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Volkswagen Navarra and the assembly of prototypes of the new polo model VW270.

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EXECUTIVE SUMMARY

The study focuses on the automobile sector and more precisely in Volkswagen Navarra. The main objective is to study the assembly of prototypes, which is an important event inside an automobile company. Volkswagen Navarra is evaluating the possibility of assembling prototypes of the new Polo model VW-270. In order to support the decision of the company with real data, a cost estimation analysis has been performed.

The costs involved in the prototype process have been grouped in two categories; prototypes´ exclusive costs and internal costs. The results found highlight that more than half of the costs of the assembly of prototypes are internal costs that already exist in the company. Therefore, the cost of the assembly of prototypes will not suppose entirely an additional monetary disbursement by Volkswagen Navarra. Nevertheless, the final decision of the company takes into account not just costs but other factors consistent with its long-run strategy.

KEY WORDS: Assembly of Prototypes, Economic evaluation, Volkswagen Navarra, Cost of prototypes, Product emergence process.

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1. INTRODUCTION

The present study has been realized in the framework of an internship in Volkswagen Navarra, as part of the product management team. Daily activities of this team are related with the design, the functioning and the management of the future Polo model. The main purpose of the internship was to study and to plan the process that prototypes will follow in Pamplona. As a final project for the internship a cost evaluation of the prototypes has been made. Hence this study is based on the personal experiences and duties performed in Volkswagen Navarra, as it is the cost evaluation.

The automobile industry happens to be one of the most globalized industries in the world. Different size firms and groups compete in order to gain market share, but few firms dominate the market. Composed of several brands, Volkswagen group is one of the leading companies of the automotive sector. Leaning into the difficulty of entrance of new firms and its strong competitive strategy, Volkswagen brand is situated in the top five car brands.

Competition in the automobile industry also happens within brands in the same group, for instance Seat and Volkswagen have similar models of car that compete against each other. As a consequence, brands have to keep up innovating and competing in order to offer better products than the competitors. An analysis of the automobile industry has been made in this study in order to see the forces and the threats of this industry, the degree of competition and the globalization of the industry.

Volkswagen Navarra, situated in the Spanish city of Pamplona, is the leading company in the production of Volkswagen Polo. The production of Polo models in the factory of Pamplona accounts for approximately a 25% of the Gross domestic product of the autonomous community. This production is mainly sent to other countries either in Europe or overseas, 90% of the total production of Volkswagen Navarra is exported. This last data represents a total of 32% of the total exports of Navarre.

The Volkswagen Polo is an economic car model which targets a medium- level income group of society, that look for a good quality-price balance in a car. The model changes every few years and the process of designing a new model is very long and takes several steps. This process starts 48 months before the launching of the final car. During that time

the car goes though different steps, one of them is the assembly of prototypes which are made 20 months before the production of the new model.

A factory like Volkswagen Navarra has to know the estimated costs that will result from the process of assembling prototypes. As a consequence, a cost evaluation has been made. The relevant costs have been grouped in four categories; confidentiality, training, logistics and production costs.

Prototypes will be made in the near future but there are different scenarios that could occur. That is the reason why an excel spreadsheet has been designed in order to conduct a sensitivity analysis. The results of the spreadsheet change depending on the premises selected for the different scenarios.

The results of the cost analysis are used in order to see the most relevant expenses inside the assembly of prototype. In addition it will be used by Volkswagen Navarra in order to decide if it is worth to make prototype in the factory of Pamplona. The decision will be made making a balance between the costs and the benefits that can be taken from the prototypes in the factory level. However, this study will only present the results and give a final conclusions but the final decision of making prototypes is still on the table and will be a decision made by the direction team of Volkswagen Navarra.

The first part of this study will deal with the analysis of the automobile industry. In order to do so, the study of the competition and globalization and a five force´s analysis have been performed. Volkswagen Navarra is the final target so in order to complete the analysis of the industry and make it more specific the strategy of Volkswagen is presented as well as the contribution of this company to Navarra´s economy.

The aim of the second part is an introduction to Volkswagen´s process of designing a new car and more specifically to the process of prototypes. The objective of Volkswagen Navarra is to know the costs involved in the process of the prototypes of the new car, which will be made in February 2016. The final sections of this work will deal with the cost evaluation of the estimated costs that will result if prototypes are assembled in the factory of Pamplona.

Finally few conclusions about the amount of costs and the distribution of those among areas and among types will be made to provide the directors of Volkswagen a backup for the decision of whether assembling prototypes is beneficial for the factory of Pamplona.

2. METHODOLOGY AND OBJECTIVES

The objective of this study is to get a deep knowledge about the automobile industry and more specifically about the process of prototypes. A five forces analysis has been implemented in order to analyze the main characteristics of this industry in terms of competition, supplier power, buyer power, threat of substitutes and threat of new entrants. Additionally, in order to see the importance of the automobile industry in the Spanish region of Navarre. ´The data of export and imports and the relevance of this sector in Navarre´s economy have been collected from the ¨Instituto de Estadística de Navarra¨.

Volkswagen Navarra wants to assembly prototypes of the future model of Polo in its factory of Pamplona. Before taking the decision, the company wants to know all the costs involved in the process. It is not the first time that prototypes are assembled in the factory of Pamplona, however, other times the body of the car was assembled in Pamplona which was beneficial for the company since the cost of making it was very low for Pamplona. This time the body will be sent from Germany so the costs of making prototypes will change as well as the payment that Germany will make to Volkswagen Navarra.

In order to see if it is still worth to build prototypes in the Factory of Pamplona the company wants to evaluate and show all the costs involved in the process. Since it is a future process, several variables are present and made up different scenarios that have been evaluated performing a sensitivity analysis. Depending on the premises selected, the values of the excel table change and so do the cost results.

All the cost data have been collected from internal information of the company, interviews with the heads, managers or chiefs of each area. In addition information from previous prototypes´ processes has been checked.

3. ANALYSIS OF THE AUTOMOBILE INDUSTRY

Companies inside the automobile sector are involved in the design, development, manufacture, marketing and selling of motorized vehicles. The automotive industry is considered as one of the most globalized industries, it is composed of several worldwide companies, such as Volkswagen Group, and each company owns different car brands. In spite of the fact that there are a large number of brands competing in the automobile sector, the industry is dominated by few companies.

3.1. Automobile sector: Globalization and competition

Globalization offered great opportunities for industries in general but especially for automakers who saw the importance of the opening of world markets. Trade liberalization brought enormous advantages for the sector as globalized markets offered the opportunity to reach bigger segments and to increase sales and production. Moreover it offered the opportunity to take advantage of economies of scale. Wider markets meant more potential consumers and the possibility of reducing costs and becoming more competitive due to the effects of economies of scale. Well established firms had a competitive advantage over new firms since the experience of the years made it easier for these firms to exploit economies of scale and offer a better quality product at a better price. Economies of scale made it very easy for well established firms to gain market share and to get a dominant position in the industry.

On the other hand, consumer preferences were not shared globally. Different cultures value different characteristics and designs of a car. As a consequence of the difference in preferences it was difficult for car makers to exploit economies of scale at the early stages of globalization, only the more successful and stable firms managed to take advantage of economies of scale. After globalization consumer tastes have converged but still differ between specific areas. For instance, United States consumers have preference for bigger cars than that of Europeans, thus, European car companies do not match perfectly North American's preferences. Although there is some evidence of convergence in preferences, car brands offer different variants of the same car in order to satisfy the specific preferences and needs of each customer.

According to the Forbes List "Global 2000: The Biggest Auto Companies of 2014" (Forbes, 2014), the most important companies inside the automotive industries are Toyota

Motor, Volkswagen Group, Daimler Motor, Ford Motors, BMW, General Motors, Honda Motor, Hyundai Motor, Nissan Motor and SAIC Motor in order of importance taking into account 2014 data.

The automotive industry is a perfectly competitive market with different size firms, each of which has different levels of product differentiation. Several tactics are used by the companies of this industry to compete against competitors and to gain or maintain market share. With product differentiation companies seek to increase their market share by offering a unique product with better characteristics than that of the competitor or by making a special advertising campaign.

A widely used method in the automobile industry is the market segmentation in which brands study the market and divide it depending on different characteristics. Companies divide customers in to groups, highly-elastic demand customers and less-elastic demand customers. The first group is very sensitive to price changes and so an increase in price will motivate this costumer to shift to other brands. The opposite also applies, if the intention is to gain market share a brand can also cut prices to attract new customers of this segment. The less- elastic demand clients do not exclusively focus on prices, they seek to find a product with higher quality, design or more environmentally friendly. After this first division others segmentation criteria can be made in order to narrow the targeted group and to offer a better product for them.

Competition in the automotive industry is very important between brands which target the same segment of the market, however, it is important always to keep innovating and offering new and improved products. The automobile industry is a very dynamic industry in which new technologies and fashions arrive so it is important to counter competitor's moves quickly since brands competing in other segments might see the opportunity to offer product to new market groups.

3.2. Five competitive forces in the Automobile industry.

The structure of the entire market sector needs to be analyzed in order to deduct the competitive strategy used in a sector and to evaluate the attractiveness and profitability of this case, the automobile industry. Michael Porter designed a framework that uses five forces to determine the attractiveness and profitability of a market sector. (Porter, 2008)

In the first place it is considered the **power of suppliers**. A large number of suppliers are competing inside the automotive industry with little differentiation between them.

Therefore, the power of suppliers is reduced. On the other hand, there are no substitute inputs since cars need specific components that cannot be changed. This last fact increases the power of suppliers and decreases profitability of auto makers.

In order to reduce the power of suppliers and increase profitability, companies inside the automobile industry sign contracts with at least two or three different suppliers with the intention of protecting themselves for possible disputes or problems that could emerge. As a consequence the bargaining power of suppliers is low; firms have the ability to switch to new suppliers with very low switching costs. In the process of looking for or negotiating with new suppliers the company can still make business with the rest of suppliers that were in the contract. In the specific case of Volkswagen, suppliers have little to say, and they have to supply specifically what Volkswagen wants and practically, Volkswagen has the power to set prices, otherwise the company will shift to other suppliers with lower prices.

In contrast, the **bargaining power of buyers** is medium-high. Switching costs of buyers is very low due to the phenomenon of internet. They can easily check information in web-pages of different brands in order to compare characteristics and prices. This new ability of buyers has decreased the profitability of the automobile industry and has increased the pressure of auto makers to improve their products and offers. In contrast, two points decrease the bargaining power of buyers. The first one is the fact that there are not many substitutes to choose from, which increases profitability for the automotive industry. Secondly, consumers identify themselves with a brand because they share the same values or thanks to the good reputation of a brand. Consequently consumers stay loyal with a specific brand. For that reasons, profitability of the auto industry increases and the power of buyers decreases. Nevertheless, the positive points that give power to buyers outweigh the power of firms. Volkswagen has to be aware of the importance of satisfying consumers and offering them a good price-quality deal in order to keep consumers and attract new ones. Thus, Volkswagen has not much power in this sense and the bargaining power of its customers is high.

The third force in this analysis is the **threat of substitutes**. The substitutes to an automobile are bicycles, taxi or train. They have same or better qualities than automobiles but they have some drawback that situates the automobile in a better position. The car is most of the times preferred by customers due to facts such as the waiting time for trains and the need to adapt to the schedule, or the inconvenient of using bikes with bad weather

conditions and the difficulties of biking for long distances. As a consequence the threat of substitutes is low.

Threat of new entrants is the fourth force in Porter´s five forces model. Several facts have to be taken into account when evaluating the threat of entrance. First of all, is important to consider the start-up costs. The capital requirements for this industry are very high and so the investment required to start in the automobile industry is extremely high. As a result, the threat of entrance is low and the profitability of the existing firms increases. On the contrary, the access to distribution and to necessary inputs is very easy. Therefore, the threat of entrance increases due to the easy access to suppliers. Despite of this last argument, the overall threat of new entrance is low due to the high barriers to entry in terms of the high start-up costs.

Finally it is important to evaluate the **intensity of Rivalry** in the automotive industry. Growth in the automobile industry is very high and so there are a lot of different brands offering similar products. The presence of a large number of companies makes the rivalry in the automobile sector very high and decreases the profitability of auto makers. The switching costs of buyers are very low so they can shift from one brand to another with almost no cost. Thus, profitability of the automobile industry is decreased by the intensity of rivalry. Many firms compete to stay profitable and so Volkswagen has to keep aware of rivals products and prices in order not to lose its current leading position.

In conclusion, according to the five forces analysis, in the case of the automobile industry the power of buyers and the internal rivalry are high, whereas, the supplier power, the threat of new entrants and the threat of substitutes are low. It can be said that the automobile industry is a very competitive industry that requires a strong and well defined strategy and a rigorous plan of all the costs and benefits of entering the market. As a result, Volkswagen has developed an intense strategy with which it intends to fight all the possible threats and continue in the business of the big automobile companies. The different brands inside Volkswagen Group follow the same strategy settled by the group with specifications for each product.

Figure 1. Porter´s five forces analysis of the automobile industry.

Force	
Power of suppliers	Low
Power of Buyers	Medium-High
Threat of substitutes	Low
Intensity of Rivalry	High
Threat of new entrants	Low

4. MARKET POSITIONING OF VOLKSWAGEN NAVARRA

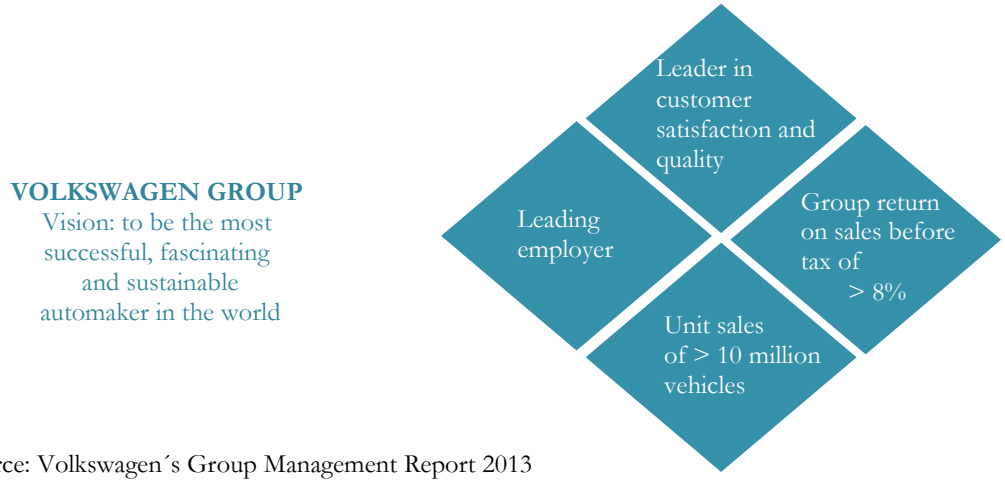
Volkswagen Group is a multinational Enterprise headquartered in Wolfsburg, Germany. It is composed of twelve different brands and has 118 plants around the world. Volkswagen group commercializes twelve different brands; Volkswagen, Audi, SEAT, ŠKODA, Bentley, Lamborghini, Porsche, Ducati, Volkswagen Commercial Vehicles, Scania and MAN. Volkswagen Group is not just a car producer but its activities go beyond, offering different services related with mobility.

Volkswagen Navarra was founded in 1983 with a production of 400 cars per day. Nowadays it is placed inside the group as the leading company in the assembly of the Volkswagen Polo, with a daily production of approximately 1300 Polo cars. In 2014, Volkswagen Navarra reached a production of 305.700 units of Polo and it finished 2014 inside the top ten of car sales. Volkswagen Navarra accounts for a 13.7% of share of the Volkswagen Brand and a 3.2% of share of the Volkswagen Group. Approximately 94% of the production of Polo cars in Pamplona´s factory is exported to more than 74 countries around the world, mostly to European countries.

4.1. Volkswagen´s group strategy

The strategy of Volkswagen has the objective of positioning the group as a global leader inside the automobile industry. The due date of this strategy is year 2018 by which the group intends to be the most successful and sustainable automaker of the world. In order to fulfill these goals, Volkswagen group is focusing on several dimensions such as customers, environment and employees.

Figure 2. Volkswagen´s group strategy



Source: Volkswagen´s Group Management Report 2013

Figure 2 summarizes the four main strategic points followed by Volkswagen group in its strategy. The catchword of Volkswagen´s group strategy is ¨to be the most successful, fascinating and sustainable automaker in the world¨.

Volkswagen focuses on customers and one of the points of the group´s strategy is to develop intelligent technologies and innovations to improve quality and consumer satisfaction. Its customer-based strategy aims not only to satisfy current customers but to capture new ones. The goal is to sell more than 10 million vehicles a year and get a market share above the average in the major growth markets.

Customers nowadays are concerned about the environmental problems and look for products that are made carefully and respectfully taken into account environment. As part of the customer-oriented strategy, Volkswagen group has an environmentally friendly orientation. According to several ecological standards they pretend to have an environmentally friendly range of vehicles which will give the group a strong position in the automobile market.

Furthermore, Volkswagen cares about its employees and pretends to be the most attractive employer. In order to achieve this objective, Volkswagen pretends to capture a team of highly qualified professionals that will be motivated to build the best vehicles. A method of feedback from employees is already taking place inside Volkswagen group, one of these methods is a questionnaire fulfilled by employees in order to measure their degree of

satisfaction with respect to their positions, superiors, colleagues and the job environment in general.

Finally Volkswagen´s long term view is to have a return on sales before taxes of at least 8%. A strong and stable financial position of a firm allows them to have a better access to financial markets and at lower costs. As a consequence it is more economically viable for them to expand business, explore new markets and invest in research and development and so in turn offer a better product and be more competitive.

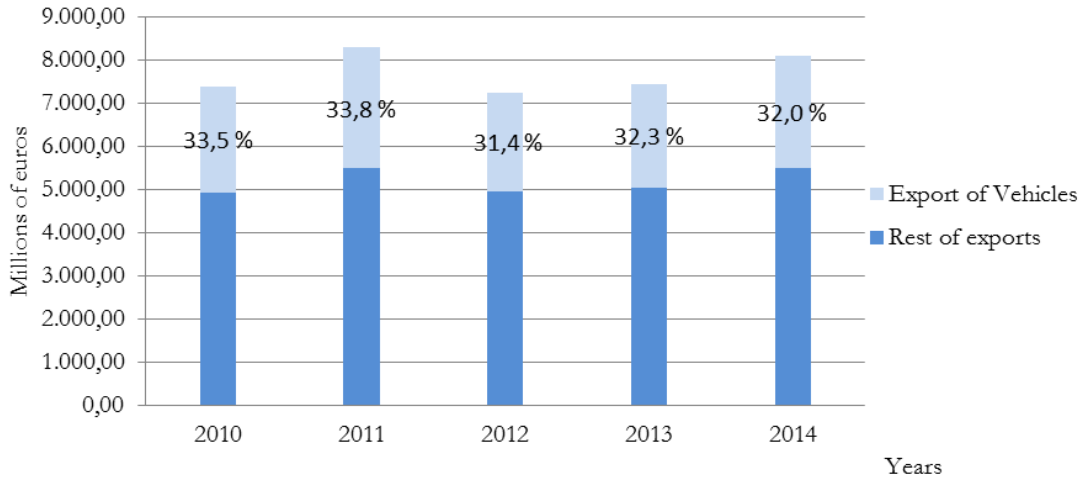
4.2. Volkswagen Navarra: its contribution to Navarra´s economy

Volkswagen Navarra has great importance in Navarra´s Economy. As a matter of fact Volkswagen´s activity accounts directly for 25% of the gross domestic product of Navarra, that´s why the production of this company highly influences the economic result of the autonomous community. Volkswagen employs, in Navarra, more than 4900 direct employees. However, Volkswagen has important contracts with suppliers of vehicles components that are also working in Navarra. As a consequence, Volkswagen Navarra is not just directly an important employer in Navarra but is also indirectly since it makes business with suppliers of the region that in turn contribute to the wealth of Navarra´s economy.

International trade is highly important in Navarra. Over the last decade Navarra had a cover rate of exports over imports of more than 100 %. Thus, Navarra´s exports are higher than imports, which mean that Navarra is a net exporter. Motorized Vehicles are the most important type of product in the rank of exports by product type.

The graph below shows the total of exports of Navarra´s economy during 2010-2014 periods. The results are divided into the exports of motorized vehicles and the rest of exports. The exports of Volkswagen Polo´s account for more than the 30% of total exports in Navarra. In 2014, 32% of total Navarra´s exports were Volkswagen´s Polo model and the other 67% is divided among other industrial sectors in the economy of Navarra such as agricultural products, vehicles components and others.

Graph 1. Yearly data of exports in Navarra in period 2010-2014



Source: Own elaboration based on data of the Instituto de estadística de Navarra

The polo model of the industrial area of Landaben is mostly sold abroad. More than 90% of Volkswagen Navarra´s production is exported to other countries, mostly European countries. That is the reason why the percentage of vehicles exported is so important for Navarra´s exports account.

4.3. Internal Rivalry inside Volkswagen Group

Volkswagen Navarra is the leading company inside the Volkswagen group in the production of Polo car model. The Polo model is also produced in the factories of South Africa, China, India and Russia.

The factory of Volkswagen in Navarra has a competitive advantage over the other factories producing Polo model. The reason behind this advantage is that Volkswagen Navarra is the factory that consumes less in its production process in terms of resources such as water and energy.

The factory in Pamplona has more experience than the other plants producing Polo car model and counts with modern technologies, robots and processes that allow them to reduce average production time of a car. For instance, the paint shop in Volkswagen Navarra is one of the newest processes of painting existing in the automobile industry. Better technologies and processes are translated into better quality, which in turn means less time spent in doing the final mends.

As a consequence, even though other factories of the brand of Volkswagen are producing Polo model, Volkswagen Navarra has not a potential threat in terms of internal competition since this plant is more efficient.

Nevertheless, inside the group there are other brands that produce models that are oriented towards the same customer as the Volkswagen Polo. Other brands such as Seat offer cars with similar characteristics and oriented to the same type of customer. Cars such as the Seat Ibiza or the Skoda Fabia are substitutes of the Volkswagen Polo since they cover the same needs and wants and are oriented towards the same market segment.

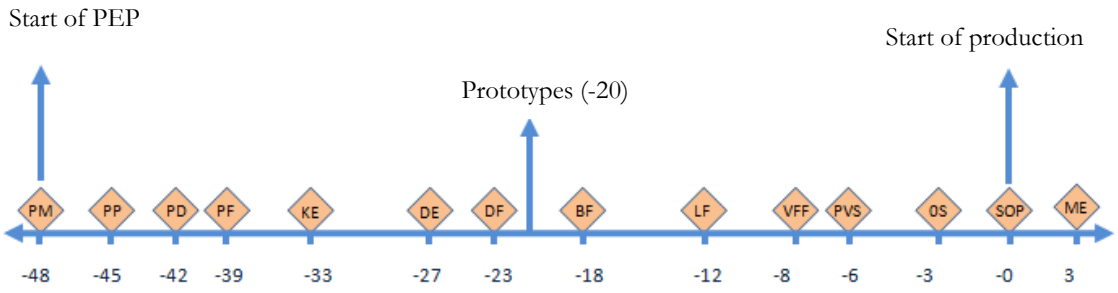
As a consequence Volkswagen has to keep offering a better product at a competitive price in order not to lose market share. Thus, there is internal rivalry between brands inside Volkswagen group.

5. PRODUCT EMERGENCE PROCESS

The process of designing and launching a new car is named inside Volkswagen Group as product emergence process (PEP). The PEP starts 48 months before the new car is launched to the market. It is a long process of fourteen phases, each of which contains different hits or steps that have to be taken with respect to documents, market, finances, styling, product, suppliers and assurance.

The group PEP is a group-wide mandatory agreement with explanations of the milestones as a basis for board of management product planning and product strategy committee meetings. This general emergence process is shared by all the brands inside Volkswagen group. However each brand includes additional specifications. Figure 3 represents all the PEP steps in a timeline.

Figure 3. Product emergence process (PEP) timeline.



Source: Own elaboration based on internal information of Volkswagen Navarra

5.1. PEP phases before prototypes

This process of creating a new car is divided in fourteen steps that start with the mission of the product **(PM)**, 48 months before the start of production. The mission of the product consists on a statement about the objectives that Volkswagen wants to reach with the new product, the financial strategy and the technical characteristics wanted and the type of targeted client. In this phase a deep analysis about the wants and needs of the customer is made. The market is segmented in different groups in order to analyze specific kind of clients depending on cultural matters. Additionally the company sets innovation targets and pretends to keep updated with new technologies, materials, innovations and fashions.

The second phase of the product is the project premises **(PP)**, which takes place 45 months before the production of the car. It includes a product profile that consists of the positioning characteristics of the product. It is very relevant in this phase the definition of the financial characteristics of the project. There is a statement of the target direct costs and expenditures and the expected operating income which is based in a demand study.

The third phase is called product definition **(PD)**; it starts 42 months before the product will be sent to the market. The characteristics catalog of the product is presented in this phase as well as the technical concept definition. The costs of commercialization and distribution, the volume and price objectives and the first characteristics of the client are stated. One of the most important steps of the product definition phase is the first 3D representations of the vehicle.

The project feasibility **(PF)** is the fourth phase of the process which takes place 39 months before the introduction to the market. The documents that are important in this phase are the target catalog and the first product description book. The product design goes through a process of styling selection in which there is an offer of "n" stylings of the exterior and interior of the car and a selection of two from the n styling concepts.

The dimensions of the new car usually change and so the production line has to be checked in order to see the platform´s feasibility. At the same time the ergonomics concepts are checked in the assembly line.

In this phase the group decides whether the project is feasible, if it is, the project goes to the following PEP phases. Otherwise the project is cancelled or revised.

The Concept decision **(KE)** is phase five of the process and happens 33 months before the introduction to the market. After the evaluation of the assembly line in phase four it is time

now to sign the documentation of technical feasibility and the changes and improvements that have to be done in the assembly line. In addition, there is an analysis of the manufacturing times that will serve in future steps to plan the production process in the different work areas of each employee. These work areas are delimited by one blue line at the beginning of the work area and another at the end. All the tasks assigned to this area have to be made in between those lines. The distance between those lines are set according to the measurement of times made by the industrial planning department.

Finally with respect to the assurance, the first concept virtual prototype is developed with a clear statement of the concept characteristics. There is an estimation of faults per vehicle, warranties and costs and the first patent check.

Styling decision **(DE)** is period number six that occurs 27 months before the introduction to the market. As is expected the main objective of this phase is to get the main surface styling options as well as the interior and exterior styling.

Phase number seven is called styling Freeze **(DF)** and starts 23 months before the end of the process. The most important document in here is the status report of product strategy committee. The detailed styling is finished and there is an alignment with the technical status. All this information about the design of the product leads to the final confirmation of styling details.

The quality team of Volkswagen works during this phase in order to set the quality targets of this model. In this phase, 20 months before the start of production, the first prototype is assembled. Once the first prototype has been made, several tests and evaluations are made to the car in order to see what could be improved or what is infeasible and has to be changed. Ever since the first prototype the product starts to get closer to what it is going to be the final outcome.

5.1. PEP Phases after the first prototype

Procurement Release **(BF)** happens 18 months before the launching of the new car and is phase number eight of the emergence process. A detailed planning of product range is made and all the data control is completed. Suppliers for operating equipment are confirmed as well as the manufacturing feasibility on prototype basis.

The acceptance part of this phase is one of the most important in the process of prototypes because there is the whole vehicle acceptance at procurement release and the

procurement release data for virtual prototype. It is included in this part the construction of the first prototype which happens 20 months before the introduction to the market.

Phase 9 starts 12 months before the introduction to the market and it is called launch release **(LF)**. The launch planning consists of concepts for launch variants, product and repair. The product presentation and the second public appearance on Open Day are included in the launch planning. The whole equipment spectrum for pre-series is developed together with a market clinic 13 months before the introduction to the market.

The financial characteristics start to take place in this phase and the first product data is ready for accounting. Definition of colors, fabric and decorative trim are included in the styling section of the PEP. Procurement release for body and equipment is completed 15 months before the introduction to the market. In this phase there is a hazard analysis of ergonomics for working environment and a start of launching requirement capacity management. The confirmation of readiness for standard production is given and the quality requirements are implemented. The whole vehicle release for launch release is present at this time.

The purpose of phase 10, which is named Pre-series Release Vehicle **(VFF)** and happens 8 months before the final vehicle series, is to prepare the car for the introduction to the market. Three main points are important; the first one is the release for whole equipment spectrum in addition with a communication platform that includes a planning of launch communication and a vehicle specification for dealer and after-sales service. Vehicles are order for photo sessions, films and press demonstration. Is not until this time that the public can start to see how the car is going to be, before that the confidential agreements are a really important measure to keep the project safe. Finally the pre-series vehicles are released, one of the most important moments of the whole process of product emergence.

The pilot series **(PVS)** is phase number 11 and it happens 6 months before the introduction to the market. The configuration matrix of country specifications is developed and so there is the first simulated pricing. The development release is completed and the technical documentation with the design data and drawing are finished.

The whole logistics processes are planned following the philosophy of Just in Time and the first pilot series vehicle is finished at checkpoint seven of the component demand deadline for individual parts.

Three months before the introduction to the market it is placed period 12 which is called Zero series **(0S)**. In here the press is present at every moment because there is a pricing date that will be said on trade fairs and press events. In terms of the product the final engineering characteristics of the product are approved and the bill of materials for zero series vehicles is known.

The production of the final car and the introduction to the market is closed by and so employees start the training process. Employees learn the new production characteristics and the quality assurance and properties of the new materials and the new product. The final step is the release of the whole vehicle with the assurance tests.

After all this previous steps the acceptance tests drive and quality targets are confirmed and the standard production **(SOP)** starts, which is phase 13 and the point of reference of the whole PEP.

The last step of the emergence process is the launch of the car **(ME)**, three months after the start of production. In here communication with the market is really important, in order to give the potential customers an overview of the car in the best possible way. The series requirement capacity management starts and finally the final product is sent to the market.

6. PRODUCTION OF PROTOTYPES

The product emergence process explained earlier goes through different steps before the car starts to take form. Prototypes are early real or virtual samples of a car model which are built in order to test and trial a new design. The reasons behind prototypes are of different kinds but all of them are very important in order to find the best final car. The intention of prototypes is to learn from them and to evaluate the possible errors or changes in the actual production process; it is a learning by doing method. Inside the prototype process there are several types of prototypes depending on the intention for which they are built. One of the first real representations of the car, that can be as well considered a prototype, is made with clay in order to see the design of the exterior and the shape of the car. Other prototypes are made in order to do crush tests, electric tests, rain tests and many more different proofs with a wide range of purposes.

6.1. Prototype objectives

Prototypes start to be developed 20 months before the final car is started to be produced. One of the main purposes of prototypes is the evaluation of the assembly line. The new

model of the car usually has different dimensions than the previous model. As a consequence, it is very important to test the assembly line and the processes followed in the assembly line in order to see what changes and modifications have to be made in the assembly shop. For instance the hook that holds the car may not be appropriate for the new model and an important investment will have to be made in order to change them for new ones. The production times may vary from model to model because new features are introduced or because some components of the car have more complexity, so in addition, the production process and the production times are evaluated.

Another objective of prototypes is to know the details and functioning of the new components and materials. Some of the personnel working in the assembly line are designated to assembly prototypes. These workers learn from this process and are in charge of transmitting the knowledge and procedures to the rest of the workers.

All this information provided by prototypes helps to improve the features of the product or to choose different technologies, platforms or even materials for the car. They also contribute to increase the value added of the new product.

After prototypes, other cars are produced and as it is explained in the emergence process they are the pre-series release vehicle, the pilot series, zero series and the start of production, in which the final car is produced. All the models after prototypes are made in order to improve the quality of the product and to take final decisions about styling, materials, production times and other important aspects.

6.2. Scenarios for the production of prototypes

The new car that is going to be assembled in Volkswagen Navarra is the new polo VW 270. The prototypes for this car are planned to be made at the beginning of year 2016, more or less in February. Five prototypes are going to be made and there are different scenarios that could be taken into account when evaluating the cost of making prototypes. With respect to the assembly of the prototypes two scenarios could emerge in terms of where to make the five cars. Prototypes can be made either in the assembly line or in the try-out area. The assembly line is where the series of the actual care are being made whereas the try-out area is a closed small area designed to carry on process which purpose is to learn, for instance, prototypes. In the try-out area there is a simulation of the assembly line with two to three hooks. The line can move as well or can remain fixed. This area is normally

used in order to see the procedures of a specific action in the assembly of the car, for example the procedure of setting up the wheels. It is as well used for prototypes.

The benefits of making prototypes in the try-out area are that the logistic process is easier to control than in the assembly line, it is more appropriate in order to keep the confidentiality of the product because the try-out area is easier to cover and to restrict the access to the area. In addition, it is very important to take into account that the assembly of the car in the try-out makes it easier to control, analyze and monitor the production process. Apart from that, the production of prototypes in the try-out area avoids the possible delays that could be caused in the actual series if the cars were produced in the assembly line.

On the other hand the major drawback from the try-out area is that the materials available in the area could not be appropriate and few adaptations will have to be made. Other instruments that are available in the assembly line such as the chassis carriage and the cockpit installer are not present in the try-out area. As a result, they would have to be placed by hand which makes the process less closed to reality and more difficult for the workers.

The major benefits of the assembly line are the drawbacks of the try-out area. Making prototypes in the assembly line makes it easier to control times and processes since all the assistant robots and instruments used to assembly the car are present.

Therefore the company will have to choose either if it is preferred to do the prototypes in the try-out area or in the assembly line. For now, the plan is to make them in the try-out area.

Where to make prototypes is not the only decision that has to be made, there are other variables that made up several scenarios. If prototypes are made in the try-out area there are three possibilities of storage. The body of the car and the components can be storage in the try-out area, in the special car storage area or in a closed space near the try-out area. In addition, no matter where the car is going to be made there are two possibilities with respect to the transportation and assembly of the prototypes. If prototypes are going to be made all at once only one truck will be needed to send them here and to bring them back to Germany but usually this is not the case because prototypes are made in different points of time and so cars will be transported separately. All these variables have to be taken into account by Volkswagen Navarra in order to evaluate costs and make a decision about the

assembly process of prototypes. In this case, probably prototypes will arrive at different points in time, with two weeks difference and the assembly will be in the try-out area. The storage will be a variable that will create three scenarios.

6.3. Prototype process and costs involved

The main office of Volkswagen establishes a cluster of prototypes with different characteristics and processes depending on the intention behind those prototypes. The first prototypes are made without specific body but instead they use other car´s body such as the golf. The intention of these prototypes is to study for example the chassis and that is why the body is not needed. Other prototypes are made for crash tests so the aspect of the car is not as important as the quality of the components. Volkswagen Navarra selects or is assigned to assembly some of those prototypes. In this case Volkswagen Navarra has to assembly five prototypes which are not yet known to which category are going to belong.

In order to make a good economic evaluation about the feasibility of making prototypes in Volkswagen Navarra, it is important to take into consideration all costs that are significant when making prototypes. With the intention of evaluating all the costs involved in this process it is convenient to list them in the same order as the assembly process.

Several steps have to be taken before the start of the assembly process of the prototypes. Since prototypes of the VW 270 are going to be made in the try-out area there are several steps that are important to be taken in order to keep the confidentiality of the product. The features of the car have to be kept unknown to the public due to copyright matters. The try-out area is a closed area but the walls are transparent so there is 100% visibility. Thus, in order to keep the confidentiality of the product it is necessary to cover all the walls with a material that does not allow people to see through it. All the room´s windows have to be covered and the accesses to the area through the room´s doors have to be restricted. In addition, the stairs that are inside the area have to be closed so no one can take photos from upstairs. Finally, the main door of the try-out area has a system that allows only the entry to people with accreditation, that system was placed for the previous prototypes made in the area and will have to be reactivated. All this measures have costs associated to them that have to be considered in the economic evaluation of assembling prototypes.

The workers that are going to be in charge of assembling the prototypes have to receive training in Germany some weeks before the assembly process starts. The 3 workers will have to travel to Germany and stay there for three weeks. The travel and hotel costs of this

training process have to be included in the economic evaluation since they are part of the prototype process.

Once all this previous steps are taken the body and the pieces of the prototypes will be sent from Wolfsburg. The transportation from Wolfsburg and the reception of the pieces in Volkswagen Navarra have to be taken into account economically. Other two scenarios emerge with transportation matters. The body and pieces of the five prototypes can be sent all in once or one by one as the different prototypes may have different assembly dates. Therefore two scenarios have to be considered since the cost of the second is greater than sending all of them at once. After they arrive to Pamplona starts the reception process of the components and body in which they make a list of all the pieces. The purpose of this reception is to check that all the components needed to assembly the car have been sent so in case there is something missing they can order it immediately. After this reception is finished the components and the body of the prototype go to the storage area. In the storage are, the logistics personnel distributes them among different shelves.

The storage of the pieces depends on whether the prototype is going to be assembled. If the assembly line is the chosen option there is only one scenario of storage that will be the assembly building as normal. On the other hand if the car is going to be assembled in the try-out, there are three possible scenarios. The first one is that the storage will be in the try-out area; the second scenario is that the pieces and body of the prototypes will be storage in a closed area near the try-out and the last scenario is that the storage will be in the assembly building as with normal series. The storage per se does not make a cost difference but the cost of distribution of pieces to the assembly area depends on whether the body and the pieces are storaged. Another difference in cost of the three storage areas is that only the area in the assembly shop is equipped with the needed shelves, so in the other two scenarios the cost could increase due to this. In the distribution process there will be a person in charge of the supply of components to the try-out area. The worker in charge of the supply process will have to be available all the time during the assembly process so the cost of distribution will be calculated with the salary paid to the person in charge and the hours the car will be in try-out.

In relation with the confidentiality of the car it is necessary that someone from the security team is with the car all the time the car is not in the try-out. When the car is in the try-out area is not necessary a security worker since the area is restricted to allow access to only authorized people.

Once all the previous steps have been taken the body of the car goes to the paint shop and the engine is sent to the engine line. All this transportations are important to take into account because a logistic worker with a pallet truck will be needed.

The same process will be made backwards in order to send the painted body to the try-out area and the motor back to try-out in order to do the union of the engine with the car in the try-out.

The complete assembly of the car will be made in the try-out area, 3 employees will be working with the car. Once the body and components are together, one of the last steps is the union of the engine with the body. The assembly of the engine will be made in the engine shop. Once the engine is finished it will be transported to the try-out area in order to do the engine marriage.

An important scenario emerges with respect to this last step of the union of the engine with the car which is called the engine or chassis marriage. The engine marriage is the union of the engine, the gearbox and the chassis with the body of the car. This union is made with a specific chassis carrier, called the triebsatz pallet, with concrete dimensions according to the shape of the new model. If prototype is made in February, Volkswagen Navarra will have to pay the transportation of a prototype triebsatz pallet for each prototype car made in February. If prototype is made in March or later then one of these types of pallets will already be in Pamplona since the engine shop has ordered one. The cost of this last option will be zero for prototypes because the cost of it will be assigned to the engine shop and not to prototypes. Hence, it is important to differentiate between the two scenarios that emerge in relation to when the prototype´s assembly starts in Volkswagen Navarra. Once the car is complete it is transported to the assembly shop in order to do the liquid filling and the electrical checkouts.

The final steps is the checkouts made by the special cars team, in which several tests are made to the car, such as the rain test or the electrical test which is part of this step. The time spent in the final revision of the car is important to take into account. The team spends more time doing these final checkouts with prototypes than with a normal car. The reason behind this is the car is different than the previous model and so they use it as a learning mechanism as well.

Finally, the quality team is of special interest in prototypes because they have to analyze several things. First they analyze the quality and the state of the pieces and main structure

of the car that comes from Germany. After the car has been painted they quality team does an analysis as well to check that everything has gone well. Finally when the prototype is finished they do a final auditory and some tests that are done for every car of the series as well. These tests consist of electric and mechanical checkouts and several auditory of the car. After each quality intervention there is a final revision intervention in which some retouches are made. The last auditory gives the approbation to the car in so the finished prototype is sent back to Germany in specific trucks that keep the confidentiality of the product.

All this activities have to be coordinated by the team of the technical office which is composed by the engineers of Volkswagen Navarra that work with the new model. These employees will dedicate part of their time during the whole process to monitor all the activities. The cost of the technical office then will have to be included as part of the prototype´s costs.

6.4. ¨Terminplan¨ or schedule plan for prototypes VW 270

The prototype process explained in the previous paragraph is often summarized in Volkswagen with a terminplan. A terminplan is a schedule in which there is a general explanation of the steps taken in each week of the process. In here the process is divided in the different steps such as montage, painting, logistics, transportation and others.

The intention of the terminplan is to estimate the process and times that the prototype will follow. It also helps to monitor the car and to control the production times during the assembly process.

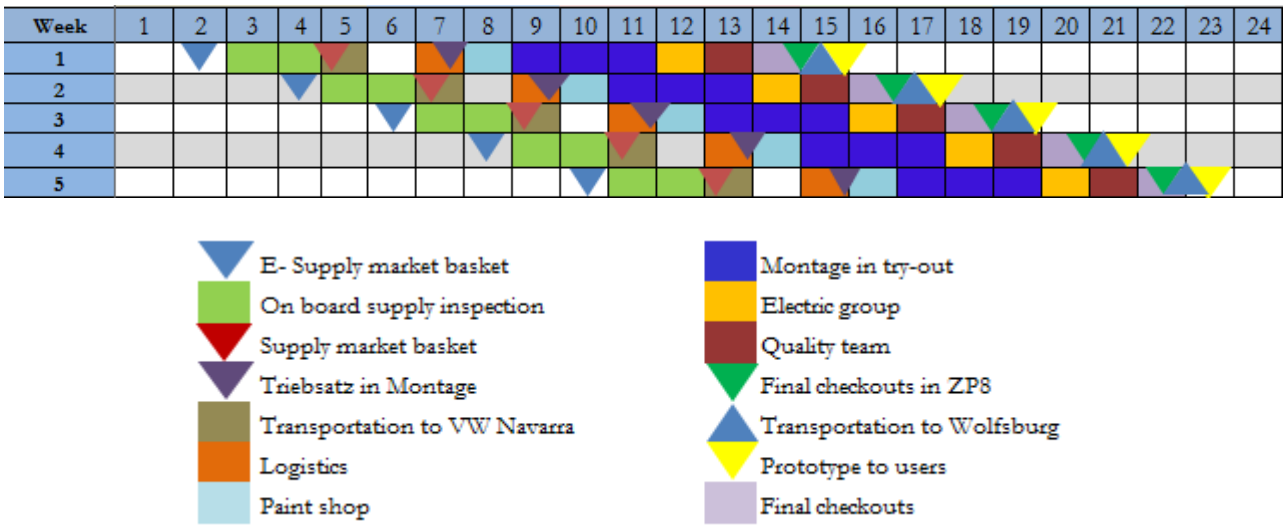
The first actions represented in the schedule are the preparation of the components and materials basket. After that it follows the supply of the components and the body of the car and its transportation to Pamplona. The reception of the parts and the body of the prototype happens right after they arrive to Pamplona and then the components are storage.

As can be seen in the terminplan, the production of the prototype starts with the body going through the paint shop. After the body has been in the paint shop it goes to try out and it is assembled. In the terminplan it is also represented the times spent by the quality team and the final checkout team. The car goes thought some tests and the filling of the liquids and finally when it is ready and finished it is sent back to Germany.

As the try-out is a very small area with only two hooks, prototypes will be assembled not all at once but instead the plan is to have two week difference between the arrival of each body and components for a complete prototype. In some points there will be maximum of two prototypes in the try- out area which will be in different stages of the assembly process.

As it can be seen in the Annex A the specific terminplan that has been made in Volkswagen Navarra has more detailed information about all the procedures and the tests that are going to be performed to prototypes. However, Figure 4 shows a summary of a general terminplan of Volkswagen for the prototypes VW 270. Approximately the process will start in February 2016 and will finish before July of the same year. As it can be seen, the assembly of the car is only a part of the long process that will take about three weeks for each prototype. The painting of the car is the first step and then follows the assembling of the prototype. The previous steps are basically logistics a of materials and components preparation in Wolfsburg and in Pamplona.

Figure 4. General Terminplan for prototypes of Volkswagen



Source: Volkswagen internal information

7. COST EVALUATION.

The finance department of Volkswagen considers only manufacturing costs when making cost evaluations. The costs of materials are not included when deciding about a project since those costs are the same for all the plants that assembly polo cars.

Consequently the cost evaluation of the assembly of prototypes in VW Navarra only includes the costs of employees in charge of different duties all related with prototypes, the transportation and similar but it does not include the cost of components or materials used. Additionally, it does not include the cost of insurances, energy, depreciation and other similar indirect costs.

The cost evaluation is divided in two different costs. First, the costs that are exclusively due to the production of prototypes, for instance, the new personnel that has to be hired for the process. Second, the other category of costs are those that already exist in the company but are going to be designated to the production of prototypes, such as the employees that are already employed but will be working with the prototypes.

For practical purposes, in this section the scenario that is going to be commented is the following: The car will be made in the try out and the production will start in February, making the first to prototypes in February and the rest in March, April and May. This means that the chassis pallet will only have to be hired for the first two prototypes, for the rest Volkswagen Navarra will have its own pallet. The storage will be made in the special´s car area and transportations to try-out will be made whenever needed.

In figure 5, we can see a summary of all the total costs by areas and by type of cost for the presented scenario.

As it can be seen in Annexes B the different areas have diverse internal costs. However in this section not all of them will be presented separately. The additional backup for all the results can be found in the annex B in a table with all different costs with times, salaries and other details.

Figure 5. Total costs by areas and by type of cost.

Costs	Exclusive costs (euros)	Internal costs (euros)	TOTAL COST (euros)
Training costs	11.190,00	16.213,68	27.403,68
Confidentiality costs	13.840,05	89,55	13.929,60
Logistics costs	41.700,00	48.552,40	90.252,40
Production costs	66.306,00	28.357,50	94.663,50
Technical office´s costs	-	106.012,80	106.012,80
Quality costs	-	109.406,10	109.406,10
Total cost by type	133.036,05	308.632,03	441.668,08

7.1. Prototype´s exclusive cost: costs incurred due to prototypes

Confidentiality is an important part of the costs that are incurred exclusively as a consequence of the prototype process. It accounts approximately for 3% of the total prototype´s cost. It is divided in three main categories. First, the cost of the covers used to transport cars and to keep cars protected from the view of unauthorized people, which is a cost of 3349.5 euros. The second confidentiality cost is the cost of security guards who escort the prototype when it is moved inside Volkswagen Navarra. This second cost is of 10490.55 euros. The third cost inside this area of confidentiality is the cost of restricting the view and access to the try-out area. This cost is low but crucial to take into consideration because it is an important step to take inside the prototype process; however, it is an internal cost.

Logistics costs are one of the main costs of the prototype process. Almost half of the logistics costs are as well exclusive costs of prototypes that Volkswagen Navarra could have avoided if prototypes were not assembled. Inside the logistics costs we have the transportation from and to Wolfsburg. Those costs account for a total of 41,700 euros, a 9% of the total prototype´s costs.

The prototypes ´ exclusive learning costs, 3% of the total prototypes´ costs, are composed of the costs of three workers that will travel to Germany. The travel costs, the cost of renting a car and the hotel expenses are exclusive costs of prototypes. In addition these three workers will receive a monetary diet in order to cover the expenses during the time in Germany. The total of these costs is 11,190 euros which represents a 41% of the training costs or travel costs. The most important cost inside the exclusive prototype´s learning costs is the hotel expenses which are estimated to be 5,700 euros. On the other hand the

salary of these three workers is part of the internal cost of the company even though it is designated to prototypes.

The scenario of the chassis marriage that has been explained earlier has a cost associated with it depending on the month of assembling the prototype. Each prototype that is assembled before March has a cost of bringing the chassis carriage of 4,200 euros. In the scenario that is being presented, two prototypes will be in need of bringing the chassis carriage to Pamplona so the cost is estimated to be of 8,400 euros. This cost is part of the production costs and related to the engine costs.

Additionally for the production area, three workers will have to be hired in order to substitute the employees that will be working with prototypes. Hence, the cost of these workers will be a cost that could have been avoided if prototypes were not made. The total cost of these workers is estimated to be 57,906 euros. The total exclusive prototypes´ costs inside the production area represent thus the 15% of the total prototype´s costs.

Figure 6 shows the percentages over the total of each cost either of the different areas or of the type of cost. The total prototypes' exclusive costs represent the 30% of the total costs. It is a relevant data since these expenses are the only ones that will have to be extra costs for Volkswagen, however the internal costs are costs that are already present in Volkswagen.

Figure 6. Percentages of costs over the total; by areas and type of cost

Costs	% of exclusive cost relative to the total cost	% of internal cost relative to the total cost	% of costs of each area relative to total costs
Training costs	3%	4%	6%
Confidentiality costs	3%	0%	3%
Logistics costs	9%	11%	20%
Production costs	15%	6%	21%
Technical office´s costs	0%	24%	24%
Quality costs	0%	25%	25%
Total % cost by type	30%	70%	100%

As it can be seen in the figure, the prototypes ´exclusive costs of the technical area are zero. It is because the four employees in charge of different tasks related with prototypes are workers that are already in Volkswagen Navarra performing other duties but during that time will be dedicated partially to prototypes. The same scenario occurs with quality costs.

7.2. Internal cost: costs already present in Volkswagen Navarra

The internal costs, as it has been explained previously, are costs that do not suppose an extra for Volkswagen. These costs were already existent but designated to other tasks. The workers included here are of two types, MOD or TAS. The two differ in positions and in wages.

The main costs in this category of internal costs are the cost of workers that are already employed by Volkswagen Navarra but will during the prototype process be working in the assembly or other processes of prototypes. These expenses are present in the different cost areas.

Firstly, the 89.55 euros spent in restricting the access to and the view of try-out is part of the internal costs of the company because the materials and the people needed to condition the place are already in Volkswagen Navarra.

Secondly the reception, storage and distribution expenses are inside the logistics costs but are part of the internal costs of the company. A worker that is already employed by Volkswagen Navarra will be in charge of this process. So this cost of 48552.4 euros is important inside the cost evaluation of prototypes but as an internal cost. As it can be seen in Figure 5 the internal logistics costs account for 11% of the total costs

Additionally, 6% of the total prototypes ´ costs are internal production costs. In here the workers of the paint shop, the electric group and the final checkouts groups are included.

The totality of the quality costs are internal costs of the company. The quality team is already employed in Volkswagen Navarra but will be involved in the prototype process. These costs are 25% of the total prototypes ´ costs.

As part of the training costs, 16,213.68 euros paid to the workers that are going to spend three weeks in Germany is part of the internal costs of the company that are designated to prototypes. This cost is the highest in terms of learning costs and represents a 59% inside this group of costs.

Finally all the costs of the technical office are internal costs. The duties performed here are the management of the process of prototypes.

The internal costs of the prototype´s process are 70% of the total cost. This cost, as it has been said, does not have to be disbursed by Volkswagen Navarra since are resources that already exist and will be allocated during some time with prototypes.

8. EVALUATION OF ECONOMIC RESULTS

The previous section explains the different costs implied in the prototype process of Volkswagen Navarra for the new Polo VW270. The costs of the different areas were commented in two groups depending on whether these costs were prototype exclusive or internal costs of Volkswagen Navarra. In contrast, in this section economic results will be evaluated by areas such as production, training, logistics and confidentiality, comparing them with the total cost in order to see the percentages and the importance of each area.

The importance of the knowledge and estimation of the costs of making prototypes is high. Volkswagen Navarra with this cost estimation will have to decide whether it is worth to assembly prototypes in the factory of Pamplona. The advantages of making prototypes such as the practicing, the learning of the methodology and the anticipation of problems before the normal series will have to be weighted against the costs of making them. The decision of making prototypes will be made taking into consideration both sides.

8.1. Economic results by areas

In graph 2 we can see the distribution of costs among the main areas inside the production of prototypes process. In addition, in graph 3 we can see the costs of the areas grouped into two categories; internal costs and new costs of prototypes. The area which takes the higher percentage of costs is the quality team which represents a 25% of the total costs, which are internal costs of the company. The reason is that the quality team likes to spend a long amount of time verifying the car.

The costs of the technical office are the second in the ranking and represent the 24% of the total prototypes ´ costs. All these costs are internal costs of the company. The technical office´s costs consist of some engineers working in the coordination of the prototype process and design of the prototype so they are not directly working with the car.

The production costs are the third in the ranking, production costs are 21% of the total prototypes ´costs. These costs are mainly prototypes ´exclusive, 70% of the total production costs. In order to assembly prototypes, three workers are needed but the line production cannot have a shortage of three workers so additional workers will have to be hired to substitute them.

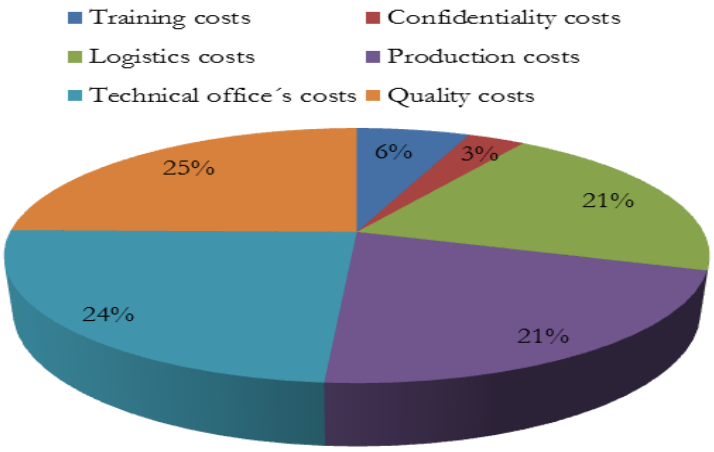
The logistic area follows the production area. The logistic ´s costs are distributed almost in equal share between internal and prototypes ´exclusive costs. The costs of this area account

for a 20 % of the total. From this, 54 % are internal costs and the rest 46 % are new costs that are incurred due to prototypes.

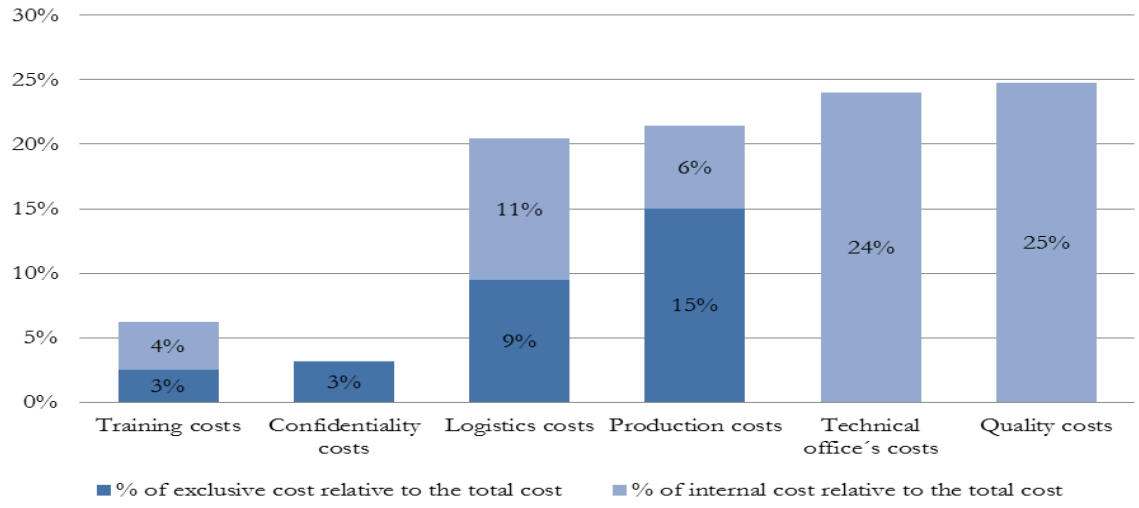
Training costs are the following in the ranking of the areas, but it accounts only for the 6 % of the total costs. The salary paid to the workers, the internal costs, are higher than the new costs of prototypes. They account for the 59 % and 41 % respectively.

Finally the confidentiality costs are mostly exclusively from prototypes, 3 % of the total costs are due to confidentiality matters. The security personnel needed for prototypes have to be hired exclusively for this so it is the only case where the salary of workers is just exclusive cost of prototypes.

Graph 2. Costs of prototypes grouped by areas.



Graph 3. Total costs grouped by areas and by type of cost.



Taking the information from figure 5 and summarizing it in figure 6, it can be seen that 70% of the total costs are internal costs of the company. The majority of these costs come from the quality and the technical office´s area in which the employees spend more time working with the car. The rest of the costs, 30 % of the total, are the new costs in which the company will incur due to prototypes. Most of these additional costs are due to the new employees needed in the production area. This data is relevant for Volkswagen Navarra since it shows that the company will have to disburse only 133,036.05 euros, a 30% of the total costs, and not the total costs assigned to this process.

8.2. Sensitivity analysis of the assembly of prototypes in VW-Navarra

As it has been presented previously, the assembly process of a prototype has several variables that are not known until the real activities start. The previous results summarize the most probable scenario that the directive team of Volkswagen Navarra believes will happen. However, depending on different premises the results can change.

For instance, if we change the storage area and instead of the special´s car area the try-out is used, the cost analysis changes and the total costs of making prototypes decrease by a

10% and the importance of prototype´s exclusive costs increase from a 30% to a 33 % with respect to the total.

Additionally if we change the schedule for assembling prototypes and the chassis engine has to be hired for three prototypes. The total cost increases a 10% with respect to the first scenario. The distribution of percentages between types of cost now changes even more and a 34% of the total costs are part of prototypes´ exclusive costs and the internal costs of the company represent now a 66% of the total prototypes ´ costs.

By choosing different premises several scenarios can emerge, all these scenarios change the result of the cost evaluation and the percentages of the different areas and types of costs. Thus, the excel sheet allows to change the data selection and according to that the excel table changes, providing different results. The purpose is that no matter which scenario is selected, by changing the data selection in the excel sheet, Volkswagen Navarra can have the cost information in order to make a decision

9. CONCLUSIONS

The automotive industry is one of the most globalized markets and competition among brands is severe. Many companies compete in order to gain market share and be able to stay in the ranking of top automakers. Their strategies have to be strong and their products have to be better than those of the competitors. As a consequence these companies inside the automobilist industry have very complex structures and processes.

The production development process inside a car company is by far one of the most important events. Innovations in technologies and designs are relevant in order to attract new customers. Hence, the development of a new car is a very delicate process which takes a lot of time. The assembly of prototypes is one of the main steps inside the product development process. A prototype is one of the first real representations of what it is going to be the final model. To perform a cost analysis of this process is an important procedure that has to be made by the factory, in this case Volkswagen Navarra.

The cost analysis of the prototypes of the new polo VW 270 shows the relevant costs divided in areas and in type of costs. The distribution of costs is relatively similar between the quality, the technical office, the production and the logistics team. All the costs of these teams represent 90% of the total costs of prototypes which is shared almost equally among them. The quality team represents 25% of the total cost, followed by technical office´s costs and production costs which account for a 24% and a 21% respectively. The logistics

costs represent a 20% of the total costs. The two last areas, training and confidentiality have a low impact in the cost evaluations since only 9% of the total cost is represented by this areas.

The analysis of costs in two categories shows that the internal costs of the company are 70% of the total, whereas the new costs of prototypes account for the 30% of the total prototypes ´s costs. It is an important result for the company since it reveals that Volkswagen Navarra will have to pay out only 30% of the total cost. Volkswagen Navarra will have to pay an estimated amount of 133,036.05 euros. The rest are costs that already exist in the company but will, during that time, be assigned to prototypes.

After all the costs are known, Volkswagen Navarra has to take another step. The company will have to analyze the benefits of making prototype. Volkswagen in Germany will pay an amount of money to Volkswagen Navarra for the production of prototypes; it usually does not cover for all the costs. Additionally, as it has been discussed previously, the production of prototypes has other monetary and non-monetary benefits; avoidance of future problems in the series model, test the size of the assembly line, calculate production times, learn better techniques, make improvements to the infrastructures and others.

Once these positive results of assembling prototypes are estimated an economic evaluation could be made in order to see whether it is economically worth to make prototypes. This framework will be the ideal in order to take the decision of assembling prototypes in Volkswagen Navarra or not to. However, it is difficult to account in monetary terms the benefits of prototypes, so Volkswagen Navarra will base its decision only with the present cost analysis.

The information provided by the cost analysis of prototypes allows VW Navarra to evaluate its competitiveness and the degree of efficiency in its production. For instance, Volkswagen Navarra can compare the cost of assembling prototypes in its factory with respect to the cost of assembling it in Germany. By doing so, they are able to evaluate its systems of production and possible improvements. The final decision about prototypes has into account the cost evaluation. However it is not decisive, the strategic plan of the company is really important when making the decision.

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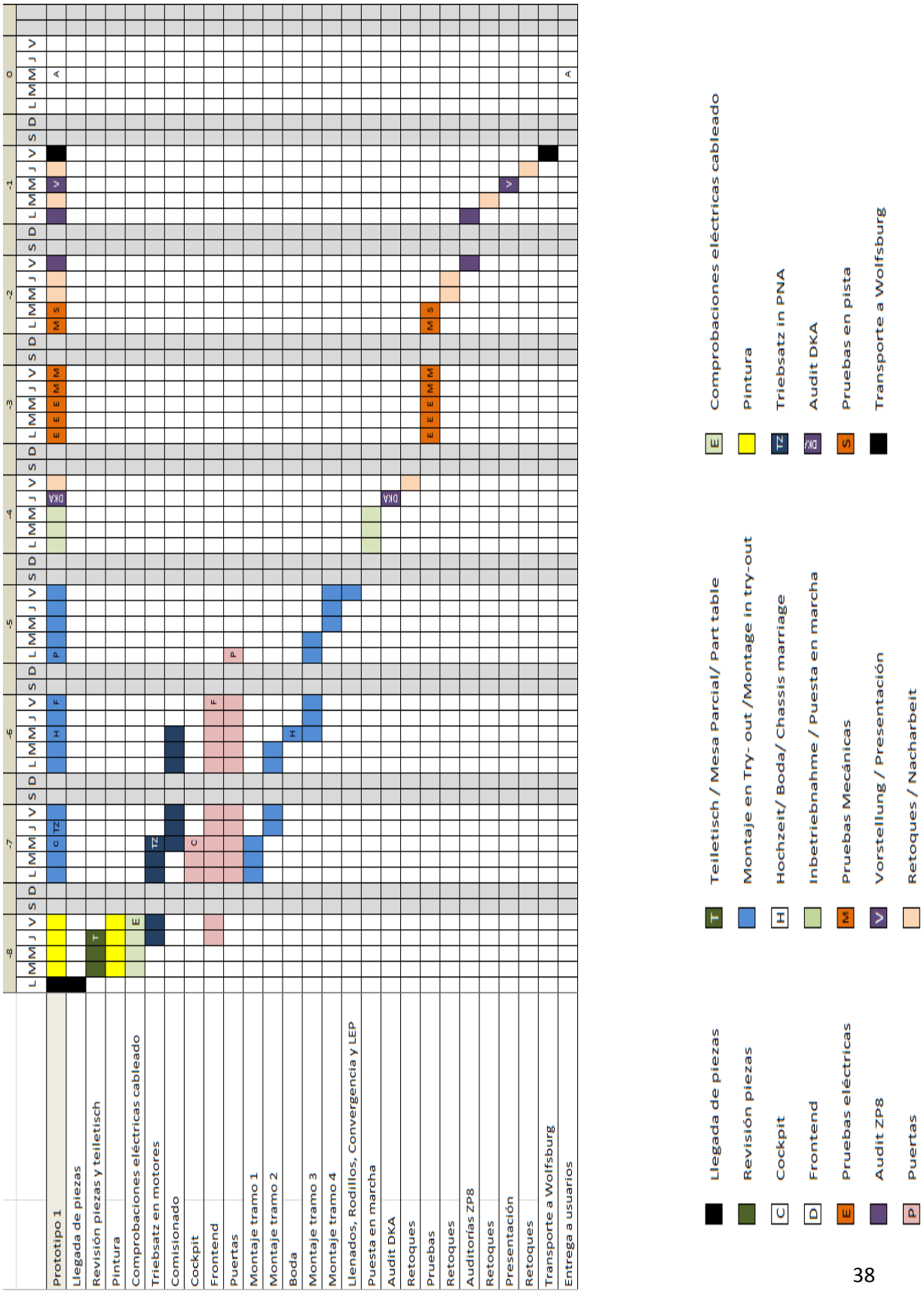
11. ANEXES

Anexo A; Real expected terminplan of one prototype disaggregated by activities.



Annex B: Training and confidentiality costs of assembling prototypes in Pamplona.

Training costs	Number of days/nights	Number of workers/cars	Unit cost in euros	Total Cost
Diet costs	21	3	46	2898
Plane costs	1	3	500	1500
Hotel costs	20	3	95	5700
Cost of rented car	21	1	52	1092
Salary (oficial de primera)	168	2	29,85	10029,6
Salary(mando)	168	1	36,81	6184,08
TOTAL prototypes´ exclusive costs				11190
TOTAL internal costs				16213,68
TOTAL training costs				**27403,68**

Confidentiality costs	Number of hours	Number of cars	Unit cost	Total cost
Cost of covers for cars		5	669,9	3349,5
Cost of restrincting acces to and view of try-out	3		29,85	89,55
Cost of a security guard	103	5	20,37	10490,55
TOTAL prototypes´s exclusive costs				13840,05
TOTAL internal costs				89,55
TOTAL confidentiality costs				**13929,6**

Annex B: Logistics costs of assembling prototypes in Pamplona

Logistics costs	Number of hours	Number of car/compon	Unit cost	Total cost
Body and components from WOB to PNA		5	1800	9000
Small transportations		8	900	7200
Packet services		15	200	3000
Body to paint shop	0,5	5	24,88	62,2
Body from paint shop to try-out	0,5	5	24,88	62,2
Body to try-out	0,5	5	24,88	62,2
Components distribution, piece reception and storage of pieces				45779,2
Motor to motor line	0,5	5	24,88	62,2
Motor to try-out	0,5	5	24,88	62,2
Body to montage building	0,5	5	24,88	62,2
Complete prototype from PNA to Wolfsburg		5	4500	22500
Personal expenses pre-production	40	-	60	2400
TOTAL prototypes´ exclusive costs				41700
TOTAL internal costs				48552,4
TOTAL logistics costs				**90252,4**

Annex B: Production costs, quality and technical office´s costs of assembling prototypes in Pamplona.

Production costs	Number of hours	Unit cost in euros	Number of prototypes	Total cost
Paint shop costs	100	29,85	5	14925
Assembly cost (mando)	120	36,81	5	22086
Assembly cost(oficial de primera	240	29,85	5	35820
Engine assembly cost	6	29,85	5	895,5
Cost of chassis marriage				8400
Electric group costs	24	29,85	5	3582
Final assembly costs	60	29,85	5	8955
TOTAL prototypes´ exclusive costs				66306
TOTAL internal costs				28357,5
TOTAL production costs				**94663,5**

Quality costs	Hours	Unit cost in euros	Number of prototypes	Total cost
Quality (MOD)	40	29,85	5	5970
Quality (TAS)	562	36,81	5	103436,1
TOTAL prototypes´exclusive costs				0
TOTAL internal costs				109406,1
TOTAL quality costs				**109406,1**

Technical office costs	Hours	Unit cost in euros	Number of prototypes	Total cost
Worker 1	64	36,81	5	11779,2
Worker 2	64	36,81	5	11779,2
Product engineer 1	256	36,81	5	47116,8
Product engineer 2	96	36,81	5	17668,8
Product engineer 3	96	36,81	5	17668,8
Total prototype´s exclusive costs				0
Total internal costs				106012,8
TOTAL technical office costs				**106012,8**