

Renault's X90 project is aiming to deliver a car for "people in emerging markets who have never owned an automobile". At that time, the estimation was that approximately 80 percent of the world's population would belong to this category. [8] The initial plan consisted of beginning by selling the car in Central and Eastern Europe and slowly expand selling to markets like South America, Africa, Middle East and Russia. [9]

Renault performed a thorough and complete study of the targeted market in order to be able to understand and take into consideration the requirements and expectations of potential customers. It came to the conclusion that the potential buyers in those markets were frequently familiar with cars from western markets but in the vast majority of cases they would not afford to buy vehicles at all. Even in the cases where they did buy a car, this was a really calculated and in detail planned purchase usually viewed as an investment. Another fact brought up in the attention by the study was that the driving conditions in developing countries were often pretty bad. Roads were mostly needing repairs, climatic conditions where rough, even extreme in some parts of Russia and Africa, while maintenance of the cars was pretty much out of standards. Needless to say that it often happened that cars had to carry larger cargo and passenger loads than specified in vehicle's limits.

Following results of the study, the goal started to take shape: the new vehicle had to be sturdy and economical, while respecting international standards like safety characteristics. Therefore no compromise was to be taken regarding safety while plenty of technology already available within Renault was to be included in vehicle's specification. The car was supposed to feature plenty of space as well for its passengers as also for their luggage. The name under which Renault took the decision to market the X90 models was a new one created from scratch - "Logan", a computer generated name that would avoid a negative signification in any language whatsoever. [6, P5]

### 2.1.1. Strategy and beginning of Logan

The Logan vehicle was developed to meet strict specifications. The design team received clear goals regarding the size, design and especially price requirements that needed to be met. Because the Logan was planned from the beginning to be an international project, Renault had to make sure that the required specifications are drawn according to each and every target market.

Renault decided to start the development of the Logan as a new standalone project and designed it from the beginning with the requirements of the target markets in focus. Usually low price vehicles are in fact "stripped down" versions of "mature" models of the producers' portfolio. There are also cases where automotive companies have modified obsolete models from developed markets and brought

them on markets in developing countries.

The main purpose of Logan's project was to "allow Renault to reach a new customer range with a product that packs the bare essentials without resorting to using a car that's been out of production for several years." [10] While referring to the vehicle's development, Hurtiger mentioned that "it was a fascinating challenge. We had to start from scratch on the first vehicle developed by Renault for sale initially outside Western Europe, and a program in which financial considerations were key." [11]

The whole technology behind, engine, gearbox and manufacturing standards and processes were developed within Renault's technical center near Paris – Technocentre. Logan was expected to be a simple notchback saloon in the subcompact or even supermini category and should have combined practicality with reliability. In contrast to the other usual Renault vehicles remarked for their style, the looks of the new Logan was to remain rather simple.

From the technical point of view, the new project was derived from the Renault–Nissan Alliance's B-platform, which enabled Renault to use on Logan the same tooling and manufacturing standards as for other cars in the group. The same technical platform was used for models like Renault Clio and Modus and Nissan Cube and Micra.

On the powertrain side, Renault decided to use the already proved and reliable 1.4 and 1.6 liters petrol. The engine bay and electric system layouts are pretty similar to those found on Renault Clio as well as on Twingo. This enabled the Logan to have its steering system, rear brakes, door handles, steering wheel, steering column and instrument panel based on the Clio and Twingo design, while the gear shifter knob and air vents were carried over from Renault Espace model. [6, P6]

The gearbox was taken over from Renault Megane and Renault Laguna models, while front suspension came again from Clio and rear one was based on the platform B specifications with some modification like vertical shock absorbers. The whole suspension was altered in order to increase the vehicle's ground clearance. By implementing already tested and proven parts, components and solutions from existing models, enabled Renault to reduce to a minimum additional

investments in design, test, validation and improvement of new components as well as tooling and equipment. This would also contribute to keeping the costs as low as possible. [6, P6]

### 2.1.2. Keeping costs low

Due to the nature of the Logan, which had the main purpose of being sold in developing countries markets, the cost of the car was the main design factor, thus being labeled as a *„design-to-cost"* project. After fixing the target sale price at 5000 Euro, the entire design and structure of the car were carefully established and finalized respecting this limit.

The purpose of the Logan was to offer the best possible features at the established price point, avoiding shallow targets such as standing out in a crowd. This is why it was designed as a modern car without superficial costly design elements and more than average technology. Renault managed to achieve considerable savings in cost, mainly by manufacturing the Logan in Mioveni, the hometown of the Dacia factory. Production costs and work force in Romania were obviously lower than in Western Europe. An example from this point of view is the estimation according to which, the gross pay for a Dacia line worker was roughly around 300 Euro per month, compared to an average of 2400 Euro per month, which was the monthly wage for an autoworker in Western Europe. [12]

To lower production costs further, Renault mobilized its suppliers and collaborators and managed to source most of the production material locally. Approximately 65 percent of the components used for Logan are being manufactured in Dacia's homeland, Romania, allowing this in an increased percentage for up to 80 percent in 2015. Critical parts and especially the engine were produced or assembled on-site, at the Mioveni production plant. Renault stimulated and encouraged all of its suppliers to set up operations in the newly developed supplier park that is created within the Mioveni factory complex. The suppliers were initially reluctant regarding the relocation to Romania, but eventually some of them began to support the car manufacturer, 26 suppliers ended setting up operations in Pitesti region. Seven of them even moved into the supplier park – producing and assembling sub-components on-site, in Dacia plant.

An important way to control costs was to keep the structure of the Logan as

simple as possible. The superficial features, such as cosmetic ones, were eliminated. The Logan had been thought to be a functional car, thus placing more emphasis on utility and safety, choosing to not insist very much on the aesthetics side. Straight lines, simple angles and very few curves were kept in mind when targeting to keep the design of the car basic. The designers considered that making any kind of more complex designs would only increase the cost of manufacturing and in an indirect way, it would also lead to quality issues.

Although it was a copy-cat, designers succeeded to reduce the number of components for the Renault models from which they initially borrowed basic features by more than 50 percent. Taking the dashboard of the Logan as an example, this was a single injection-molded piece. Normally, in mid-sized cars found in western countries, the dashboard would comprise several pieces, colors, and finishes. In the cases of high-end Renault cars, the dashboards would be created by up to 30 parts. Keeping the dashboard simple, Renault engineers made assembling easier and also automatically eliminated many potential quality problems.

The case of the windscreen of the Logan is another example. It was designed with a simple curve, instead of a double curve – which is technologically more challenging to produce, and also increases the chance of defects during the production process. Logically, designers gave up using complicated electronics and other parts in the production of the car.

Most of the Logan's parts were made symmetric, to help increase their versatility, thus also lowering costs. An example for this case is the left and right rear view mirrors, which were made identical – a trait which reportedly resulted in savings of up to 2.5 Euro per Logan. The rubber coverings on the doors, also known as the protective moldings, were another case of identical details on either sides. Because of this, tooling and assembling was made much easier during the manufacturing stage, also simplifying the inventory management of Dacia factory. [13]

The Logan was a completely computer-imagined project, made by a design team consisting of 40-50 people, led by Gerard Detourbet. This completely abolished the need to build prototypes, meaning a substantial diminution in the expenses needed to build them. Once designs were finalized using digital mockups, the car would go directly into production. This simple innovation succeeded in saving

Renault a whopping 37 million Euro, this only during the pre-production phase. At the same time, Renault began using digital mockups for all its car models. [13]

There was almost no automation in Dacia plant. A small number of robots were used in the production process of the Dacia cars. This allowed Renault to take great advantage of the low labor costs in Romania and also helped eliminate the need for later heavy investments. At Dacia plant, applying a specific quantity of glue to the rims of the windshields is an example of when robots were used – mainly for tasks requiring extreme precision. Except for these precise tasks, roughly 1000 workers would do the rest of the work in the factory. Compared to the car plants in Western Europe, almost fully automated, using mostly robots, Dacia was almost in complete contrast.

The idea to set up a Greenfield facility would have cost Renault much more. This is why the French group focused mainly on investing in upgrading the Dacia factory in a significant way. According to analysts, an investment of minimum 2 billion Euro would have been required to set up a highly automated car factory. Renault managed to spend only a fraction of that, succeeding to upgrade Dacia plant to European and international standards.

Logan succeeded in being one of the cheapest cars to manufacture in its class, due to Renault's emphasis on keeping costs low. A Deutsche Bank report estimated the production cost for the Logan to be around 1000 Euro per car, meaning less than half the estimated 2200 Euro per car, needed for an equivalent vehicle (such as the Volkswagen Golf). [12]

### 2.1.3. Safety

Renault reassured everybody that no compromises had been made regarding safety, despite Logan being a no-frills car. This was done by designers, simply by adapting the safety solutions used in state-of-the-art Renault cars and making them compatible with the Logan. [6, P8]

Logan was designed to meet E.U. safety norms. The top-end version of the Dacia model included an Anti-lock Braking System (ABS) similar to the one put on the Megane. ABS was initially an optional feature, for the lower-end versions. The

high-end Logan version also included driver and passenger airbags, also backseat safety belts for up to three in the rear passenger cabin. Logan's structure also included deformation zones, being especially designed to disperse the kinetic energy of the impact, in the worst case scenario event of a collision. The dashboard included a honeycomb-type structure, being composed of highly absorbent polypropylene, thus reducing the risk of knee injury, in the case of impact. The structure of the seats was designed especially to keep the pelvis in an appropriate position. [6, P8]

Evidently, the Logan was not only subjected to safety and impact tests by the Euro NCAP but also by some independent bodies in Europe. The car received a medium rating of 3-stars in the Euro NCAP tests for adult occupant safety and child protection. Unfortunately, it managed to score only a 1-star rating for pedestrian safety. The ratings were considered as being fair, even though other comparable cars usually managed to rank higher.

### 2.1.4. Logan's Specifications

The Logan is projected as a 3 box saloon, with a „tall boy" design, targeted at maximizing the interior space. It had a wheelbase 30 of 2.63 meters. The design of the car was aimed to carry five adults and planned to have a generous boot space of roughly 510 liters (greater than in many cars, including high-end ones). Although the main purpose of the car was not to become an off-road vehicle, the Logan was being given the advantage of having a base height of 15.5 cm. This differentiates the car from the competitors by approx. 2.54 cm which is mainly due to a better fit to the bad roads in certain markers. [6, P9]

The first generation of Logan was developed with two engine versions: first version was a 1.4-liter engine with 75 HP and 112.5 Nm of torque, second version was a 1.6-liter, 90 HP and 128.8 Nm of torque. Both cases were eight valve engines, initially being fit on other cars such as the Clio and the Kangoo. The 1.4L managed to get from 0-100 km/h in 13 seconds, with a maximum speed of 162 km/h. However, it took only 11.5 seconds for the second engine to reach the speed of 100km/h and a maximum speed of 175 km/h. [6, P9]

Both engine versions were modified to accept lower quality fuel, due to the

target to sell the Logan in developing markets, where fuel quality is not assured. However, both engines met Euro4 emission standards. In 2005, Logan was presented with a 1.5 dCi diesel engine and 65 HP. The petrol versions of the Logan estimated to reach a mileage of 13 to 14 kilometers per liter (7.14 to 7.7 l/100km), while the diesel version was estimated around 18 to 19 kilometers per liter (5.26 to 5.55 l/100km).

The 1.4L engine version of the Logan was sold from a base price of 5000 Euro and did not include automatic windows, central locking, fingertip radio controls on the steering wheel, nor sophisticated seating adjustments. The top end Logan, automatically included airbags, ABS, power assisted steering, electric windows, remote-controlled central locking, and CD player as normal features. Following the target to keep the car as basic as possible, the Logan interiors were not very fancy. There was almost no variation in colors and finishes, several customers finding it quite stark. [6, P9]

### 2.1.5. The launch and its aftermath

June 2004 was the marking point of Renault's launch of the Logan which placed the lowest price for a sedan, their base line version being 5000 Euro. After first being launched in Romania, it made its way to the Central and Eastern European markets.

The launch of the car was made with little buzz. Despite this, it managed to create a big surprise, even before its launching, because of the low price. The market was filled with extremely positive initial responses to the Logan. Even though most of the buyers agreed that the car was not a beauty winner, they said that the tremendous value for money it offered made up very much for the lack of looks. Logan became really quick very popular in countries like Russia, Romania, and Poland, among others. [14]

What Renault did not manage to anticipate was the reaction to the Logan by the people in Western Europe. Renault originally had the intention of selling the Logan everywhere in EU except in Western Europe, but soon after the launch, the Renault dealers in countries like France, Spain, and Germany started to get requests from customers about the car. Many of the customers started completing

waiting lists for Logan deliveries. As this had a massive impact, despite considering the times, it took approximately three months before manufacturing one. [15]

If we think about it, the interest from customers in the Western European region was not that surprising. Many of the available cars in W-EU markets came at a consisting higher price than the price of the Logan. A relevant part of the price was for accessories and gadgets which many customers never actually used or needed. This is why a no-frills, simple, basic car appealed to buyers.

Due to the unexpected demand arisen for the Logan, Renault had to increase production considerably. In early 2005, the Logan started being produced in Avtoframos, the Moscow production plant of Renault's Russian subsidiary. Shortly after, production in Morocco and Colombia started.

Renault launched a slightly modified model of the original Logan for buyers in Western Europe in June 2005. The first launch of the car was made in France, followed by Spain and Germany. The Western European basic model included passenger side airbags and a three-year warranty. The base version of the car was estimated around 7500 Euro, approximately half the price of other cars situated in the same class. (Ford Focus was estimated around 13910 Euro and the Volkswagen Golf roughly 14728 Euro). In Western European markets, the majority of buyers reportedly requested the high-end version of the Logan, with some extras, raising the price to about 9676 Euro. [12]

Taking advantage of its main characteristics, of being a low priced, low maintenance car, the Logan was quite popular among college-goers. According to the majority of customers, the price and ease of maintenance have been the determining factors, when picking the Logan. A reasonably good ride quality was one of the top reasons buyers chose the Dacia model over other manufacturers.

In 2005, Renault sold 145 000 units of the Logan in the entire world (of which 13 719 were cars sold in Western Europe, after its launch in June that year). Based on the car's outstanding success in Western European countries such as France, Spain, and Germany, Renault quickly reacted, planning to launch the model in Italy in January 2006, and later on in Belgium, Switzerland, Netherlands and Austria. [6, P10]

In early 2007, Logan was launched in Iran. Renault hoped to sell around 500 000 units a year in the country. The car, called Tondar in Iran, was produced in a joint venture with the Iranian car manufacturers Iran Khodro and Pars Khodro. The initial market reaction in Iran exceeded all expectations, with 100 000 pre-orders placed in the first week after bookings were opened. The car's price was fixed at approximately 8000 Euro in the country. Launches in India, Brazil, and Argentina in the middle of 2007 followed the Iranian success. The Logan was sold under both Renault and Dacia brands around the world. In Mexico, it was identified as the Nissan Aprio. [12], [16]

Beginning with April 2007, Renault managed to sell a total of 450 000 Logan vehicles around the world. Renault's target was to sell one million Logan a year worldwide, before 2010. The Logan succeeded in improving Renault's presence in many emerging markets. In 2006, Renault's sales outside Europe increased by 8.8%. This meant a staggering 30% of the company's total global sales. [17]

### 2.1.6. The prospects

Following the major success of the Logan sedan, Renault has decided to release, in the autumn of 2006, the Logan MCV - station wagon. The MCV came with five and seven seat versions, being priced between 8000 and 11 500 Euro. This vehicle used the same engines which were used on the Logan saloon. In January 2007, a minivan version had finally been launched. This was sold with prices between 6700 and 8800 Euro. A hatchback version was also expected by buyers to be launched in Romania in 2008. When being compared to other cars in its class, such as the Chevrolet Kalos, Skoda Fabia, Hyundai Accent, Kia Rio, Ford Focus or VW Golf, the Logan's main strength was the low sell price. Logan might have lacked some of the standard features which were in many of these cars, but because its price was only half that of competing cars, a lot of buyers felt that Logan was a great deal, even if taking into account spending a bit more on accessories. [6, P11]

Analysts also felt that Logan could manage to mingle its way into the markets of countries like the US and UK, as an entry-level car. Nevertheless, until early 2007, Renault did not make official its plans to launch the car in these markets. Even in Western Europe, the Logan was not only targeted to the lower income groups, but also to higher income customers. Buyers from the higher income status were buying

it as a second or third car.

The main disadvantage of the Logan was its not so friendly looks, which were categorized as being rather unappealing, especially if compared to other Renault cars. Despite this, analysts came to the conclusion that its looks did not deter too many buyers.

Another big minus of the Logan was the fact that the low-end version of the car was totally stripped down, not having even basic features, such as air conditioning or power steering. Whoever was looking for an element of comfort from the Logan, was up for a slight disappointment. They had to choose the high-end version, or completely refit the basic model with optional extras. Both of the highlighted versions would mean additional costs. Because of this, a wide variety of people felt that Renault had no justification when asking for up to 5000 Euro per a Logan car.

Another more important concern was regarding Logan's 3-stars average rating gained at the Euro NCAP tests. The reason for the raised concerns was that most of the Renault family cars scored high and very high on this tests. Thus creating the premise that Renault may have scrimped on safety in its attempt to cut costs in the Logan's production. Renault continued to say that the 3-stars score was an acceptable one, even if the result was reportedly lower than most of the other cars in its class.

Due to Renault's success with the Logan, other carmakers felt encouraged to also announce similar low-budget projects. Volkswagen made public a project codenamed 3-K, targeting to develop a saloon car to compete with the Logan. This car was supposed to be manufactured by Volkswagen's subsidiary from the Czech Republic, Skoda, and it was planned to have a price of 3000 Euros. The launch was thought to be made in China, during 2008. Further launches in Brazil, Malaysia, India, Russia, and Mexico, were supposed to follow. [6, P11]

All over the world, even carmakers from developing countries started working on extremely low-priced cars. India caught the attention of the public with Tata Motors, which was expected to launch in 2008 a car priced around $2000, for the domestic market.

In January 2007, Toyota announced that the company was looking to develop a radically different process of car manufacturing. This was supposed to cut costs significantly across the entire production chain. Toyota planned to review its entire production system, lowering development costs for each and every stage to of a new model. This formula was later on supposed to cut costs across its entire lineup. Toyota's plan to overcome its competitor, Renault, was "a rough target of being at least cheaper than the Renault Logan" despite never disclosing the price of their low cost options. [18]

Most of the market analysts have stated that the Logan has become a statement in the automotive industry as the car has been declared as being very close to becoming the most successful car worldwide.*(Fiat had once attempted to do so with its model - Palio, but the car had not been very successful.)*
Adam Jonas sustained that other companies' attempts of making world cars had largely been failures because they did not have the correct cost structures. The cars did not succeed because it was difficult for them to recoup costs when customers failed to opt for upgrades and extras, which at the end prove to be the main sources of profits. Taking into consideration that most of the customers from developing countries bought cars without any frills, this approach was not successful. Nevertheless, Renault's design-to-cost approach of making the Logan worked perfectly to the company's advantage. Despite the clear shortcomings of the Logan, in the end, it proved to be a great success all over the world, having a significant role in Renault's global overall strategy.

## 2.2. Tata Nano

### 2.2.1. Background note

Tata Motors dates back to the mid-1900s. In 1945, Tata Motors was incorporated as TELCO. The company was engaged in producing locomotives and engineering products. The launching of a steam road roller, by association with UK-based Marshall Sons was the result of a three year collaboration. [19, P2]

In the 1950s, Tata Motors ventured into the production of medium commercial vehicles. In 1954, TELCO signed a contract with Germany-based

Daimler Benz AG to produce medium commercial vehicles and, within six months, the first vehicle was already rolling on the streets. In 1959, it also set up a R&D center at Jamshedpur, India. In 1961, TELCO began exporting vehicles. The company also managed to establish an engineering research center in Pune, India, in 1966. [19, P2]

In 1983, the company started producing heavy commercial vehicles. In 1985, in collaboration with Hitachi, TELCO produced hydraulic excavators. From the next year on, it started the production of the Tata 407: the first “indigenously designed” light commercial vehicle. [19, P2]

In the 1990s, TELCO introduced some new vehicles including the first indigenous passenger vehicle, the Tata Sierra, and the multi utility vehicle, the Tata Sumo. In 1994, the company entered into a joint venture understanding with Mercedes Benz to produce Mercedes Benz passenger vehicles in India. In 1998, indigenously designed passenger vehicle, Indica, was launched. In the same year, TELCO launched India‘s first sports utility vehicle, the Tata Safari. In 2002, TELCO launched the Tata Indigo and entered an understanding with the UK-based MG Rover to sell the Tata Indica as the City Rover in the UK, its first indigenously developed passenger vehicle. In 2003, TELCO was rebranded as Tata Motors. In 2004, Tata Motors acquired the second largest truck producer in South Korea, Daewoo Commercial Vehicles Company. [19, P3]

In 2006, Tata Motors and Fiat India Automobiles signed an understanding to share a dealer network. Tata Motor also signed a Memorandum of Understanding with Fiat in 2006 to produce engines, transmissions and passenger vehicles. As part of an understanding signed in 2007, Tata Motors agreed to manufacture pick-up trucks which would have the Fiat brand. It was decided that the trucks would be built at Fiat‘s production plant in Argentina. These trucks were expected to be sold in South America and in some European countries. [19, P3]

In 2007, the company began constructing its first small vehicle plant at Singur, in West Bengal, India. Due to the move of the manufacturing base all the way to Gujarat, the launching plan of Nano, agreed by the end of year 2008, has been delayed. And also because of the concerns of the farmers in the Singur area on the purchase of their land by the company. On the 7$^{Th}$ of October 2008, the

company signed an understanding with the government of the western state of Gujarat, allowing them to set up a Nano manufacturing plant in the state. The understanding entitled Tata Motors to 1100 (4.45 Millions square meters) acres of land for the mother plant of the Nano near Sanand, 30 km away from Ahmedabad. [19. P3]

In 2008, Tata Motors acquired both Jaguar and Land Rover from Ford, the US based automotive company, with a capital of over two billion Euro. Jaguar Land Rover (JLR) was part of Ford‘s Premier Automotive Group, being split into: Jaguar producing high-end luxury vehicles, Land Rover - high-end SUVs. [19, P3]

As of 2008, Tata Motors was the largest automobile company in India from revenues point of view. It was also the leader in the heavy commercial vehicles business in India with a market share of 65%. The company‘s production facilities were located in Jamshedpur, Pantnagar, Lucknow, Ahmedabad, and Pune. There was no difference made in the way Tata Motors has decide the market both passenger and commercial cars across ECMEA and APAC. [19, P3]

### 2.2.2. Nano – the vehicle

The Nano was powered by a two cylinder, 623 cc, rear engine with a rear wheel drive. The fuel economy of the vehicle was expected to be around 21 kilometers per liter (4.76 l/100km) in city driving conditions. It had a 4-speed manual transmission and the maximum possible cruising speed was of 105 kilometers per hour. [19, P3]
The Nano met all Indian safety standards. According to the claims made by Tata Motors, the Nano was BS III compliant and could be upgraded to BS IV emission norms. It also aced the crash tests, meeting all required international safety norms. At the beginning, Tata Motors planned to introduce the petrol version, later on following it up with a diesel and electric versions. [19, P4]

The vehicle was available in three options – the Tata Nano Standard, the Tata Nano CX, and the Tata Nano LX: [20] Refer to Appendix A for prices related to Nano.

- Tata Nano Standard: The basic version was available in three color picks, single-tone seats, and fold-down rear seat. The base option complied with

BS II and BS III emission norms.

- Tata Nano CX: The second option comes with a variety of five colors as well as heating/air-conditioning, two colored seats, parcel shelf, brake booster for assisted brakes and a foldable rear seat with nap rest. This variant complied with BS II and BS III emission norms.
- Tata Nano LX: The third option had all the features offered with Tata Nano CX. Additionally it featured complete fabric seats, central locking, powered windows in front, body colored exteriors in three premium colors, fog lamps, electronic trip meter, cup holder in front console, mobile charger socket, and a rear spoiler. The option complied with BS III emission norms.

### 2.2.3. The Nano project

The project to manufacture the Nano began in 2003. The one who became responsible to run the development of Nano, Girish Wagh, had to manage a number of approx. 500 employees. Right from the beginning, the team members were asked to be as frugal as possible, maintaining the low price target which was set for this vehicle. However, the top management of Tata Motors had specified that while the small car had to be made at low cost, it had to meet the regulatory requirements and achieve performance targets, especially fuel efficiency and other international standard emission norms.

The development team repeatedly stated that it was Ratan Tata's involvement in the project and continuous support which always boosted the morale of the team. According to Wagh, "Mr. Tata's involvement with the project, his constant encouragement and support, and his presence at the Pune plant were what made it all happen. He led by example. His interactions were not only with senior managers; he discussed things and asked for suggestions from everyone. And this attitude percolated to all team members". [21]

The main objective of the plan was to obtain a "four wheel version of an auto-rickshaw". No doors or windows were included in the initial plan. The innovation would be the plastic flaps, projected to protect the passengers from the rain. The team came up with the idea of using plastic instead of steel, and also to buy a low-priced engine. Elaborating on the initial plan, Nikhil A. Jadhav, Industrial Designer at INCAT, Tata Group's engineering and designing firm, said "The idea was to try

and create a very low cost transportation with four wheels; it was not even defined as a vehicle." [22] After beginning to develop the plastic flap vehicle, the team came to realize that it was possible to create a vehicle within the price target.

According to analysts, Tata Motors was able to achieve its low price target due to the Nano's innovative design. The company has no less than 37 patents for the design. Refer to Appendix B for Tata Nano specification. Following its main target to reduce costs, the R&D team responsible for developing the Nano came up with modifications on most of the components of the vehicle. Here they included the engine, steering, driveshaft, wheels, tires, seating systems and interiors. [23]

### 2.2.4. Nano's specifications

Engine

At first, the Nano team believed it was a better plan to outsource the engine. The main thoughts drawn from the next brainstorming sessions were that the engine had to be created by themselves. In 2005, work on the new engine began, having a total of three design changed during the period. At the end, they decided to go with a 623 cc, two cylinder petrol engine.

Where the production allowed, lightweight steel was used on the Nano, making the vehicle much lighter compared to other small vehicles. Trying to reduce steel content in the vehicle, Tata engineers used an aluminum engine instead of a conventional engine, normally made of steel. The aluminum engine saved costs and also reduced weight in the vehicle. The rear positioning of the engine had the purpose to increase the space in the interior of the vehicle. Commenting on the rationale for the rear position of engine, Abhay Deshpande, Assistant General Manager, Vehicle Integration at Tata Motors' Research Center, said, "It made the vehicle more low-cost, more efficient, and more compact." [22]

Due to the lack of space for the battery in the back, this was placed under the driver's seat. Because the engine was easy and positioned in the rear, it put less pressure on the steering system. Due to this matter, the rear wheels were under no conditions required to be linked to the engine. While adding these modifications, the Nano team ensured that the engine achieved all emission standards and sound norms, also being fuel efficient. Trying to reduce the price of the Engine Control Unit

which controlled the operation of the vehicle's engine, Tata Motors and Bosch collaborated in creating some modifications, which also included reducing the number of sensors used by the Engine Control Unit to oversee the vehicle's engine. Such changes greatly improved the company's overall goal of reducing costs.

Having a rear engine affected the air flow of the vehicle. The supplier of the engine cooling system - Tata Toyo Radiator, came up with never used before ideas to take care of this problem. The design of the rear doors was in a way which allowed easy air flow in the vehicle. Redesigning the fan motor and fan blade also increased their efficiency.

Steering and driveshaft

The steel rod of the steering was replaced for Nano vehicles, with a steel tube. This tweak managed to reduce the total weight of the vehicle. The supplier of these tubes - Rane Group - redesigned them to be made of only one piece, changing the normal traditional set-up of two pieces. The result of this change was the saving gathered from the cost of machining and assembling the usual two pieces of the steel tube. According to Harish Lakshman, Director of the Rane Group, "The world has seen this sort of integration of two pieces into one, but applied differently – not for a new vehicle, and not to reduce costs." [23] Transferring power from the engine all the way to the wheels of a vehicle is being conducted by the driveshaft. The driveshaft for the Nano was supplied by GKN Driveline India, a subsidiary of GKN Plc. After experimenting with 32 different types of driveshaft, the supplier created the appropriate driveshaft for the Nano, receiving help from French and Italian designers. GKN produced a smaller diameter driveshaft for Nano's rear wheel drive system, thus managing to make if lighter and also reducing material costs.

Wheels and tires

The wheels put on the Tata Nano were produced and offered by Wheels India, promoted by the TVS Group. The company especially researched and developed a lighter wheel than those used on other passenger vehicles in India. Quoting Srivats Ram, Managing Director of Wheels India, "The wheel that was developed is lighter than any other passenger car wheel in the country and the first wheel to my knowledge in passenger car wheels to have three bolt-holes instead of the conventional four." [24]

MRF supplied the tires for the Nano. Because of the rear engine car status

which Tata Nano has, the rear tires were made wider than the front tires to compensate the larger rear load. MRF developed three types of tires for the Nano vehicle. The front tires were 135/70 R12, while the rear ones were 155/65 R12, having tubeless radial tires of 12-inch rim diameter. The spare wheel was different from the rest, having 135/70 R12. This made it use up less space and automatically reduced weight and costs. The purpose of the spare wheel was to manage to drive the car to the nearest place where the main defective wheel could be repaired. The tire was branded “TEMP” by the MRF.

Seating systems and interiors

Tata Johnson Controls Automotive supplied the seating systems. Front seats were based on a single support structure, instead of the traditional “individual rail”. Seating comfort was given be a sufficient amount of foam. The driver‘s seat could be moved forward and backward, as well as reclined. The rear seats were able to be folded - helping increase the rear space available inside the car. The basic option did not have the option of seat adjustments, thus managing to reduce further costs.

Tata AutoComp Systems supplied the interior and exterior plastic components, including the bumpers, instrument panel, air vents, cockpit, door handles, etc. The Nano and all its components were designed to reduce weight. The recess in the front dashboard was designed so the passengers could keep small items in it when traveling. The “main console” in the vehicle was placed for both right handed and left handed drives. It also included a speedometer, a digital fuel gauge and an odometer. [19, P6]

Various parts

Following the purpose of reducing costs, each individual component of the Nano car was taken into observation in the search to lower the price. Thus, in order to reduce the weight of the vehicle and also save costs, the Engine Induction System was made almost entirely of plastic, which is more easy and cheap than aluminum. Bosch supplied a conventional vacuum booster, searching to further reduce costs on the vehicle’s brakes. Instead of having conventional front wheels disk brakes, the Nano car was fitted with a pair of drum brakes. This was a solution which had to be implemented because of the engine positioning in the rear of the car. This caused the load on the rear wheels to be higher than on the front ones. The Nano team came up with an innovative cable type gear shifter developed by themselves. This was used instead of the rod type, helping reduce the weight of the gear shifter

system and automatically smoothening gear shifting.

The windshield washing system was made smaller compared to any other vehicle and the washer tank was fixed in front of the vehicle, to save space and reduce costs. The Nano was given only one wiper and only one outside rear view mirror. The inner rear view mirror was especially redesigned so that it could integrate with the cabin lighting system. This way, it reduced the total number of required components inside the car. Regular bulbs met regulations and helped cut costs, this is why they were preferred, instead of long life bulbs. [19, P7]

### 2.2.5. Managing the supply chain

Because of the ambitious targets and the continuous cost cuts, the part suppliers for Tata Motors were skeptical at the beginning regarding the project. Later on, they were convinced that an important contribution to achieving the cost target could be made by their side. Refer to Appendix C for suppliers of Nano project.

The suppliers were split into two different types: some developed a number of auto parts through their personal R&D, while others teamed-up with Tata Motors, developing certain parts required for the Nano. Tata Motors also helped some auto part suppliers find international partners, thus developing products required for the Nano.

Taking into consideration one of the main targets: reduce costs, from logistics point of view, Tata Motors planned to assemble the Nano at dealers' workshops. The Nano's components could have been built and sent separately for assembling. To do so, if entrepreneurs agreed to set up an assembly operation, Tata Motors gave training to their employees and supervised quality aspects in the production phase. The company wanted these entrepreneurs to set up a "satellite assembly operation" for it. Hence, the Nano would be sold in "kits" and it would be assembled at the satellite assembly operations and sold via local distributors. According to Ratan Tata, "A bunch of entrepreneurs could establish an assembly operation and Tata Motors would train their people, would oversee their quality assurance, and they would become satellite assembly operations for us. So we would create entrepreneurs across the country that would produce the vehicle. We would produce the mass items and deliver it to them as kits. That is my idea of dispersing wealth. The service person would be like an insurance agent who would

be trained, have a cell phone and scooter, and would be assigned to a set of customers." [25]

### 2.2.6. The challenges

Tata Motors kept its promise and launched Tata Nano at the price of Rs 100 000 (ex-factory). The maintenance of the price was the real challenge which had to be faced. They managed this by decreasing the raw material costs from January 2008 to March 2009. But, were the price raw material to increase and, as a consequence, the price of the vehicle too, orders would have decreased, experts concluded.

According to Bijoy Kumar Y, Editor, Business Standard Motoring, "You have to design a vehicle at a specific cost and without comprising on the safety. You also have to ensure that the price remains the same for few years that is critical as you cannot have a Rs 100 000 - 120 000 vehicle which scales up to Rs 300 000 vehicle" [26]

Among Nano critics, complains were the unappealing plastics used for the interior design, the engine's sound that resembled to a lawnmower, the lack of space for luggage and the fact that, except the driver's seat, the rest was not adjustable for the standard model. They would also characterize the Nano as an intra-city driving vehicle, more than an inter-city one.

The quality issue was raised by analysts at a certain point. They questioned the quality of the Nano considering the fact that the vehicle was assembled component by component into the dealer's workshop, without any control on the final result by Tata. This would discredit the brand's image.

All this taken into account, Nano was a success according to the high demands and the booking numbers. However, poor quality of the car would have generated decreased confidence and affected sales, agreed the experts.

According to Wagh, "Today, the Nano has become a big brand. But the bigger challenge now is how to sustain the demand. The product has to be very good and consistent." [21]

The high demand raised other concerns, those related to the plant's capacity to manufacture these vehicles, knowing that the Pantnagar plant had the competency of producing only 50 000 Nano per year. Moreover, the mother plant at Sanand was programmed to start producing Nano only at the end of 2009, which meant a long period in the waiting line for the customers and thus, analyst thought, the danger of the decrease of interest.

Two-wheeler owners were considered, by Tata Motors, potential clients as they thought that the attractive price of the Nano, comparable to the motorcycles, would attract them and make them want to replace the two wheels with four wheels. But some of the critics disagreed, saying that the two wheelers search for something else: motorcycles run generally for a mileage of about 55 km per liter (1,8 l/100km), while Nano runs for a mileage of only around 21 km per liter (4,76 l/100km).
According to Venu Srinivasan, Chairman of the TVS Motor Company, "There will be no major impact on two-wheelers. It (Nano) will create its own segment". [27]

A low selling price meant low dealers commission too. While the average commission was of 3 to 3.5%, Nano dealers perceived an average commission of only 2, 2.5%. Experts said this thing would not make it to profitable for Nano dealers.

Commenting on this issue, SP Shah, President of the Federation of Automobile Dealers Associations (FADA), said, "We expect that since the manufacturer gets wafer-thin margins in selling the Nano, dealers selling the model will be expected to make do, too". [28]

Reportedly, Tata Motors had spent approximately US$ 400 million on developing the Nano. Analysts opined that considering the Nano's low price, Tata Motors had to compromise with very low margins. According to them, it would be as low as 5 percent. Experts appreciated that with such low margins, it would take about five years for the Nano project to turn profitable. However, the management of Tata Motors was confident that it would be able to sell huge numbers to cover the costs of developing the Nano. According to Ratan Tata, "All I can say at the moment is that the project is highly profitable. After all, I am not doing it for philanthropy." [29]

# 3. Cars market future

After having a background of what was the beginning and what is in the present the low cost car market over the last chapters, our goal is to have a clear picture of where is heading the automotive industry in general and the low cost car segment in particular. Such an image of the future would be very hard to predict, taking into account the today's uncertainty. This is why we linked the low cost car segment to three evolution scenarios.

## 3.1. Future evolution scenarios

The yet to come status of the auto industry is impacted by a number of fluctuating indicators. Some might be linked to the car itself, while some will have a more generic character. In our case we must define as basis the specific conditions of the most relevant factors. As for the time factor, we choose a period of 10 years that it should be enough for the scope of this thesis. However, until 2025 is still a long way to go and during this time all the above mentioned factors is shaping the future. Nobody can guess or predict with accuracy what will be the future.

Taking into account the above statements we agreed to base our analysis on the following hypothesis defined by the extreme scenario model proposed by Roland Berger. Even if such a scenario would be unlikely to happen, the future could be shaped by different unique trends from all the scenarios.

There are five so called "megatrends" that are shaping the automotive industry's future:

- Geopolitical evolution;
- Demographic evolution;
- Sustainability;
- Evolution of mobility;
- Technological trends. [30, P5-33]

Based on the possible evolution of each megatrend have been identified three scenarios for automotive industry evolution:

1. the „High Tech" scenario;
2. the „Budget" scenario;
3. the „Sustainable" scenario.

Each and every scenario has its own implications in the industry, starting with the markets, customers, products or business models and finishing with the business organizations and their employees.

Following this description, we will try to identify which are the real factors that have the biggest influence on buyers' decision and how they are impacted in each scenario up to the year 2025.

The three extreme scenarios based on the megatrends in the automotive industry are pictured in the table below. [30, P42-46]

**Table 1. Scenarios in the automotive industry** [30]

| **The „High Tech" scenario** | **The „Budget" scenario** | **The „ Sustainable" scenario** |
|---|---|---|
|  |  |  |
| • High **brand content;**<br>• **Differentiators** (style, technology, etc.);<br>• **Regional platform;**<br>• **High level of innovation;**<br>• Strong **customers relationship** between OEMs and customers (loyalty, follow-up, etc.);<br>• **New actors**: luxury or sport brands. | • **Basic vehicles, standardized** quality, reduced prices;<br>• **Worldwide standardized** car, locally integrated;<br>• **Multiple branding**;<br>• Much **outsourcing**;<br>• Sales via **mega dealers** and **Internet**;<br>• **Mass distribution.** | • **Green** cars (electric...);<br>• **Local/regional models**;<br>• Specific uses;<br>• **Specific regulations**;<br>• Sales via **eco certificates**;<br>• Shared models;<br>• **Complete mobility solutions,** based on consumer needs. |

### 3.1.1. The High-tech scenario

The high-tech scenario shows a different world, one that uses high-tech devices to simplify most parts of our day by day life. These products are to be activated by vocal commands, eye-contact, even simple gestures and complex sensors. The people are living in a strong interconnected environment and are even part of inter-networked ecosystems. The rivalry between infrastructure and content providers is high. Consumers demand and get non-stop service. To change between applications and providers is quick and simple. In automotive business, the high-tech scenario brings full car features that make drivers connected to their usual networks and services while on the move, enable internet use, including cloud services, or even featured personalization of the MMI. Complex E/E systems, inactive and passive safety, as well as driver assistance and auto-diagnosis become common things. In marketing, gadgets as CRM play an important role helping OEMs to be able to reach beyond the product (viral marketing, community-based, etc.).

Efficient R&D processes are the major success factor to thrive in the high-tech scenario. It ensures fast innovation and makes collaboration simple by connecting partners from automotive and non-automotive sectors. Module based solutions allow technologies to be updated quickly and easily. High configuration management is a preliminary condition. Production plants need to be quite flexible and make possible often updates and new configuration of produced goods. [30, P44]

**Table 2. The "High Tech" scenario overview** [30]

|  | **The „High Tech" scenario – Innovation, connectivity, technology-driven world** |
|---|---|
| **Key factors** | • Importance of **high-tech products** in daily life – simplifications of many tasks;<br>• **24/7 service**;<br>• **Virtual reality applications**;<br>• **New MMI commands:** vocal, eye-contact, gestures;<br>• **Exclusivity**;<br>• **Customer choices driven by the brand attributes**;<br>• **Multiple connections** between people and machines (M2M); |

| | | | |
|---|---|---|---|
| | • Powerful interactions between content and infrastructure providers – **easy to swap and switch**;<br>• Deployment of **networking ecosystem**. | | |
| **Implications for the automotive industry** | **Vehicle features**<br>• Connectivity;<br>• MMI;<br>• Highly personalized;<br>• Complex E/E systems: active safety, driving assistance, etc. | **Brand**<br>• Powerful OEM brands associated with a technology mindset and exclusivity. | **Marketing**<br>• Strong use of CRM with customers going beyond product (viral marketing, community-based, etc). |

### 3.1.2. The Budget scenario

The budget scenario repaints a world where the purchasing power of people is very low, partly because of taxes and inflations, partly due to low income figures. Globalization gives rise to shortage of employment and makes the price of raw materials to grow higher. Automobiles become less affordable and the amount spent on cars competes with the other potential expenditures. Leasing and financing solutions become usual practices and pay-per-use schemes are applied to more and more products. This also creates the premises for new low cost brands to appear on the market. The main characteristics of the cars according to the budget scenario are a big amount of simplification, no-frills technology and limited equipped variants as standard, thus enabling low-cost concept. Besides new low cost brands emerging, players outside the traditional automotive industry enter this market by selling affordable low cost automobiles under their own established label, e.g. Amazon or Wal-Mart.

The key factors to success in the budget scenario are reducing the development and production costs to the minimum. Standard technical platforms become industry's prerequisite for producing global goods with limited equipment. Multi-badging enable OEMs to bring to local markets different brands and players while still sharing the same product base. The low-cost centers will assure engineering and production needs by introducing a great amount of local sourcing. The cost becomes the most important driver, the development and production of

numerous sub-modules or even complete cars in some cases, will be achieved by outsourcing. [30, P45-46]

**Table 3. The "Budget" scenario overview** [30]

|  | **The „Budget" scenario – Money for the basics only** | | |
|---|---|---|---|
| **Key factors** | • **Back to basics** performances;<br>• **Limited purchasing power** of customers (increasing tax burden due to debt, inflation with low income growth, etc);<br>• **Scarcity of employment** due to globalization, surge of raw material price;<br>• Sales via mega-dealers and the Internet – **mass distribution**;<br>• **Decline of the traditional brands** – emerging of new low cost brands;<br>• Development of the **pay per use models** for various products ;<br>• Cars become unaffordable and a trade-off with other services and products – cheapest possible car bought;<br>• Little diversity, maximum standardization. | | |
| **Implications for the automotive industry** | **Vehicle features**<br>• Low cost cars;<br>• Decontenting on power and weight, increase in E/E features;<br>• Mobility services models, emphasis on low TCO;<br>• Cars defined by customer needs (target costing);<br>• Additional features as options (high level of diversity) | **Brand**<br>• New low cost car brands emerging. | **Marketing**<br>• Affordable cars from new private-label brands belonging to mega-dealers and large retailers (Wal-Mart, Decathlon, etc.). |

### 3.1.3. The Sustainability scenario

The sustainability scenario shows a world where consumer's decisions are driven mainly by regulations, legislation and taxes, while in the same time recommendations and ratings from other users play a major role. Transport means are restricted as sustainability is partially imposed by laws and partially by means of a changing approach from consumers. Most people have access to quality education and use the transparency enabled by the media to purchase high quality and long term durability products and services. At the same time, the market used products is growing. In the auto industry, the result is that cars must obey regulations currently present and those which will be introduced in future situations. Existing brands are expected to be able to achieve a competitive edge by bringing on market a more sustainable product, which usually means a higher share of electrified cars –EVs or HEVs. OEMs move toward new mobility solution services working closely together with other providers.

The key factors to success in the sustainability scenario are focusing the R&D efforts towards enabling innovation by means of green technologies. Successful recipes involve low-emission cars and mobility solutions while assuring intelligent traffic management. [30, P46-47]

**Table 4. The "Sustainability" scenario overview** [30]

|  | **The „Sustainability" scenario – Maximum regulation and environmental lobbying** | | |
|---|---|---|---|
| **Key factors** | • **Strict environmental regulation** (CO2, noise, speed, etc.);<br>• Market influence shifts to **regulators and certificates**;<br>• **Importance of ratings** for most products and services, great transparency;<br>• **Widespread of secondhand** products and goods with long lifecycles;<br>• **High taxes** to support sustainability (pollution, recycling, social sustainability, etc.);<br>• **Stricter rules** on transportations (tolls, exclusion areas, etc.);<br>• **Complete mobility solutions**, customized for consumer needs;<br>• **Low consumption technologies**, green materials, etc. | | |
| **Implications for the automotive industry** | **Vehicle features**<br>• Compliance with all legislations;<br>• Differentiation by rating agencies or labeling;<br>• Mobility solutions focusing on TCO;<br>• Rapid introduction of green cars (EVs and plug-in hybrids) | **Brand**<br>• Cars distributed through leasing, utilities (EVs) and insurance companies specifying the model required. | **Marketing**<br>• Emergence of new mobility service providers offering products and services. |

By making a comparison between these three extreme scenarios for the year 2025, it is possible to point out some common success factors between them. Regarding branding for example, it is of utmost importance in all scenarios to ensure clear positioning. The products emerging in the year 2025 will be highly customized on the demand for low cost and in the same time still flexible in some extent to accustom different upgrades and personalization.

Customer care management will be an integrated part of the product or service being offered, as well as complete mobility solutions. R&D will move closer to the

market and local R&D centers spread across the world will still be connected through strong yet flexible networks.

A solution to have fast access to new technologies, markets and innovative business models is to find productive partnerships which will give them access to untampered information. By using them as a base, it is possible to identify various influences for the automotive business. Accordingly the players can define their strategies for the future.

**Table 5. Success factors of the three scenarios** [30]

| **Despite the scenario, some common key factors will become crucial** | | **The „Budget" world** | **The „ Sustainable" world** | **The „High Tech" world** |
|---|---|---|---|---|
| | |  |  |  |
| **Key success factors** | Brand | Clear brand positioning and customer targets with a globalizes approach | | |
| | Product | Tailored design to specifications, leveraging both high content features (e.g. connected cars, ...) and low content features, greater level of customization to needs. Product and service approaches going toward customer relationship and are also offering mobility solutions. | | |
| | Operations | Global/Local R&D approach and network, modularization, mix of more flexible plants and LCC plants. Capacity management driven by profitability | | |
| | Partners | Strong relationship with well-chosen partners: downstream (distribution, services providers), upstream (Tier-1), co-branding partners. | | |

## 3.2. Factors influencing buying decision

We have now set the "environment" by the three scenarios. But what about the customer? What does he need and what counts for the buyer when he is about to

take a decision? Because in the end the buyer's decision will drive the automotive industry.

We used two studies of the KPMG made in 2014 and 2015 and compared the answer to the question: what factor is the most important when is time to buy a new car?

[31] shows that the most important feature for the current car customers is long lifespan for the vehicle and, in the same time, low fuel consumption. Fuel efficiency is still the most important criteria for a decision, as buyers have in mind the high growing price of the fuel at the pump. *Greater car lifespan* has grown in importance as decision factor for the third year in a row with 70 percent, placing it as an influential factor. On the contrary, the *alternative fuel technologies* take a less important role in the search for a better cost efficiency. Less than 50 percent of the respondents involved in the current survey mentioned this factor as critical for the buying decision, compared to round 70 percent in year 2009. Even though *owning an environmentally friendly vehicle* still occupies a high position in the customers' desires, other factors like *car styling* weigh more in the buying decision, giving rise to the assumption that it is very probable the car will continue to be a fashionable accessory still for quite some time. An even increasing share of the customers in BRIC auto markets is expected to look for greener cars as a reaction to the rising level of pollution which the megacities in China, Brazil, India and Russia face. In-car technology solutions continue to come in ever growing demand due to people, who are expecting a smooth extension of their home or office towards the vehicle, either through proprietary solutions or by plug-in extensions for their mobile devices. For the moment, this kind of features don't come cheap, therefore OEMs may look at this as an opportunity to improve their profits by means of such added value services as well as gaining and keeping the control over critical automotive technologies.

### 3.2.1. Factors most likely to influence consumer's purchase decision in 2014

According to [31] the factors that are most likely to influence one's decision to purchase a specific vehicle are presented in the table below, the percentage showing rates of respondents that marked the factor as "important" or "very important".

**Table 6. Factors influencing purchasing decision** [31, P7]

| Rank | Factors | Percentage |
|---|---|---|
| **1** | **Fuel efficiency** | **92%** |
| **2** | **Safety innovations** | **79%** |
| **3** | **Ergonomics and comfort** | **79%** |
| **4** | Vehicle styling/ exterior | 74% |
| **5** | Environmental friendliness | 73% |
| **6** | **Enhanced vehicle lifespan** | 70% |
| **7** | Plug-in solutions for navigation, speech recognition and mobile internet devices | 69% |
| **8** | Vehicle bound internet connectivity and built-in technologies | 65% |
| **9** | Telematic / personal assistance services | 53% |
| **10** | Use of alternative fuel technologies | 47% |

For a better visualization of the figures above, below are the same figures in a graphic diagram:

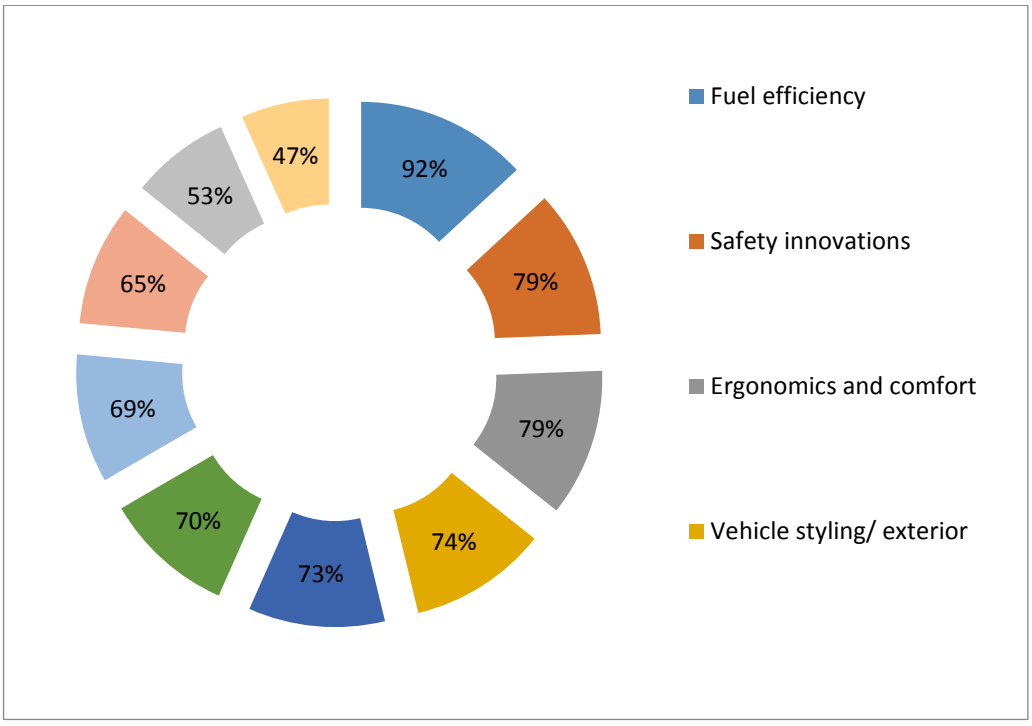


**Fig 5. Factors influencing purchasing decision**

### 3.2.2. Factors most likely to influence consumer's purchase decision in 2015

According to [32] the importance of the features that will influence consumer's buying decision until 2020 has slightly changed from the previous period.

Compared to the 2014 results, we can observe variation in the importance of same factors, as some of the factors receive more attention than the other on the respective period. Same as previous, the percentage shows rates of respondents that marked the factor as "important" or "very important".

**Table 7. Evolution of the factors influencing purchasing decision** [32]

| Rank | Factors | Percentage 2015 | Percentage 2014 | Percentage 2013 |
|---|---|---|---|---|
| **1** | **Fuel efficiency** | **67%** | **66%** | **68%** |
| **2** | **Enhanced vehicle lifespan** | **53%** | **45%** | **19%** |
| **3** | **Safety innovations** | **52%** | **48%** | **46%** |
| **4** | **Ergonomics and comfort** | **49%** | **36%** | **47%** |
| **5** | Environmental friendliness | 41% | 38% | 35% |
| **6** | Vehicle styling/ exterior | 40% | 34% | 23% |
| **7** | Plug-in solutions for navigation, speech recognition and mobile internet devices | 38% | 39% | 20% |
| **8** | Vehicle bound internet connectivity and built-in technologies | 24% | 26% | 17% |
| **9** | Telematic / personal assistance services | 19% | 16% | 11% |
| **10** | Use of alternative fuel technologies | 18% | 15% | 21% |

### 3.2.3. Most important factors for the low cost car segment

It can be observed that the purchasing choices are not yet driven by the new innovative concept or online services.

From the rated factors for year 2015, the top four were selected to have a deeper insight on them. It seems that a customer interested in a low cost vehicle is searching for the basic features and is not ready to spend more on an environmental-friendly vehicle. Nevertheless, he looks forward to a vehicle with a greater lifespan and which provides in the same time more comfort. New technology features like ADAS were already rising the attention of customers, fueled also by the big automotive companies and independent organizations like Euro NCAP, emphasizing the increase in comfort and security the vehicles equipped with these assistance functions bring to the driver.

The basic conclusion is that buyers are still paying most attention on basic vehicle's features like fuel efficiency, safety and comfort. The factor that gained in importance is the lifespan which was on the 8$^{th}$ place in 2013 on buyer's list when choosing a new vehicle and now became the second most important aspect after fuel efficiency. Regarding internet connectivity solutions in car, even though both solutions are ranked low, one could observe a bias towards plug-in types instead of car-bound internet connectivity. The presence of alternative fuel technologies continues to rank low on buyers' priority list, emphasizing the fact that the buying decision is most influenced by the cost rather than by consciousness. Even the simple fact that current consumer trend "smart choice" heads towards low cost vehicles confirms this.

As mentioned before, we will treat more deeply the factors which exert the most influence on the potential buying decision from the customer point of view. A buyer who is looking for a low cost vehicle will always pay attention to get the best deal for his money. Because of this, we selected only those factors which represent basic features, without getting into the costly value added functions.

Next we will take a closer look at the fuel efficiency, enhanced vehicle lifespan and innovations in safety, ergonomics and comfort, and how these factors are expected to influence the decision when choosing to buy a new vehicle. [31, 32]

### 3.2.3.1. Fuel efficiency

Defined as being either the proportion of energy solicited to journey a given distance, or as the length traveled with an available quantity of energy, fuel saving for motorized vehicles represents the efficiency of converting of the energy in the fuel to mechanical work at the driven wheels of the vehicle – measured by the travelled distance. The term “fuel economy” is relating to the distance travelled by the vehicle over to energy unit, usually as volume, therefore resulting measuring units as liters per kilometers in most countries that use the metric system and miles per gallon in USA and UK respectively. Another way to express it is in grams of $CO_2$ per kilometer. This is possible because tailpipe $CO_2$ is very close associated with fuel utilize, irrelevant of the type of fuel considered. The measurement of fuel economy, according to the European Union, is done by grams of tailpipe $CO_2$ emissions per kilometer.

In various available documentations, there can often be sensed an equivalence between “fuel efficiency”; “fuel intensity” and “fuel economy”. The word “efficiency” is able to have a broad range of interpretations for vehicles. One of them is the effectiveness of an engine to convert energy into power, another is the energy effectiveness required to move an automobile, considering its weight. The focus will be made on vehicle fuel economy. This means that there will be taken into consideration the energy utilized per distance moved, ignoring the weight of the vehicle, power of the engine or other such factors, unless otherwise specified.

Based on the different locations of countries across the world, there is a various number of units which are normally utilized to evidence fuel economy (Figure 6). Fuel economy of vehicles represents just a part of the entire transport energy chain. Before being able to utilize the energy of a vehicle, producing it is the first step. After that it requires transportation and loading it onto the vehicle itself. Considering “wheel-to-tank” and “tank-to-wheel” effectiveness, the “full fuel life-cycle” approach takes begins to resemble as a complete picture. The interchangeable energy required to obtain the final form of energy from the initial source of energy has a very relevant role in establishing overall efficiency (also $CO_2$ emissions in net values) of different vehicle/fuel combinations. [33]

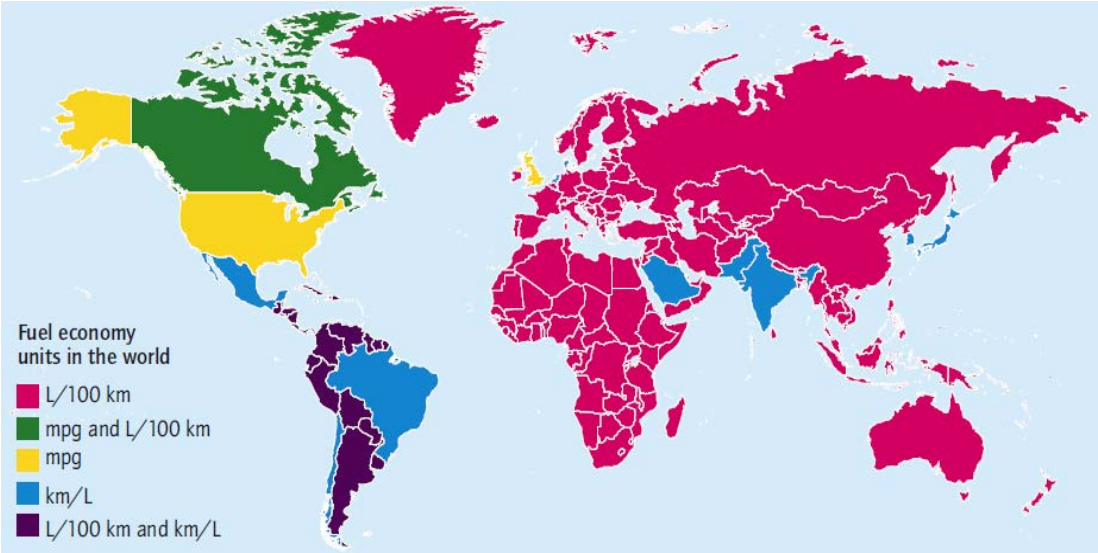


**Fig. 6 Fuel economy units in the world** [33, P9]

Various technologies are available in the aim to improve vehicle fuel economy. As any market, there are some affordable technologies which are commercially used and have slight market inclusion, missing a more extensive application; while there are others which are too expensive and too new to be widely spread at this moment. The real and applied potential for including such technologies to cars, trucks and two-wheelers has been undoubtedly proven to be very large. Biofuels, natural gases and electricity are viable alternative fuels used for less $CO_2$ emissions. The technical efficiency of ICE vehicles continues to be the focus, irrelevant of fuel type taken into considerations.

Statistics prove that approximately 20% of the energy contained in 1L of fuel is utilized to propel a vehicle – offering an enormous space for improvement. The majority of the losses are considered to be from the power train (Table 8). Waste heat from engine exhaust, coolant and brake pads are considered to be the main segments which need improvement. Turbo chargers are able to recover a relevant proportion of the heat wasted, thus providing a more efficient combustion cycle. Despite being widely utilized in the industry of power generation, the Rankine cycle, converting heat to power, is nevertheless in its early stage in the automotive industry (GCC, 2009 and 2011). [33]

**Table 8. Different losses inside a vehicle** [33, P17]

<table>
<tr><td rowspan="2">  </td><td>Power to wheels: 5% to 21% dissipated as:<br>wind resistance (7% to 10%)<br>rolling resistance (4% to 6%)<br>braking (4% to 5%)</td></tr>
<tr><td>Parasitic losses: 4% to 6%<br>(e.g., water pump, alternator)</td></tr>
<tr><td rowspan="2">Engine losses: 67% to 72%.<br>Thermal such as radiator, exhaust heat, etc. (57% to 62%)<br>Combustion (3%)<br>Pumping (4%)<br>Friction (3%)</td><td>Drivetrain losses: 4% to 6%</td></tr>
<tr><td>Idle losses: 3%<br>Considered as part of the engine and parasitic losses</td></tr>
</table>

### 3.2.3.2. Vehicle lifespan

A car is a vast and elaborate accumulation of complex subcomponents, each of it having its own life expectancy and life span attributes. The mean time between failures (MTBF) of several parts is estimated to be small, as the available substitution of these is listed as being part of maintenance. Other pieces, mostly of which have high substitution costs, are anticipated to have a longer life; but, a longer life might very easily require substitution of several of these, triggering economic issues.

The reason why manufacturers chase a longer life span can differ. The economic comparison of buy versus repair always has a relevant role in the decision. Evidently, lots of factors overtake basic economics – such as the nature of the car or the age. Drivers find it relevant and willingly they try to extend the life span of their own car by fighting "planned obsolescence".

The life expectancy of a car can be compared to the “bathtub” pattern. Preceding the first phase, where failure may be possible (thus the presence of warranties offered by the manufacturers), there might follow a long period of farfetched failures, as the chances shall be low. Because the car has been present for more than a century, the becoming of cars and the maximal life expectancy are open questions.

The Environmental Protection Agency, present in the US, estimates a normal car is usually driven around 24 150 km per year. Based on New York Times statistics, during the 60s and 70s, the typical car ended its normal lifespan around 161 000 km. However, thanks to manufacturing improvements, the typical car lasts closer to 322 000 km in the 2000s. [34]

Sikorsky along with successors, succeeded in developing lists that itemize steps which a car owner can follow. These have been considered to extend the maximal longevity of the auto, by following simple operating and maintenance rules, such as: [35]

1. Regular oil changes
2. Monitor the key fluids
3. Maintain the transmission
4. Change the spark plugs as needed
5. Replacing the timing belt as per manufacturer recommendation (if needed)
6. Replace air filter as required
7. Know and utilize your maintenance manual
8. No jack-rabbit starts and stops

Kasmer argues that updating old autos with a contemporary transmission has the impact of extending the lifespan, while also increasing fuel efficiency, reducing the values of carbon emissions and preventing random influxes of vehicle discarding into car grave yards, thus being replaced by newer modern vehicles.

Based on a study done by AutoM, of which the main question is: “What do you consider the appropriate lifespan of a vehicle?” the results can be seen in the following chart.

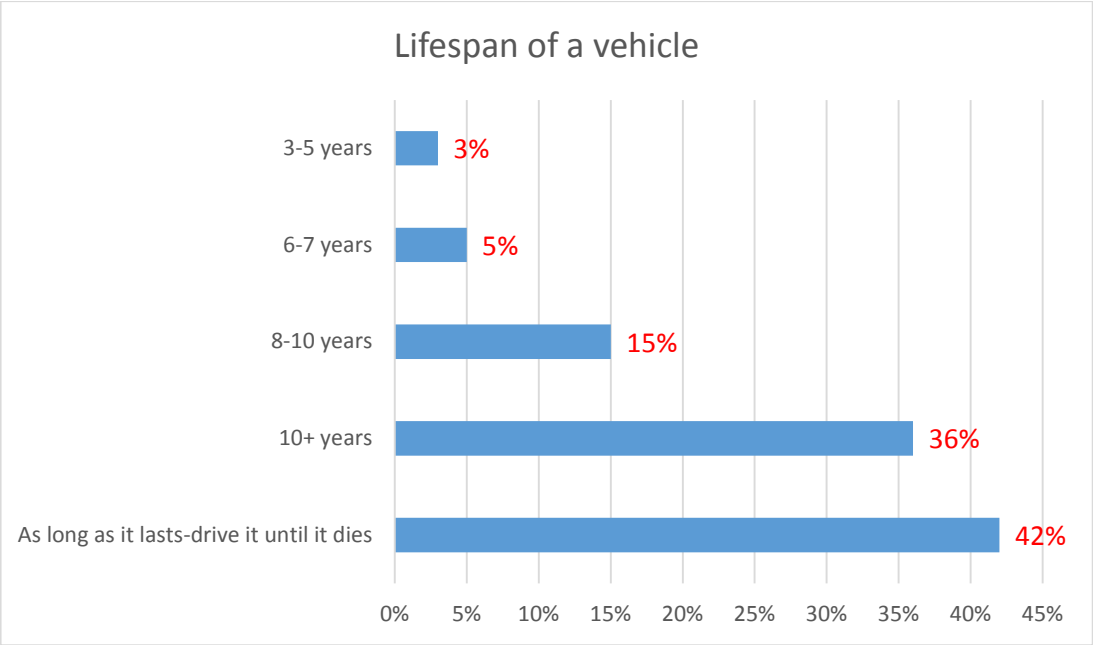


**Fig 7 Lifespan of a vehicle** [37]

Owning cars for a longer period of time is the new normal, as the economy improves, based on [36]. Approximately 80 percent of consumers seem to be comfortable with a 10+ years vehicle lifespan. According to subjects, not even an improving economy would change the duration they would consider keeping a vehicle. A clear proof of this ascending trend is the steady growth in km driven as being reported on participants' primary vehicles.

Consistently, year by year, the number of owners who admit on planning to drive their primary vehicle "until it rolls out" has been dropping from a 56% in a recession-impacted 2010, around to 35% in 2013. More than half continue planning to drive their cars for more than 322K km, with the overall of participants stating that previous two to three-year ownership model is beginning to disappear.

Vehicle users continue to add on km to their boards. In the year of 2011, a percentage of 47 reported having over 100K miles on the initial vehicle. Currently, over 64% have managed to hit that limit of miles and some have managed to overpass it. Thus, 33% have stated to have over 242K km on their current vehicle.

**Table 9. Percentage of vehicles with mileage over 100k** [36]

| Primary Vehicle Has Over 100K Miles | |
|---|---|
| **2013** | 64% |
| **2012** | 60% |
| **2011** | 59% |
| **2010** | 47% |

A percentage of 46 say that they plan to add an additional 75 000 miles on their current car - in comparison to previous vehicles. There is a downfall since 2011. During that year, when 67% stated they had in mind to put 75K additional miles onto their car. It seems only fair that many of these owners have mostly changed their increased mileage car for their following automobile since 2010. Most probably, buyers who said in 2010 that they were planning to add 100k extra miles on their car's dashboard have already managed to add that additional distance during the past few years. [36]

Elementary, "Do It For Me"-type of customers take into account adding 75K more miles on their cars than "Do It Yourself"-type: 38% compared to 51%. Out of the group which is planning on holding their automobiles for a longer period than previously, over half state that the growing economic trend has zero impact on how long they will continue keeping their cars for.

The studies show that three out of four car owners confirm that purchasing a new car every 2 to 3 years is a past trend. Approximately 80 percent of buyers consider that 10+ years or "until it rolls out" is the correct lifetime of an automobile, with no more than 3 percent stating that 3 to 5 years is the correct period of time to own a vehicle, not having changed ratio over the past few years. This emphasizes third party statistics that double check that the average car lifetime of a car is of 11.3 years, trending towards an estimated 11.5 in 2018. [36]

Asked what the main incentive for holding onto their car for more than 100 000 miles is, a large number of buyers argued their main reason as being the repairs and services which may occur. This was closely followed by the economy and cost savings. Repair shops can consider this as being good news: 1 out of 4 owners planning on keeping their cars for a longer period of time says that they are most probably tempted to continue respecting the automobile's maintenance schedule. This will automatically mean visiting independent repair shops, thus saving a

considerable amount of money. The independent repair shop was the preferred option chosen by most of the subjects, when asked where they would prefer to take their car to. [36]

**Table 10. Service center utilization by types** [36]

| **Which kind of service center are you most likely to utilize?** | |
|---|---|
| **Independent repair shop / mechanic** | 71% |
| **Dealership** | 19% |
| **Chain store** | 10% |

### 3.2.3.4. Ergonomics and comfort

In the current days, an important competitive role is taken up by the mixing of product qualities. Even though nobody is able to contest the importance of technological performance, this isn't by far the only criteria to be taken into consideration nowadays. Other associated qualities like comfort, usability and satisfaction are added up next to the technical performances.

Competitiveness made branches of ergonomics - such as comfort, pleasure and cognitive engineering - to be considered as means of adding value to goods related to the use along with macro ergonomics, participatory ergonomics, or strengthening companies' image.

Technical performance reached its level of satisfaction and it is getting more and more difficult to sustain its advantages as nowadays all companies can have the equivalent of the same technical performance by buying licenses and getting together components and qualities. That's why only product qualities brought together can represent a competitive factor and can bring competitive advantages.

Customers attraction for the technical functions was replaced with requirements for other qualities, use related ones. Former functionality, cost and reliability are not enough anymore. Clients add requests for some other qualities too: comfort, satisfaction and usability.

People spend a lot of their day in transportation, whether is public or private transportation. From here the focus of the car manufactures on improving the riding comfort. Also, by providing comfort, it is believed to ensure performance of the driver by focusing better on the road. Not to mention safety given by the reduction of the tiredness of the passengers.

Definitely, from the automotive industry perspective, one of the factors that contribute to the brands image is the passenger comfort. Nowadays, with similar performance cars, the thing that makes the difference is comfort, the well-being.

One should take into account three classes of factors when evaluating traveling comfort: organizational factors, local factors and riding factors.

Driving and seat comfort are able to be evaluated by three points of view. The first classification is split into: dynamics (vibration, shocks, acceleration); ambient (thermal comfort, air quality, noise, pressure) and ergonomics.

### 3.2.3.5. Ambient Factors

Vibration

The human body enters in contact with numerous vibrations, from multiple sources. This thing happens when the body, no matter the position – standing, laying or sitting, gets in contact with a vibration surface. The vibrations which are considered to be in the existing standards are those with an oscillation in frequency range from 1 to 80 Hz, sometimes maybe higher. For those surpassing these frequencies, the human body will turn less sensitive.

The human body time of exposure limits to a vibration condition is defined, considering three principles: preservation of comfort, preservation of work efficiency, and of health and safety.

In the case of the vehicle passengers, there are two frequency ranges to be taken into account: 0.5 - 80 Hz (for health, comfort, perception) and below 1.0 Hz for motion sickness. When analyzing the effects of the vibration on the human body, one should take into account the fact that the body is made of different parts that respond differently. [38]

Noise

If we were to define the word noise, it would be described as an unwanted sound. Sound waves – which are the frequencies between 20 Hz and 20 kHz – shows a fluctuation of the air pressure around a mean value which corresponds to the local atmospheric pressure of a person’s ears while in a stable position. As a matter of fact, the sound level is also an important factor in the automotive industry as the clients evaluate the cars performance based on the sound characteristics too. A sound event can be classified based on the level of the sound, of its duration and temporal

structure, as well as its quantity, spatial distribution, subjective attitude and signal information. Being inside a moving vehicle, a passenger may witness numerous kinds of unwanted noises. Thus, engineers and designers goal is to reduce them as much as they can or to convert it into a more agreeable sound.

Noises can be categorized in two: airborne noise and structural noise, according to the nature of noise and its way of transmission. In the first case, the source comes from the aerodynamic noise and it is the consequence of the vehicles body moving through the air volume around. In the second case, the structural noise comes from the transmission and the suspension resonances. The two categories of noise can also be combined.

An uncontestable truth is that a totally silent vehicle is still not possible to obtain. The only thing that can be done is to convert the unwanted sounds into some more convenient, likeable sounds. And therefore, the constructor will adapt its vehicle, in terms of noise, to the markets expectations: engine noise, sound of sliding doors etc. [38]

Thermal comfort

The definition of thermal comfort is “that condition of mind that expresses satisfaction with the thermal environment”. Although a subjective concept, the thermal comfort is extremely important if we keep in mind that people evaluate the environmental conditions throughout their senses. The balance between the human body and the environment is influenced by certain phenomena. It is thanks to the thermoregulatory system that the human body temperature stays in the limits, preventing it from hyperthermia or hypothermia. In the hypothalamus, the human body has a center that controls several physiological processes and which keeps the temperature at the level of function of the metabolic rate (36.8 ºC to 37.9 ºC). The heat exchange of the body is influenced by the environments physical parameters like temperature (air and radiant), humidity, speed of the air etc. An important role in ensuring the thermal comfort is played by the metabolic rate and the clothes thermal insulation.

When inside a vehicle, passengers encounter a specific kind of thermal environment. Weather conditions outside the car habitat have an important impact on the interior of a car. The things that have a big impact on the thermal environment in the vehicle are: the size and the position of the glass, the number of passengers per

volume/area, the amount of insulation material, the limitations on weight and the asymmetries of air temperature rapidity and of the temperature that is radiating.

The thermal climate systems in the vehicles have an undoubtable impact on the health, comfort and, very important, safety too. That's why the car manufacturers' attention is strongly directed towards it. Any discomfort created by the lack of climate conditions will have an impact on the driver's driving ability, reducing its capacity to react and to concentrate. Thus, the air-conditioning systems are to be considered more a safety component than a simple comfort equipment. [38]

Air quality

Quality of air inside the car is uncontestably an important factor which needs to be considered when thinking about car performance and comfort. Poor ventilation inside a car will give birth to a bad indoor air quality. Without the ventilation, the air inside a vehicle will degrade due to the human gases emanated when breathing etc., or due to the combustion products and particles.

The air quality inside a car can be improved by using filters and by diluting/replacing the pollutants with fresh air. The indoor air quality is evaluated via numerous sensors. It has been proved that indoor air had direct impact on tiredness, especially while driving. Thus, it is considered that accidents can be prevented based on this.

There are three major targets to achieve when talking about indoor air quality: develop a monitoring system, identify the driving conditions that could bring to poor air quality, identify the limits and the senses algorithms for the monitoring system of the quality of air. All these in order to achieve an automatic regulation system that monitors the gases inside the car and thus prevents health problems to the passengers. We may conclude that the monitoring system of the air quality it's not just a matter of comfort but of a providing safety equipment. [38]

Various factors

Passengers' comfort is also directly impacted by other factors. One of this factors is the seat, which actually plays an important part when it comes to the overall pleasantness of the car perceived by the occupants. No wonder that a lot of studies focus on pressure distribution, seat deflection, the influence of seats on interior noise absorption and the thermal sensation given by the heated or ventilated seats. They all add up to the comfort level. [38]

# 4. Future trends

All factors have their specific trend. Getting together all these trends we can make an estimation about the future of the low cost car sector. When making this estimation, there will be taken into account the effect of all these factors.

## 4.1. Trends on fuel efficiency

Engine, transmission, weight, aerodynamics, tires (overall vehicle improvements), lights heating, air conditioning etc. (auxiliary power systems), all of these are technologies which can improve nowadays the LDV (light duty vehicles) fuel economy. Per a comprehensive report done by the US National Research Council in 2009, researching fuel economy potential, focused mainly on North American market, comparing 2006 with 2020, it is clear to see that with the technology available, vehicles' efficiency will increase by 15% for the conventional gasoline engine; 28% for diesel systems and full-hybrid vehicles will see a clear growth of 44%. If we are to extend the number of years to 2035, the efficiency will grow even more: an estimation puts the diesel engine vehicles to a 50% improvement, the same with the turbocharged gasoline vehicles and not to mention a 65% lower fuel use per kilometer for the hybrids.

Similar estimations are predicted in the European context also. However, the non-OECD countries do not benefit of so many studies. The GFEI target, which is to reduce by half new LDV energy consumption by 2030, seems to be reliable if we take into account the technologies available. The aim is to bring these technologies to their fullest into the market in order to improve fuel economy, detrimental to manufacturing larger, heavier, more powerful vehicles while keeping steady the fuel economy.

The majority of the ICE vehicles nowadays work with petroleum gasoline or diesel fuel, using spark-ignition for gasoline LPG and natural gas, and compression-ignition for diesel fuel, thus having different efficiency. It is well known, the diesel engine registers a 25-30% higher efficiency on same vehicle than the petroleum one. It is truth, both gasoline and diesel engines' efficiency have improved in the last decades, but even better results, around 25% improvement compared with the year 2005 could be realized in the future with the help of the existing technologies. Even if several of them improved from 2012 to the present date, space for upgrade will

continuously be available. In terms of costs, improving the efficiency of the gasoline engine by 25% would mean around 1 000 USD/vehicle, and even a bit more for the diesel considering their already elevated efficiency, pursuant to IEA analysis. These statistics were made based on the communication among technologies and contain the rate penalties and the fuel economy related to the systems meant to reduce the pollutant emissions. [33]

The table below shows that, no matter the situation, the cost of improving the efficiency of the fuel can fluctuate between some hundred euros in the budget world, and some thousands of euros in the high tech world. Nevertheless, the fuel efficiency will definitely have a positive tendency by 2030 and with no doubt the low cost market will get the most out of it, in any circumstances.

**Table 11. Estimated fuel economy and cost improvement** [33, P18]

| **Estimated tested fuel economy improvement potential and costs relative to a 2005 vehicle** | | |
|---|---|---|
| | **Improvement potential (% reduction in fuel use)** | **Cost (EUR/vehicle)** |
| **Gasoline engines** | | |
| Low friction design and materials | 2% | 35 |
| Tyres: low rolling resistance | 3% | 35 |
| Aerodynamics improvement | 2% | 50 |
| Reduced driveline friction | 1% | 50 |
| Lightweight components other than BIW | 2% | 50 |
| Thermal management | 3% | 100 |
| Variable valve actuation and lift | 2% | 230 |
| Auxiliary systems improvement | 5% | 350 |
| Thermodynamic cycle improvements | 14% | 400 |
| Strong downsizing | 17% | 520 |
| Dual clutch transmission | 6% | 700 |
| Strong weight reduction | 12% | 1000 |

| | | |
|---|---|---|
| **Cumulative before full hybridization** | **51%** | **3520** |
| Full hybrid: electric drive 25% 2 750 | 25% | 2750 |
| **Cumulative after full hybridization** | **63%** | **6270** |
| | | |
| **Diesel engines** | | |
| Tyres: low rolling resistance | 3% | 35 |
| Reduced driveline friction | 2% | 50 |
| Combustion improvements | 4% | 50 |
| Aerodynamics improvement | 2% | 50 |
| Lightweight components other than BIW | 2% | 100 |
| Thermal management | 3% | 100 |
| Variable valve actuation and lift | 1% | 250 |
| Auxiliary systems improvement | 6% | 440 |
| Strong downsizing | 10% | 600 |
| Dual clutch transmission | 5% | 700 |
| Strong weight reduction | 10% | 1000 |
| **Cumulative before full hybridization** | **39%** | **3375** |
| Full hybrid: electric drive | 22% | 2750 |
| **Cumulative after full hybridization** | **52** | **6125** |

*Note: Technology improvement potential and cost are assumed to be as of today, using devices already commercially available. The cumulative improvement potentials are not the sum of the individual technology improvement potential.*

Another positive tendency in the fuel efficiency can be observed in the next chart.

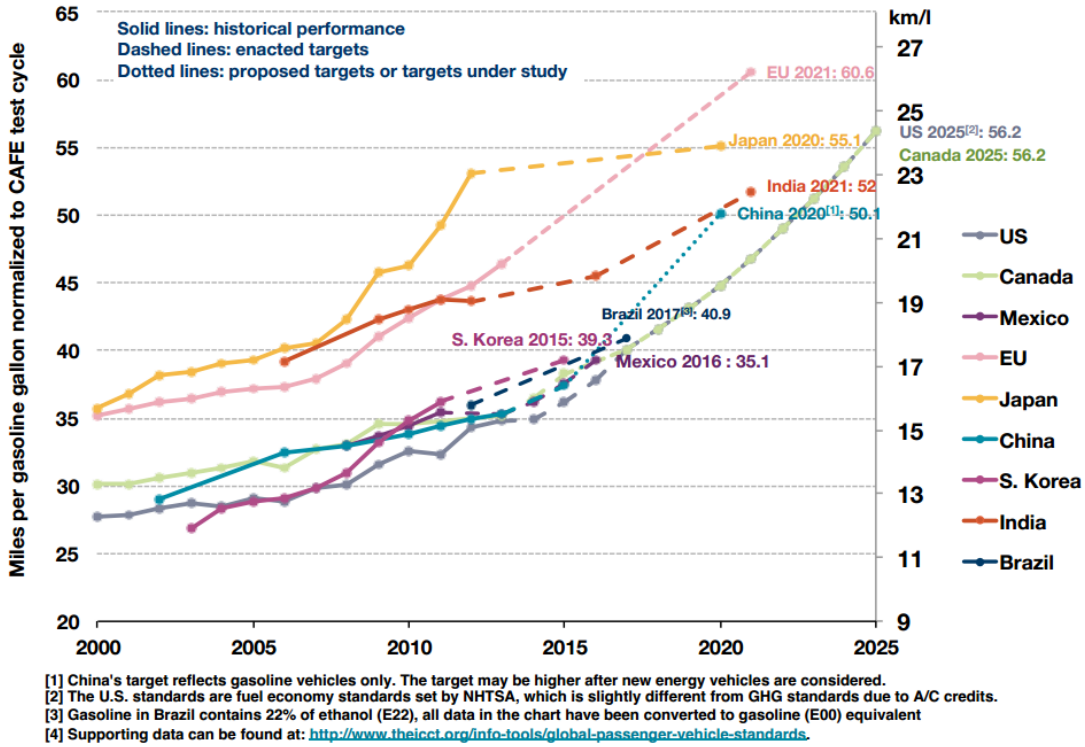


**Fig. 8 Fuel efficiency estimation trend** [37]

## 4.2. Trends on life span

According to [36], only 10% of the surveyed answered that they planned to buy a new car, while 90% said that they planned to keep and repair their old vehicles. From the 10%, most of them argued their intention as a consequence of the fact that their car was at the end of its life, and only one third said that it is because of grater model is available on the marketplace. As a matter of fact, to only 7% of them the intention to buy was taken for reasons of improved economy. The customers are more interested in late model used vehicles, rather than in brand new produced vehicles. The tendency in the next years is obvious if we consider that almost 80% of the clients think that the suitable lifespan of a car is somewhere between 10+ years and “until it dies” philosophy. In consequence, we can deduct a way of thinking perfectly suited to the low cost philosophy. The positive trend will last across all circumstances, increasing in importance in all stages – from budget to technology.

## 4.3. Trends on safety innovations

Continuously increasing road safety is critical and a priority. This is a topic which must be accessed by different levels. One of the primordial actions that must be applied is the training for drivers, particularly in the under-developed countries. Another efficient action, temporary though, proved to be the information campaigns. Road safety values have to be better revealed to young people, their awareness on dangers encountered on road must grow. Penalties applied exemplary are also a source of discipline when talking about respecting safety principles. But the truth is that no human being can drive constantly perfect. This is related to driving skills, concentration, fatigue level, judgment decisions and many others. Beside these, the driving conditions differ and can threaten the safety of the driver. We refer here to bad weather conditions like rain, fog, night, snow etc. that can jeopardize the visibility and the ability to drive. Everybody's expectancy is that technological progress should solve all safety issues, and some deficiencies indeed they were fixed. Technology provides real and valuable support nowadays, and these performances mustn't stop only to the top-end vehicles, but be available for everybody's budget, including for the low-cost vehicle customers. That's why the only authority that could intervene for making the advanced safety equipment mandatory is the government. Making it obligatory would lead to a mass production that would eventually lower down the prices and make it available for everybody. Thus, the trends predict safety innovations to be passed on from the top-end vehicles to the low-cost cars. Maybe not all in the same time, but at least after one model cycle. In this way, safety innovations will be available on all cars.

## 4.4. Trends on ergonomics and comfort

Low-budget cars lack the same level of comfort as the ones obtained by high tech cars, despite the fact that comfort has been and shall continue to be one of the most important components taken into consideration when buying a car. Still, low cost cars own nowadays a good level of basic comfort characteristics, which is enough if we take into consideration the fact that the low cost philosophy doesn't necessary rely on comfort and that the customers' expectations of comfort are not as high as on high tech cars. This comfort characteristics available on the low cost cars are marketed

“smart choice”. In the future we will see if these “smart choice” features have the capability to influence customers’ intention to buy a low cost car.

## 4.5. Challenges in the overall mobility sector

In the future, there will be a revolution in the car manufacturing industry in terms of next generation mobility solutions. A great amount of alternatives will be accessible to the new client, serving his purpose. The urban sector will be the most impacted by these new solutions that is why analyzing the situation in the cities seems more relevant. Nevertheless, one must keep in mind the fact that, due to its reduced price, the low cost car will make such kind of comparison more difficult for a client.

Cities all around the world will have a major challenge in the future if we look at the trajectory of the urban living nowadays. The estimations says that, by 2030, 60% of the globe’s population will live in cities, up from about 50% nowadays. [39] Moreover, about 2 billion people are expected to become a part of the middle class at this time, making the megacities grow even more. As a normal tendency, most of the new middle class people will want to purchase a car. As a matter of fact, sales are predicted to increase up to 125 million a year by 2025, of which more than a half are predicted to be purchased in the cities. Some specialists have gone that far as to say that the 1.2 billion existing global car fleet could double by 2030. [39]

With all these predictions, nobody would be surprised to hear that we won’t be able to support the huge amount of vehicles predicted in the future, with the urban infrastructure we have today. Already traffic jams are a real problem in the cities. Costs derived from this situation vary between 2% and 4% of the national GDP if we take into account the time lost in traffic, the wasted fuel and the costs of doing business. Cars create emissions of greenhouse gases and smog is a serious issue of public health. In 2014, the World Health Organization estimated that 7 million premature deaths are because of the air pollution, mostly as a consequence of the urban transit. [39]

Alternative urban mobility solutions will appear through new mobility services, offering alternative means of transportation making the money road go directly into the sector. The global venture-capital investments into mobility services raised in 2014 to more than 5 billion dollars. A huge growth if we take into consideration that the investments in the field were less than 10 million dollars in 2009.

Ola, India's biggest online cab service raised 677 million dollars and China's Didi Dache, with around 100 million users in 300 cities, has raised around 800 million dollars.

Table 12. New mobility services offer alternatives for transport [39]

| | **Traditional mobility solutions** | **New mobility services** | |
|---|---|---|---|
| **Individual-based mobility** | Private car ownership | Car sharing: peer to peer | A peer-to-peer platform where individuals can rent out their private vehicles when they are not in use |
| | Taxi | E-hailing | Process of ordering a car or taxi via on-demand app. App matches rider with driver and handles payment |
| | Rental Cars | Car sharing: fleet operator | On-demand short-term car rentals with the vehicle owned and managed by a fleet operator |
| **Group-based mobility** | Car pooling | Shared e-hailing | Allows riders going in the same direction to share the car, thereby splitting the fare and lowering the cost |
| | Public Transport | On-demand private shuttles | App and technology enabled shuttle service. Cheaper than a taxi but more convenient than public transit |
| | | Private buses | Shared and Wi-Fi-enabled commuter buses available to the public or to employees of select companies. Used to free riders from driving to work |

All these mobility services and new product concepts might change deeply the way we perceive the public transit and also the private transport. Yes, not all of these start-ups will make it, but the concept, the business model, not to mention the technology and the experiences created, they will all last and even improve.

Reality proves it, consumers are extremely receptive when it comes to using new mobility models. For example:

1. E-hailing: Operating in over 300 cities and 58 countries, Uber is here the best example. In some cities, Uber is even larger than the taxi industry. Only in China there is estimated that not less than 170 million people seek for different forms of e-hailing services. [39]

2. Car sharing: Car-sharing service offers access to a motorized vehicle on-demand and on-site. Also, the car-share system provides roundtrip or one-way services, depending on the provider and place. How does it work? Car-shares demand people over 21 years old to have a valid driver's

license and to pre-register with a credit/debit car. An annual membership fee must be paid by the user and also a fee for the traveled distance or number of hours rented. The peer-to-peer car-share system gives the opportunity to private people to rent their own cars to others.

Car-sharing membership is continuously growing. In the USA we're talking about a growth of 35% per year, attaining back in 2014 1.6 million members. In Germany, this service has massively grown 50% a year since 2010, and in 2014 had reached already 1 million people.

3. Shared e-hailing: Lyft Line accounts for the majority of its San Francisco business. [39]

4. On-demand private shuttles: Although the service is available for decades, like the New York City's "dollar vans", in which customers had at their disposal smaller and more flexible shuttles, the new service is more popular than ever. The new connected, on demand services gave birth to loyal clients and to an operating system which allowed the model to expand in new cities.

5. Private buses: Private companies use transportation networks for their employees. [39]

Also, apps like Moovit were created by software companies in order to improve the transport. For example, this app allows their customers to plan their trips by stringing together more journeys in an efficient way.

Waze redirects drivers in order to avoid traffic. Urban Engines collects real-time travel information in order help the public-transit agencies better see, analyze and increase the performance of the public-transit system.

There are some companies, such as TransLoc and RideCell, who are developing technology platforms in order to improve and automate agencies operations, allowing them to have on-demand and more flexible services. In this way, over booking can be avoided by supplementing the fleets where the demand exists.

Transportation becomes more multimodal, shared and on demand than ever, thanks to the mew mobility services. Actually, this improved mobility services are literally increasing the consumers' choice and comfort. Given the environment, tendencies lead to a more digital and efficient traffic-control centers and better fleet management in the future. This means improved matching between demand and

supply thanks to the upgraded data and analytics abilities. Also, it becomes more and more predictable that the public transport will have to deal with serious competition from the new private-transit sector.

Ownership vs. other mobility solutions

We can say that the inefficient use of the private car nowadays represents the most adverse impact of the current urban mobility model. Although the car represents one of the biggest investment of capital one family makes, it is actually being used only 50 minutes per day and it carries 1.2 to 1.6 passengers, on average. [40]

Drivers in big cities start reconsidering the worth of car ownership. This is because they have to struggle with deteriorating driving conditions and more stringent regulations, not to mention more expensive utilization and less safe conditions.

On the other hand, public transportation has become more accessible and convenient thanks to the huge infrastructure investments and new mobility solutions are being available on the market.

Owners would consider to renounce their vehicles if traffic conditions continue to deteriorate. This together with stringent regulations will make them reconsider car ownership. Their inclination to renounce to their private car is reinforced by the alternative of an improved public transit, car rental and taxi services available and not to mention the appearance of the new mobility solutions. [41]

Undoubtable, everybody agrees that car owning is expensive and polluting. In big cities, drivers confront themselves with traffic jams all the time, thus deepening even more the threat of the environment and of the human health. [42]

Crowded buses, trams or metros and multiple transfers in between make traditional public transportation not to be preferred by users anymore. This situation makes the limitation of the traffic growth in the urban areas impossible. Car sharing isn't a remedy either: in the end it doesn't reduce that much the total vehicle mileage and, if prices lower enough, may even intensify solo driving.

No matter the consumers' option, he will end up choosing one situation or another, depending of the place, distance or comfort dictated at a precise moment. The choice will always be made according to the consumers need.

# 5. Conclusions

Our goal in this document paper was the analysis of the concept known as “the low cost car”. The first “low cost car” was the result of a much needed affordable and decent mean of transportation. This is why the concept was initially launched to cover the transportation needs of the emerging markets. We presented the characteristics of these markets as well as the categories of potential clients. But the automotive market is constantly evolving to keep up the pace with the mindset of the customers over time. And despite the opinion of many automotive experts, the low cost cars were successful also in the mature automotive markets. This is why the future trends are not exactly easy to predict. Did the moment of glory for the low cost car segment already passed or there is still to come?

We explained in a previous chapter that we based our analysis on three extreme evolution scenarios: High Tech, Budget and Sustainability scenarios. Each of them can be the future in the automotive sector. We can see today that parts of each scenario are becoming reality, a sign that the market is continuously changing shape.

Based on the available market research studies, we analyzed what factors are more likely to influence the car buyers’ decision. And from all the factors, we identified the ones that are characteristic for the low cost car buyers – the factors that are the most important in the buying decision. Each “most influential factor” will be ranked between + and +++, according to its importance in each scenario. In the end, analyzing the evolution of each factor (in the table below), we will be able to predict a trend of the automotive market in general and an evolution of the low cost car market in particular, on a medium term period, until 2025. We can assume that the evolution of all these factors, in each scenario, can describe the evolution of the low cost car models within next period.

**Table 13. Influence factors for the different scenarios**

| Influence Factors | The „High Tech" scenario | The „Budget" scenario | The „ Sustainable" scenario |
|---|---|---|---|
| |  |  |  |
| **Fuel efficiency** | +++ | + | ++ |
| **Enhanced vehicle lifespan** | + | +++ | ++ |
| **Safety Innovations** | +++ | + | ++ |
| **Ergonomics and comfort** | +++ | + | ++ |
| **Trend to 2020** | +++ | + | ++ |

Fuel efficiency was rated as the most impacting factor. Without any doubt, the overall trend should be positive, due to the increased efficiency of the new technologies. However, in the high tech scenario the difference is made by the innovations and connectivity related technologies. In comparison, within the frame of the budget scenario, this factor will still be the most important one. People will have less buying power and new low cost brand can compete in the market with increased efficiency and decreased cost of car operation. Following the sustainable scenario, fuel efficiency will still be a factor that impacts the buyer decision but this time in a form of strict legal requirements related to fuel efficiency.

Vehicle lifespan is increasing in our days, as we presented in the previous chapters. In the high tech scenario a longer vehicle lifespan is not possible because new technologies emerge overnight and the client demands the latest technologies. The budget scenario and the sustainable scenario will support a longer vehicle lifespan. The reason is however different, we see that in the budget scenario the decision is taken due to the low buying power of the consumer and in sustainable scenario the reason can be resources related.

The next two factors, safety innovation and ergonomics and comfort, are expected to have a positive trend overall, especially on high tech scenarios where the latest technologies are mandatory. In the budget scenarios as well in the sustainable scenario we see as well a positive trend, imposed by the competition and legislation.

In both budget and sustainable scenario the manufacturers will comply with the minimum legal requirements, at least on safety side.

It can be seen that all the factors are on a more or less positive trend. This fact allows us to conclude that the automotive market will continue to grow, in whatever scenario we will be in 10 years from now. If we consider the hypothesis that the low cost buyers' decision is driven by the factors mentioned above, is easy to see that we will have, at least for the next period, a good market for the low cost vehicles.

Considering only the above mentioned factors, our estimation shows the budget scenario being the most possible one. In this frame, the low cost segment will prevail, driven by the poor economic conditions in the BRIC countries, for example, and the value/money value in the "western" countries.

My personal opinion is that the evolution of the technologies and mobility services will transform the low cost car concept. The low cost alternative will include technologies reserved in the past only for premium brands. It may be not state of the art technologies and innovation but it should be for the same low price.

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# 7. List of figures and tables

# 8. Appendix

## Appendix A

Prices of Tata Nano in Delhi (In Rupees)

| | **Tata Nano Standard** | **Tata Nano CX** | **Tata Nano LX** |
|---|---|---|---|
| Base Price | 109,654 | 134,543 | 153,209 |
| Value-added Tax | 13,707 | 16,818 | 19,151 |
| Ex-showroom Price | 123,361 | 151,361 | 172,360 |
| Octroi | 0 | 0 | 0 |
| RTO | 5,168 | 5,728 | 6,148 |
| Insurance | 4,416 | 5,186 | 5,784 |
| Other | 2,206 | 2,206 | 2,206 |
| **Estimated On Road Price** | **135,151** | **164,481** | **186,498** |

Source*:* http://www.infibeam.com , 2009.

## Appendix B

Specifications of Tata Nano

| | | |
|---|---|---|
| Engine | Type | 2 cylinder petrol with Bosch multi-point fuel injection (single injector) |
| | Size | All aluminum 624 cc (38 cu in) |
| | ECM | Value Motronic engine management platform from Bosch |
| | Valves | 2 valves per cylinder, single overhead camshaft |
| | Compressio n Ratio | 9.5:1 |
| | Bore X Stroke | 73.5 mm (2.9 in)×73.5 mm (2.9 in) |
| | Power | 33 PS (33 hp/24 kw) @ 5,500 rpm |
| | Torque | 48 Nm (35 ft-lbft) @ 2,500 rpm |
| Suspension, Tyres and Brakes | Front Brake | Disk |
| | Rear Brake | Drum |
| | Front Track | 1,325 mm (52.2 in) |
| | Rear Track | 1,315 mm (51.8 in) |
| | Ground Clearance | 180 mm (7.1in) |
| | Front Suspension | McPherson strut with lower A arm |
| | Rear Suspension | Independent coil spring |
| | Wheels | 12-inch steel rims/alloys |

| | | |
|---|---|---|
| Performance | Acceleration | 0-70 km/h (43 mph) in 14 seconds |
| | Maximum Speed | 105 km/h (65 mph) |
| | Fuel efficiency | 20 km per liter (5 liters per 100 kilometers) |
| Layout & Transmission | Rear Wheel Drive, 4-speed manual transmission | |
| Steering | Type | Mechanical rack and pinion |
| Body & Dimensions | Seat Belt | 2 |
| | Trunk capacity | 30 liters (1.1 cu ft) |

Source1: S. Muralidhar, "The Great Indian Engineering Feat" http://www.thehindubusinessline.com, 22.03.2009
Source2: http://www.mytatanano.co.in , 2009

# Appendix C

Auto Part Suppliers of Tata Nano

| **Components** | **Supplier** |
|---|---|
| Cylinder Heads | Sundaram Clayton Limited, Rico Auto Industries Limited |
| Batteries | Tata AutoComp Systems Limited, Exide Industries Limited |
| Starter Motors | Bosch, Lucas-TVS |
| Alternators | Bosch |
| Radiators | Taco |
| Engine Management System | Bosch |
| Mirrors | Taco |
| Tyres | MRF Limited |
| Brakes | Bosch |
| Sheet Metal | Caparo Group, JBM Group, Rasandik Engineering Industries Limited |
| Bumpers | Taco |
| Lamps | Lumax Industries Limited |
| Steering | Sona Koyo Steering Systems Limited, Rane Group |
| Dashboard | Taco |
| Seats | Taco |

Source: S. Muralidhar, "The Great Indian Engineering Feat", http://www.thehindubusinessline.com 22.03.2009