POLITECNICO DI TORINO

Master of Science in Management and Engineering

Master's Degree Thesis

Website Quality of MiaCar.it

Candidate:
Francesco Romano

Academic Supervisor:
Prof. Domenico Augusto Francesco Maisano

Internship Supervisor:
Lorenzo Sistino

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Chapter 1

INTRODUCTION

The thesis focuses on the quality degree of the website “MiaCar.it” used by the startup MiaCar S.r.l. to show cars of official car showrooms and car dealerships to customers and help the former category on selling these cars. In this precise context, “website quality” refers manly to ease of use and quality of information produced. It is pretty intuitive to understand that perceived information quality affects perceived value and loyalty intentions and perceived value influences loyalty intentions toward the website.

Comparisons with competitors’ services and further investigation of customer and engineering requirements will be performed too in order to better understand the actual goodness of the website.

From internal firm’s studies, it would seem that the main issue to solve in order to improve the service quality of its online platform is to reducing mistakes in the data-entry process, namely when car profiles are charged on the website, since the process is scarcely automatized and errors in costs of the car equipment shown or in its description could mean losing a previously agreed deal with car customers. Thus, it would not only affect directly sales, but also firm’s reputation contrasting the rapid growth that a startup such as MiaCar needs in order to survive.

Theoretical and practical methods, such as Quality Function Deployment and AHP model, will be applied for an assessment of the current situation to see what already works and what does not in order to adopt corrective actions to improve the service offered by MiaCar.

In particular, the AHP model will be applied when correlating customer requirements and technical characteristics of the service. Since the AHP model is not a conventional method for this activity, an assessment of its robustness will be done too.

Finally, different solutions to this issue will be briefly described by listing and analyzing the main pros and cons of each and every one of them and a final solution will be proposed as the optimal one.

In details, the thesis is composed by seven chapters, including this introduction as the first one.

In the second chapter, the description of the context of my work will be given. Thus, there will be a detailed description of the firm MiaCar S.r.l. by enlightening its innovative business model. For a better understanding of how much this business model is innovative and unique a basic explanation of business model and business model Canvas will be present in this chapter. Then, the current situation of MiaCar's innovation diffusion process will be defined. To this purpose, Rogers-Moore model of customer adoption will be carefully explained, followed by the illustration of the phase MiaCar is in, according to this model. In the third and last part of the second chapter, my job roles in the firm during the internship will be briefly described.

The third chapter presents the description of the theoretical and practical methods that will be used in the study in order to understand the actual quality of the website www.miacar.it and to see if and how improvements should be applied to the website itself. The first method described is the Quality Function Deployment analysis - QFD (or simply, House of Quality - HoQ). Since this is the main method that will be used, the description will be performed in a quite deeply way. In fact, each and every step of the QFD analysis will be defined, from the research of the main customer needs to a very brief description of the Correlation Matrix.

The fourth chapter talks about the criticalities present in the quality of the service offered by the website www.miacar.it. More specifically, in this chapter there will be a very short definition of what is service quality and why it is so important today, followed by what works and what does not in the website of MiaCar. Practical example will be present too in order to better understand why corrective actions should be taken.

In the fifth chapter, the actual work executed is described. Thus, the House of Quality of the service offered by MiaCar is defined and a very detailed description of how it has been developed will be present, including the way SuperDecisions software will be utilized.

The sixth chapter includes the sensitivity assessment of the AHP model. It will be performed with the aim of evaluating the method robustness in order to see whether or not it is the appropriate method for the study.

In the seventh and last chapter, the final conclusions of the study will be analyzed under a managerial perspective. In particular, possible actions to be undertaken will be listed and defined in order to understand pros and cons of each and every one of them. Then, one (or more than one) of these corrective actions will be suggested to be chosen in order to improve the actual situation of MiaCar. Finally, suggestions to future strategic actions to be taken will be given.

Chapter 2
MIACAR

This chapter will deal with the description of MiaCar S.r.l (from now on it will be mentioned just as “MiaCar”), its business model and current situation and the role that I will have while working there. MiaCar S.r.l. is a startup founded by Lorenzo Sistino, ex CEO of Fiat Brand and president of Iveco and New Holland, in the July 4th, 2017. With its revolutionary business model, the firm is basically in between the costumers of cars and car dealerships (and showrooms) by means of its online website platform that shows cars with all the information about their main features and relative costs.

2.1 An innovative Business Model

2.1.1 What is a Business Model

The concept of “business model” is relatively recent, since the term came in use only at the beginning of the twenty-first century, when Internet companies started to emerge (Mahadevan, 2000).
The key elements of a business model are shown in Fig. 2.1. These elements cover the main strategic choices that define a business, the resources which enable the firm to create value, the positioning of the firm in its value network, and a high-level definition of cost and revenue structures.
At the same time, the elements in the business model cover both sides of supply, what is being offered and how it is going to be produced - by the firm and by its suppliers and partners, and demand, namely who is the customer and how it can be reached (Cantamessa M. & Montagna F., 2016).
The worldwide most used qualitative tool to describe the business model of a firm is the “Business Model Canvas” whose key elements are shown in Fig. 2.2.

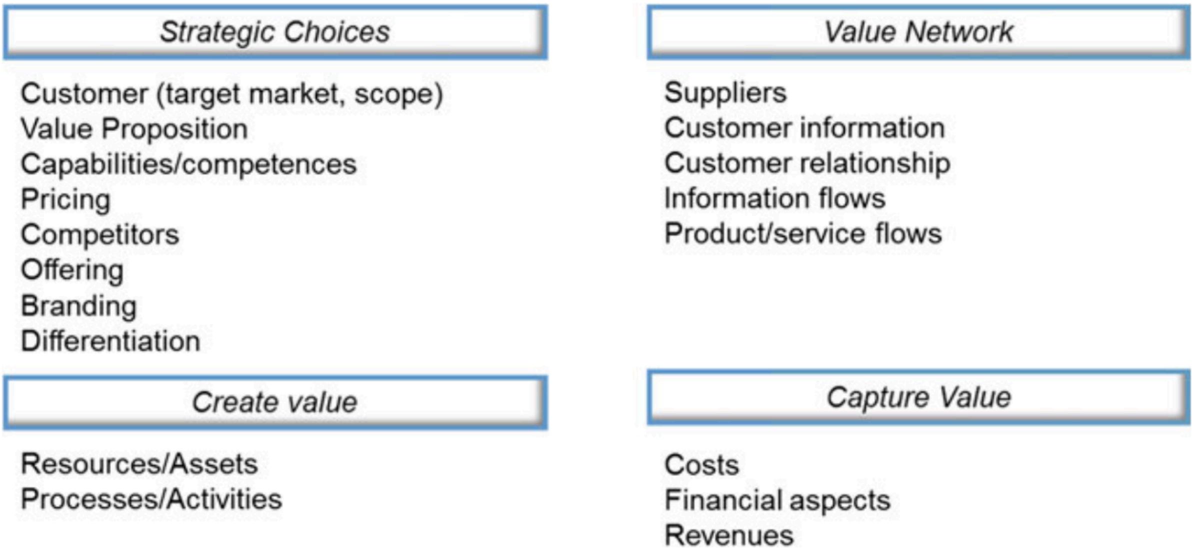


Figure 2.1 The main elements of a business model

Since this is the informal tool that will be adopted for describing MiaCar's innovative business model, a very brief explanation of it seems necessary.
The Business Model Canvas brings together four main areas of the business model structure:

- the product and its value proposition,
- the infrastructure (which covers key partners, key activities and key resources),

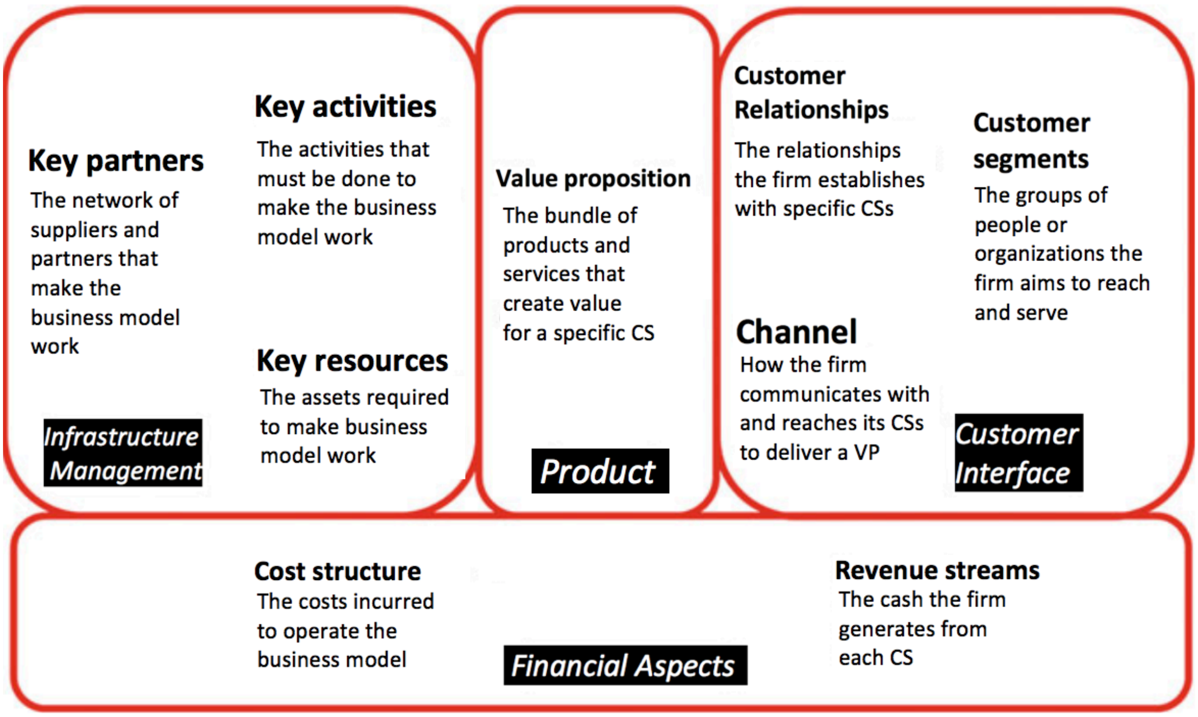


Figure 2.2 The business model Canvas

- the customer interface (which covers distribution and promotion channels, customer relationship management and customer segments),
- the associated financial aspects (based on the costs that characterize the side of "offer" and the revenues deriving from the side of "demand").

The first two areas cover the "offer" side of the business model, while the customer interface covers the "demand" side. In turn, these major areas are split in nine sections that will be treated when representing the Business Model Canvas of MiaCar.

2.1.2 MiaCar's Business Model Canvas

In MiaCar's Business Model Canvas representation (see Fig. 2.3), Infrastructure Management includes mainly car dealerships and showrooms as suppliers, while IT firms, venture capitalists and private investors are the main sources of funding (key partners), key resources are mainly composed by human, IT services and investors' funds for promotions above of all) and the key activities done in daily routines are customers and supplier phone calls to perform respectively sell and "acquisition" activities and car charging on the website (data entry process). In the product (or service) section, the value

proposition is given by website quality, lower car prices and low transaction costs that allow customers not to lose time and money in the research for the right car in different

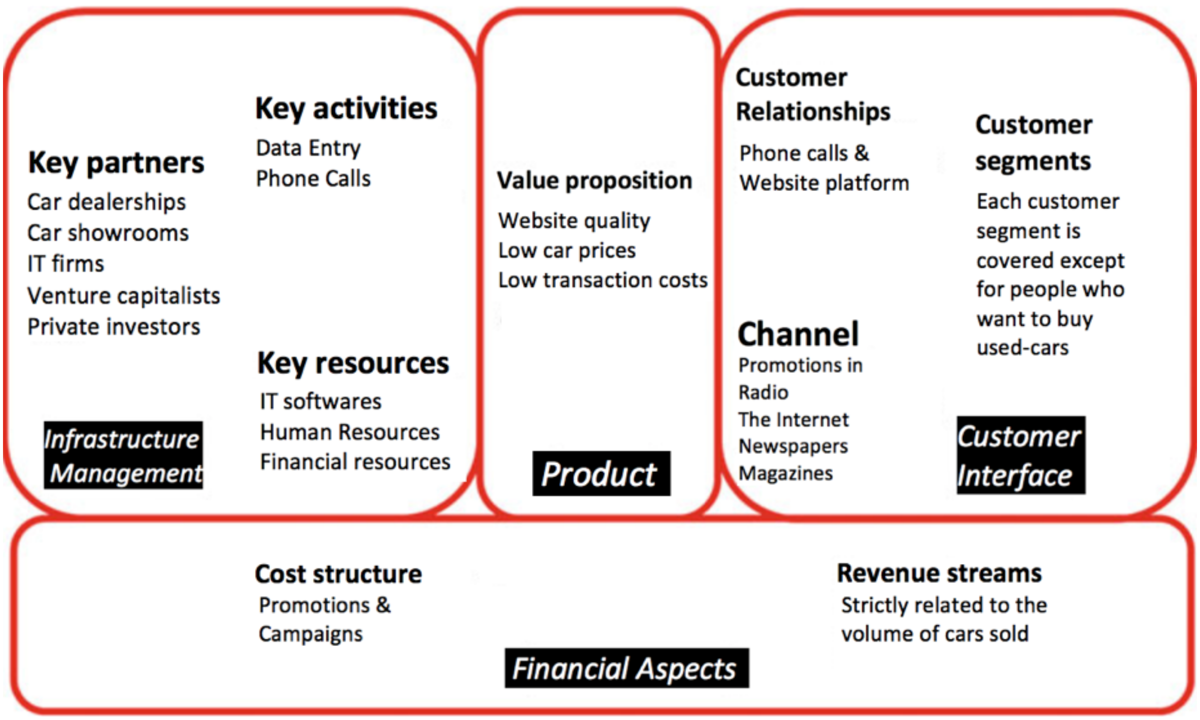


Figure 2.3 Business Model Canvas of MiaCar

showrooms and the immediate car availability in the showrooms. This subject will be subject to further analyzation in the next sections. By looking at the customer interface, the firm interacts with each and every person that wants to buy a car, new or zero-miles (customer segments).
Moreover, the firm establishes relationships with its clients by means of phone calls and the website platform (customer relationships).
The channel voice shows the different type of promotion channels: by radio, the Internet (with the aid of Google AdWords, Facebook campaigns, landing pages and others) and many important Italian newspapers and magazines such as “La Repubblica”, “La Stampa”, “Panorama” and “Quattroruote”.
Finally, the main costs are relative to promotions and campaigns since human resources are just a few (very common in case of startups) and physical asset are not relevant (typical for a firm whose business totally relies on a website), whereas revenues strictly depend on the volume of cars sold. In particular, MiaCar registers revenues that amount on a little percentage of the price of cars sold by the car showrooms and dealerships with the aid of its website plus a little fee from car loan if the customer decides to buy the car by means of a financing method.

2.1.3 Why MiaCar’s Business Model is innovative

High website quality, low car prices, low risks assured by official car showrooms and dealerships and avoiding waste of time to customers are the key elements of MiaCar’s service that distinguish it from competition and make it new and unique (characteristics that should bring competitive advantage, at least “for a while”).
More specifically, previously no website had the degree of completeness and quality of information that is present in the website MiaCar.it, where all the costs the customer will incur by paying the car are showed with detailed description of them and of the most relevant features of the product demonstrating absolute transparency of the website. Indeed, many other websites where cars are showed with the aim to be sold do not have detailed description of the offer (quite often it even happens that car optionals are not present in the description of the car!).
The low car prices shown on the platform have been already dealt by MiaCar with the car dealerships and showrooms. This is the classic situation of a “win-win game” in the Game Theory of John Nash where the participants are customers and showrooms. The former group will gain simply by buying a car at a lower price, whereas the latter one will gain new customers from different regions by lowering prices of the car (they will earn more money by selling more cars than usual, thus minimizing their overstock of cars). Moreover, customers will lose quite less time on the boring, tiring and money-wasting activity of looking

for a car in different car dealerships and showrooms and also because cars showed on MiaCar.it are all ready-for-delivery.
As Lorenzo Sistino said in an interview for AdnKronos, “the idea of creating this startup was born with the aim to help car buyers in the choice of which car to buy, without taking out car dealerships and showrooms from the process that still have the task of delivering the car, thus an additional warranty of reliability for the customer too. […]. Moreover, by using the website www.miacar.it, on the one hand the customer that wants to buy a car does not find just advertisements for car sales, but real cars, new or kilometer-zero (or zero-miles) cars at the best conditions he or she would ever desire, characterized by discounted and deeply detailed prices and without any kind of risk, and with the warranty of the home care maker. On the other hand, this new and innovative business model allows the car dealership to access to an additional and original sales channel, and this easily accelerates the process of cars turnover in a car dealership” (Adnkronos, 2017).
Moreover, original is the way customers can book the car. Basically, “the chosen car can be booked by paying a little initial amount of money (the 2.5% of the price), that will be subtracted from the total price and thus without any extra-cost for the customers” (Panorama, 2017).
Finally, the customer can freely decide whether or not to pay the rest of the amount to buy the car. In the former case, he or she can choose if going to see the car in the relative showroom and buy it later on or if paying it directly from home. In the latter case, the client would directly receive the total amount spent for booking the car (without losing a single penny!). In fact, by booking the car the customer simply obtains the right to have a certain interval of time to decide freely whether or not to buy the car since after it the car disappears from the website thus making impossible for other potential customers to book for it.

2.2 Current Situation

2.2.1 Customer adoption a la Moore

Rogers (1962) customer segmentation along the technological lifecycle can be a pretty useful tool for understanding in which phase (in terms of customer adoption) MiaCar is in.
Rogers uses a diffusion sales curve (see Fig. 2.3) and partitions it in five customer segments: 2% of innovators (a tiny number of visionaries and imaginative innovators) that can be considered as lead users and can provide important feedback on the performance of a product or a service, 14% of early adopters (once the benefits start to become apparent they start buying) that can spread “word of mouth”, 34% of early majority (pragmatists, comfortable with moderately progressive ideas, but won’t act without solid proof of benefits), 34% of late majority (conservative pragmatists who hate risk and are uncomfortable with respect to new idea) and 16% of laggards (people who see a high risk in

adopting a particular product, service or behaviour).

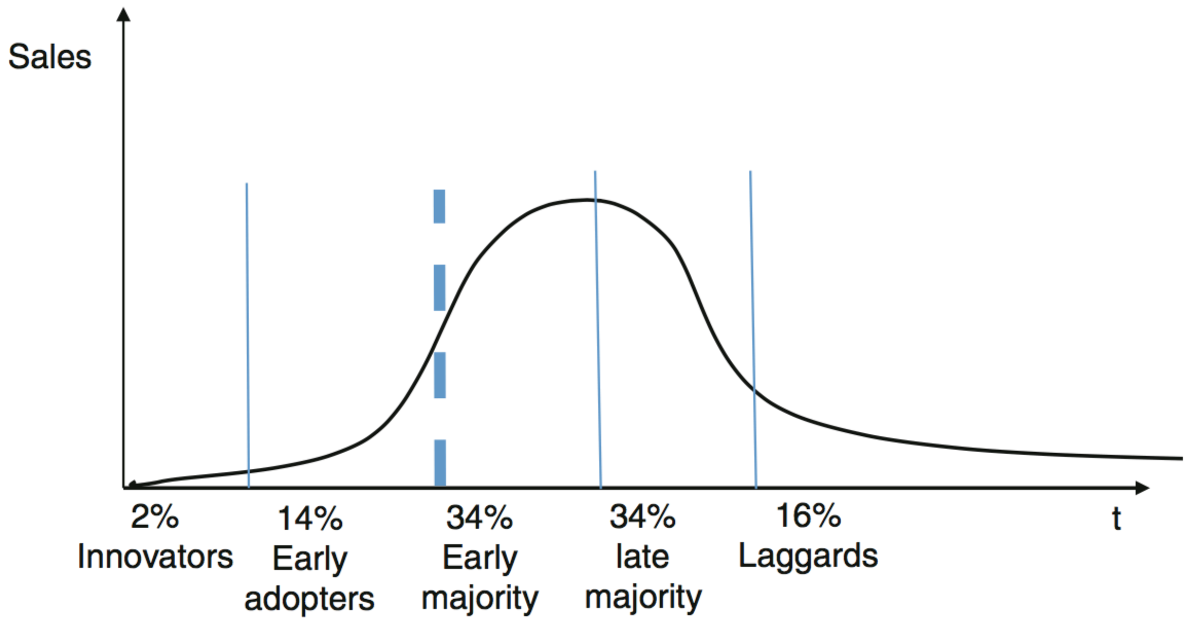


Figure 2.3 Market segments along the technological lifecycle

The point, or gap, between the early adopters and the early majority segments is called chasm (Moore, 1991).

This is the most important transition that an innovative firm has to do because it allows to reach a segment that is quite attractive for its size, thus allowing to the product (or service) to become quite known and diffused in the market. In Figure 2.3, the chasm is represented by means of a dashed line.

2.2.2 Miacar's service diffusion

According to top management evaluations, MiaCar has been in the first diffusion phase (innovators) until the beginning of the year 2018, when sales growth rate has been subjected to a remarkable increase that has continued for the next months.

Now, the firm is considered to be in the second phase (early adopters; see Figure 2.4) in which more and more people are becoming aware of this service and are starting on using it or at least are visiting the website.

This is happening mainly thanks to people word of mouth and an efficient and very careful promotion process through channels such as Subito.it, Automobile.it, Facebook and recently via Radio.

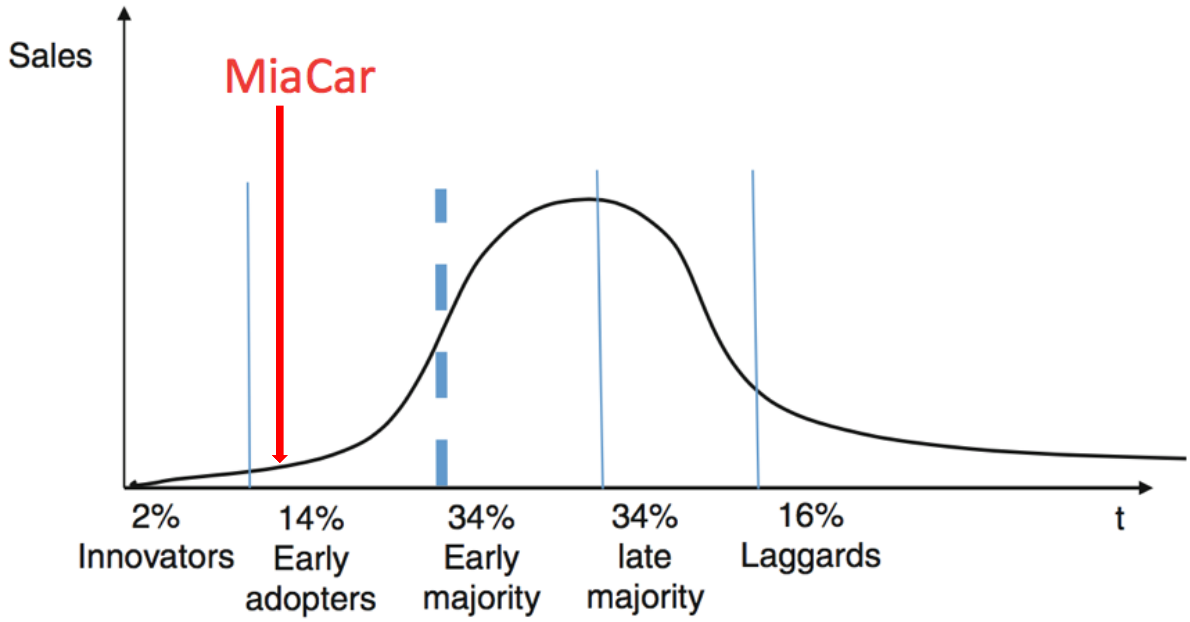


Figure 2.4 **Rogers' model applied on MiaCar case**

Top management hopefully foresees "crossing the chasm" during the first semester of 2019, when a sufficient network of car dealers and showrooms will accept to work with the firm and many people in Italy will know the website and will use it for buying a car.
Moreover, since many experts believe that this kind of service is what really customer wants, the diffusion is expected to grow at a very high rate in the next months. In fact, many newspapers, magazines and consulting firms talked about the website celebrating its innovative business model. For instance, La Stampa affirmed that "many studies demonstrate that nowadays, the 94% of car buyers search on the internet the cars for <<studying>> them, and then go to deal a final price in the car showrooms" (La Stampa, 2017).
Accenture (2014) made a report talking about what car customers really want, where it has been stated that "online content about cars is an essential part of the overall path to purchase. Consumers are more likely to start their search online and then visit a dealer". Even the magazine Money (2015) cites another survey made by Accenture over 10,000 people in the U.S., in which results have clearly shown that "consumers indicate that they would like to see a big change in the way they go about negotiating the deal structure. Of those who liked the idea of online deal building, over half, 56 percent, want the ability to start the negotiation on their own terms—preferably online—and 45 percent would like to remain anonymous until they lock in the deal structure. […]. Nearly three fourths of consumers, 72 percent, want to complete the credit application and financing paperwork online. The key factors driving this desire are to save time at the dealership (reported by 72

percent of those who favor online paperwork) and to have less pressure while filling out paperwork (reported by 71 percent of those who favor online paperwork)”.
Not only newspaper, magazines and consulting firms talk pretty well about Miacar, but also customers have the opportunity to express their feelings about the service offered. Indeed, in the website www.miacar.it, it is possible for customer to give a public feedback. As shown in Figure 2.5, the results are pretty positive.

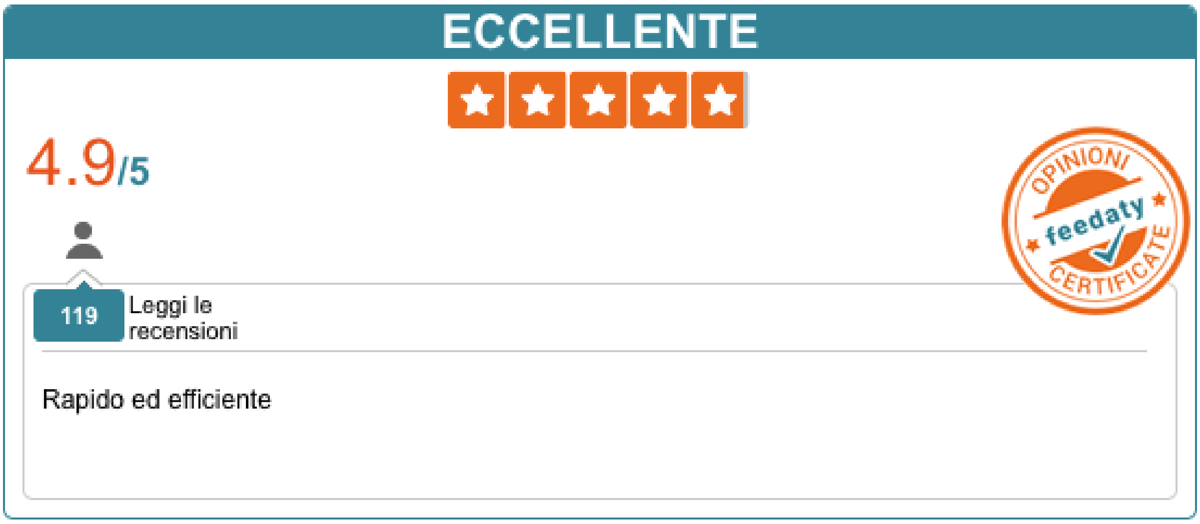


Figure 2.5 Results of customer public feedbacks

2.3 My role

My job in MiaCar S.r.l is characterized by many different activities that require the right flexibility needed for the high diversified tasks of a daily work in a startup where no clear routines are present.
These activities basically include working on data-entry process, helping sales activity (made on the phone and by answering to customers’ questions on the online chat of the website), performing basic web-marketing studies (in order to decide promotions channels and budgets) and working as deputy of quality control. In this particular context, data-entry refers to the process of charging car profiles on the website www.miacar.it that can be considered as a pretty manual task that needs quite a lot of concentration and time to spend in order to avoid mistakes that could directly affect customer satisfaction.
Sales activity on the phone (with the aid of the online web-chat) does not stand for classical sales activity, but for the process of leading the customer to the decision to book the car. In fact, the actual sales activity will be performed by the sellers (car dealers) in the official car

showrooms and car dealerships, if the client does not decide to acquire the car directly from the website (the great majority of the cases).
In web marketing activities, my main task is to perform qualitative and quantitative studies that will be used on important issues, such as deciding the right promotion channels by which customers should be reached.
The main job to do in the activity of quality control is to “control the actual quality of the website” mainly in terms of quality of information perceived by the customer and compare it with respect to the competitors’ services and internal engineering/design requirements.
The focus of my thesis will be exactly on this task.

Chapter 3

THEORETICAL AND PRACTICAL METHODS

In this chapter, the two methods, that will be adopted for the assessment of the service quality of the website MiaCar.it, will be described and analyzed.
The first method that will be defined in this chapter is the so-called House of Quality – HoQ (also called, Quality Function Deployment – QFD) and it will be used to benchmark the website with competitors' ones to assess the real value of it and to see how much the firm "hears" the Voice of the Customer (VoC).
Finally, the Analytical Hierarchy Process (AHP) methodology will be defined. Basically, this method will be used for the evaluation of the customers' requirements with respect to engineering/design requirements. A description of the software that will be used to apply this methodology (called "SuperDecisions") will be present too in this subsection.

3.1 Quality Function Deployment (QFD)

The Quality function deployment (QFD) method has been developed in Japan in 1966 (Yoji Akao is considered to be the original developer of the method) to aim of helping firms on transforming the voice of the customer (VoC) into engineering characteristics for a product (or service). Kenneth Crow described QFD as "a structured approach to defining customer needs or requirements and translating them into specific plans to produce products to meet those needs. The VoC is the term to describe these states and unstated customer needs or requirements. The voice of the customer is captured in a variety of ways: direct discussion or interviews, surveys, focus groups, customer specifications, observation, warranty data, field reports, etc. This understanding of the customer needs is then summarized in a product planning matrix or "house of quality". These matrices are used to translate higher level "what's" or needs into lower level "how's" – product requirements or technical characteristics to satisfy these needs" (Crow Kenneth, 2002).

Moreover, NPD Solutions (Customer-Focused Development with QFD) states that while the Quality Function Deployment matrices are a good communication tool at each step in the process, the matrices are the means and not the end (NPD Solutions, 2016). The real value is in the process of communicating and decision-making with QFD. QFD is oriented toward involving a team of people representing the various functional departments that are involved in product development: Marketing, Design Engineering, Quality Assurance, Manufacturing Engineering, Test Engineering, Finance, Product Support, etc.
As shown in Figure 3.1, QFD matrix is composed by six main parts:

- Customer Requirements and the degree of importance of these requirements,
- Product Engineering/Design Requirements,
- the Relationship Matrix,
- Competitive Benchmarking Assessment,
- Technical Importance Ranking,
- Correlation Matrix.

Further description of each element of the QFD matrix will be given in the next subsections of this chapter.

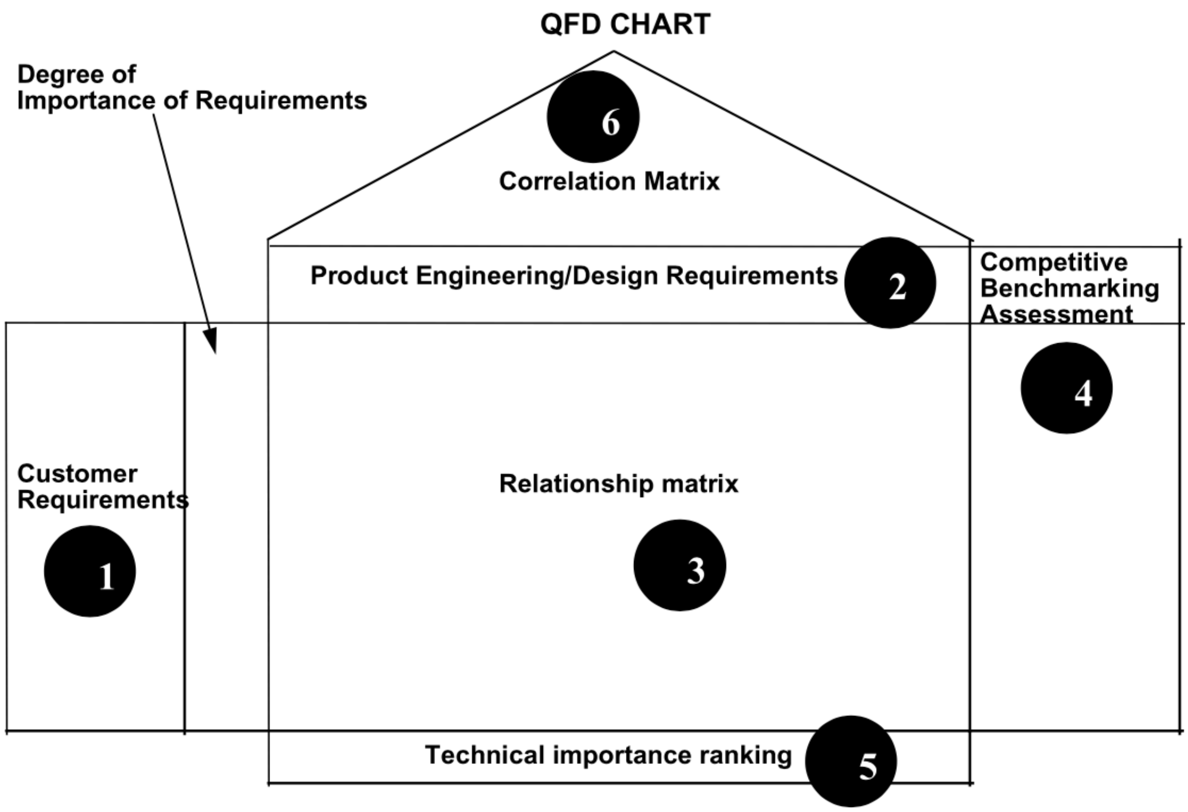


Figure 3.1 Main components of the House of Quality (HoQ)

3.1.1 QFD – Customer Requirements

Customer requirements play a key role in planning a new product. They can be very different and come from different fields regarding the product/service, so they must be chosen very carefully. As previously said, the first step when doing QFD matrix (also called House of Quality - HoQ) is to define who the customer is and to decide on which type of market(s) and end user(s) to focus on.

Afterwards, customer main requirements must be individualized and put on a list (point 1 in Fig. 3.1).

Data sources may be several, all to be taken into consideration: market research, specific surveys on significantly representative groups of customers–users, ad hoc questionnaires, information from marketing, technical maintenance data, complaints studies, panels of significant customers, brainstorming among company specialists, and many others (Tosalli et al., 1990). All these data are to be considered as the expression of the Voice of the Customer (VoC) that will explicitly be in the HoQ in a list of names and in the form of number values that stand for importance degree of customer requirements.

Firstly, the most basic customer requirements are found (*tertiary needs*), and then grouped into few *secondary needs* (the ones that will appear in the customer requirements in the QFD). Finally, another clustering is performed by finding primary needs from the secondary needs. Notice that this ranking of needs just delighted is according to the Kano's model of Needs Satisfaction (1984).

For instance, let's consider the product "electric toothbrush". Examples of tertiary needs can be "it does not slip away", "it does not break while you clean your teeth" and "it has to be easy to hold". Then, they can be grouped into a secondary need such as "ergonomic handle". Finally, this secondary need can be one of the secondary needs that will be part of a general primary need such as "usability". Examples of other secondary needs clustered in "usability" can be "easy to clean", "affordable purchasing", "effectiveness" and "durable product".

Customer requirement analysis is carried out on the horizontal part of the House of Quality, usually under the leadership of the marketing function. The requirements are listed on the left-hand side, while the detailed analysis is performed on the right-hand side. The first column in the analysis part is an evaluation of the average importance of each customer requirement, while the second column contains its percentage values (the so called "Relative Importance" of customer needs). User requirements and their importance ratings should ideally come from market research, since a development team being asked to "estimate" weights for user requirements will unavoidably draw from their specific experience, which may be very far from what actual target customers really feel and look for (Cantamessa M. & Montagna F., 2016). By referring to Kano's model, secondary needs should be used as customer requirements in QFD matrix mainly since their number is manageable.

Basically, the traditional QFD methodology solves this delicate problem of assigning degrees of priority to customer requirements by ranking them according to a scale from 1 (for a requisite of negligible importance) to 5 (for an indispensable requisite) or from 1 to 10.

Finally, the results of these questionnaires are analyzed to find the statistical distribution of the weights over each customer requirement.
Moreover, one of the most used approaches that are adopted for the prioritization of customer requirements involves the use of the Analytical Hierarchy Process - AHP method (Akao, 1988; Armacoast et al., 1994).
This method will be used for this study and will be described more deeply in the subsection 3.2 of this chapter.

3.1.2 QFD – Technical features

The vertical part of the House of Quality contains the engineering/design requirements of the product/service (namely, its technical features).
A list of $j = 1...m$ engineering/design requirements is placed at the top of the matrix. Then, values of these requirements will be collected by the technical team from the same panel of products for which a comparison was performed in the analysis of customer requirements.
In basic words, determining the technical characteristics of the product means translating the market model as expressed in subjective terms by the customer's words, into objective factors of a technical nature (performance characteristics), that is, into a description of the product or service expressed in the designer's own language (the so-called voice of the engineer - VoE). Thus, a list is compiled showing the technical design requirements, characteristics, and parameters or the engineering characteristics (ECs) that represent the "hows" determined by the engineer to satisfy the "whats" defined by customer requirements. Some authors call these parameters substitute quality characteristics (SQCs) because they substitute customer requirements and constitute the input data for design (Franceschini F., 2002).

3.1.3 QFD – Relationship matrix

The relationship matrix simply contains the correlation between the WHATs and the HOWs (respectively, customer requirements and engineering/design requirements). As already said, the whats are listed on the left of the relationship matrix and the hows are shown on the top of it (see Fig. 3.2).
Determining how the technical decisions may affect the degree of satisfaction of the customer needs is not a trivial task as it could seem. The goal is to clearly determine to what extent the technical features of the product (or service) influence the level of quality expected by the customers.
Therefore, the development team will relate customer requirements to technical features, in order to understand how the weights given to the former lead to priorities concerning the

latter. Firstly, the strength of the relationships (r_{ij}) between each customer requirement and each technical feature must be decided. These relationships express the degree by which a customer requirement *i* is affected by technical feature *j*.
Usually, the values of r_{ij} are expressed on the basis of expert judgment, using a {0, 1, 3, 9} scale, where 0 means “no relationship”, 1 a “weak” relationship, 3 a “medium” relationship, and 9 a “strong” relationship. Sometimes, 5 is used instead 9 for indicating a strong relationship between technical characteristics and customer needs.
Quite often, symbols such as Δ, O and **O** are used to indicate respectively “weak”, “medium” and “strong” relationship.
It is common use to leave empty the cell in the relationship matrix with “no relationship” (this mainly happens in the case symbols are used instead of numbers to represent the values of r_{ij}).

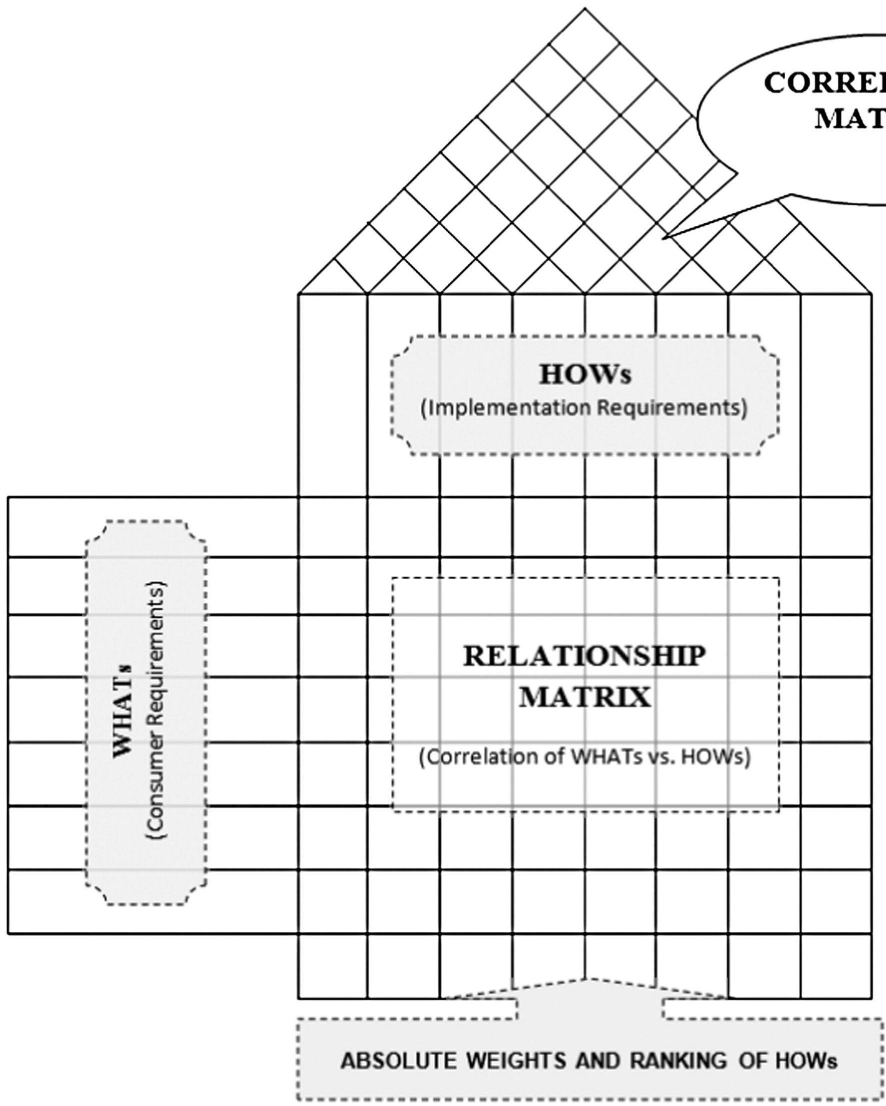


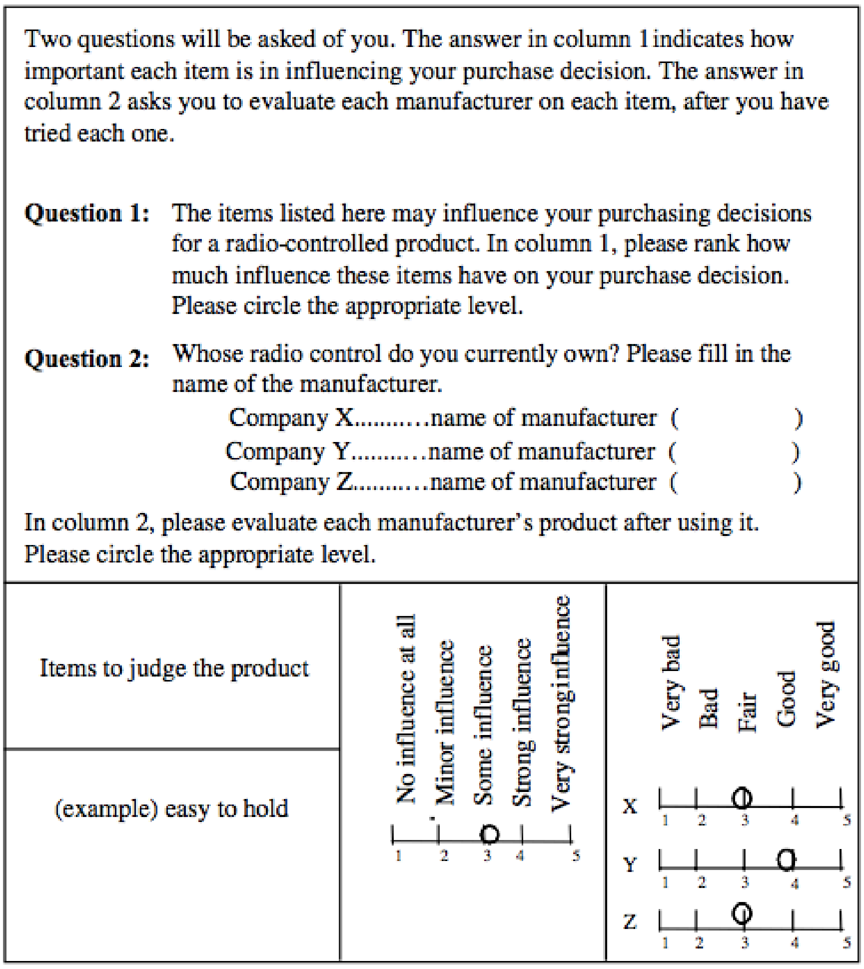
Figure 3.2 Relationship matrix

3.1.4 QFD – Competitive Benchmarking Assessment

The same questionnaires used to collect information about customers' satisfaction by using the product (or service), can be used to determine their degree of satisfaction obtained from the product marketed by their strongest competitors (Fig. 3.3 shows an example of questionnaire).

This information is very useful for benchmarking on the basis of Perceived Quality and to define a target of perceived quality for the new product (or service).

As already seen, the Competitive Benchmarking Assessment will be performed on the right-hand side of the Relationship Matrix and it is usually composed by eight columns (see Fig. 3.4).



Two questions will be asked of you. The answer in column 1 indicates how important each item is in influencing your purchase decision. The answer in column 2 asks you to evaluate each manufacturer on each item, after you have tried each one.

Question 1: The items listed here may influence your purchasing decisions for a radio-controlled product. In column 1, please rank how much influence these items have on your purchase decision. Please circle the appropriate level.

Question 2: Whose radio control do you currently own? Please fill in the name of the manufacturer.

Company X..........name of manufacturer ( )
Company Y..........name of manufacturer ( )
Company Z..........name of manufacturer ( )

In column 2, please evaluate each manufacturer's product after using it. Please circle the appropriate level.

Items to judge the product	No influence at all / Minor influence / Some influence / Strong influence / Very strong influence	Very bad / Bad / Fair / Good / Very good
(example) easy to hold	1 2 3 4 5	X: 1 2 3 4 5 Y: 1 2 3 4 5 Z: 1 2 3 4 5

Figure 3.3 **Example of questionnaire for customer requirements prioritization (Akao, Y., 1988)**

The first three columns on the left are the customers' assessment to product/service performances of the current product/service model of the firm that is being analyzed, and of the two main competitors on the market with respect to each and every customer requirement.

Based on these results, the technical team will decide the target of the new model. For example, in the figure customer assessment for its first need is 3 for the current model, while 4 and 5 for the competitors' ones. According to the development team, 4 is an acceptable value.

Then, the Improvement Ratio is computed as Target value divided by Current model value to have at least a rough percentage of product/service improvement (in the example, 4/3 = 1.33).

Strength value means product's potential strengths for an improved brand image and this evaluation depends strictly on the company strategic policy. It is common use to adopt a {1, 1.2, 1.5} scale where 1.0 stands for "not considered as strength", 1.2 stands for "possible strength" and 1.5 stands for "very important strength".

Current Model	Competitor 1	Competitor 2	Targets (new model)	Improvement ratio	Strength	Absolute weight	Relative weight
3	4	5	4	1.33	1.5	8.0	16.1%
3	4	5	4	1.33	1.2	4.8	9.7%
4	2	2	4	1.00	1	4.0	8.1%
2	5	4	4	2.00	1.2	4.8	9.7%
5	3	2	5	1.00	1	4.0	8.1%
5	2	2	5	1.00	1.5	7.5	15.1%
4	2	4	4	1.00	1.2	6.0	12.1%
3	3	3	3	1.00	1	2.0	4.0%
2	3	3	3	1.50	1	1.5	3.0%
3	2	3	3	1.00	1	1.0	2.0%
4	3	3	4	1.00	1.2	6.0	12.1%

Figure 3.4 Example of Competitive Benchmarking Assessment

Finally, Absolute and Relative Weight are computed. The former can be found by using the following formula:

$$Absolute\ weight = Degree\ of\ importance\ \cdot\ Improvement\ Ratio\ \cdot\ Strength$$

In the example, for the first customer need the absolute weight will be 8 since improvement ratio and strength are respectively 1.33 and 1.5 and since we suppose a degree of importance (stated by the customer) equal to 4.
The latter is the percentage value of the weight of a single customer need with respect to all the weights collected. Namely, it is given by the absolute weight of a customer need over the sum of all the absolute weights and then multiplied for 100 to obtain a percentage value.

3.1.5 QFD – Technical Importance Ranking

In the House of Quality, the evaluation of the importance degree of the product (or service) engineering/design requirements is performed just below the Relationship Matrix and it basically consists in the computation of the four parameters that are shown in Figure 3.5. These parameters are Technical Importance (w_j), Technical Relative Importance (w_j*), Absolute Weight (W_j) and Relative Weight (W_j*). A further description of each and every parameter follows below:

- **Technical Importance**. The first parameter to be computed basically stands for the level of importance of each technical characteristic j and it is given by the following formula:

$$w_j = \sum_{i=1}^{n} d_i \cdot r_{ij}$$

  where, d_i is the relative importance of the technical characteristic *i* (stated by customers' evaluation and put in percentage value), namely the percentage value of customer needs, and r_{ij} is the value in the relationship matrix relative to the technical characteristic *i* and the customer need *j*. In the example in Fig. 3.5, the technical importance of "frame material" is given by:

$$w_j = 0.111 \cdot 9 + 0.083 \cdot 9 + 0.056 \cdot 3 + 0.139 \cdot 9 \approx 3.17$$

- **Technical Relative Importance**. This parameter represents the importance that the customer indirectly assigns to each product characteristic and may be used to define a ranking order of the levels of attentiveness the designer will have to attribute to the technical engineering characteristics during design.
  Thus, it simply refers to the relative importance of the j-th technical characteristic and is given by:

$$w_j^* = \frac{w_j}{\sum_{j=1}^{m} w_j}$$

In the example, the technical relative importance of "frame material" has been computed as follows:

$$w_j^* = \frac{3.17}{3.17 + 3.03 + 0.67 + 2.22 + 0.94 + 1.19 + 2.25 + 1.67 + 1.56} = 19.0\%$$

	Customer Requirements / Technical Characteristics	Degree of importance	Relative importance	frame material A	frame geometry B	coat of paint C	frame mass D	lens material E	lens surface F	lens thickness G	lens treatment H	lens clutching system I
1	Strength of frame	4	11.1%	●	△		○					
2	Inalterability	3	8.3%	●				○			△	○
3	Anti-scratch	4	11.1%					△	●		●	
4	Long life	2	5.6%	○		●	○	●				△
5	Ergonomic frame shape	4	11.1%		●		○			△		●
6	Lightweight	5	13.9%	●			●			△		
7	Comfortable	5	13.9%		●		△			○		
8	Anti-reflex	2	5.6%					△	○		●	
9	Anti-fog	1	2.8%			△			△	●	○	
10	Modular	1	2.8%		●			△		○		●
11	Aesthetically pleasant	5	13.9%		○	△				●		
	Total	36	100.0%	↑	↑	↑	↓	↓	↓	↓	↑	↑
	Technical Importance			3.17	3.03	0.67	2.22	0.94	1.19	2.25	1.67	1.56
	Technical relative imp.			19.0%	18.1%	4.0%	13.3%	5.7%	7.2%	13.5%	10.0%	9.3%
	Absolute weight			3.97	2.52	1.02	2.50	1.30	0.88	2.02	1.28	1.29
	Relative weight			23.7%	15.0%	6.1%	14.9%	7.8%	5.2%	12.0%	7.6%	7.7%
	Unit of Measurement			(E) N/m^2	-	µm	g	(ρ) kg/l	(R_a) µm	mm	time (min)	-
	Current Model			10500	type 1	100	20	2.2	0.5	1.5	50	type 2
	Competitor 1			15000	type 3	80	16	1.9	0.6	1.4	50	type 2
	Competitor 2			18000	type 2	115	20	2.5	0.7	1.5	60	type 3
	Targets (new model)			**18000**	**type 3**	**100**	**16**	**2.5**	**0.5**	**1.4**	**50**	**type 2**

Figure 3.5 **QFD with Technical Importance Ranking delimited by a red line**

- **Absolute Weight**. Instead of considering only the degree of relative importance d_i assigned by the customer to each of the requisites, the Absolute Weight considers also the relative weight D_i calculated on the basis of company policy (last column on the right in Fig. 3.4).

  Thus, the absolute weight of the j-th technical characteristic will be computed in the following way:

$$W_j = \sum_{i=1}^{n} D_i \cdot r_{ij}$$

where, accordingly to what has just been said, D_i stands for the relative weight of th i-th customer need. In the example of Figure 3.5, the absolute weight of "frame material" has been computed as:

$$W_j = 0.161 \cdot 9 + 0.097 \cdot 9 + 0.097 \cdot 3 + 0.151 \cdot 9 \approx 3.97$$

- **Relative Weight**. It is the relative normalized weight of the j-th technical engineering characteristic. It can be easily computed by using the ratio between the absolute weight of the j-th technical engineering characteristic and the total sum of all the absolute weights:

$$W_j^* = \frac{W_j}{\sum_{j=1}^{m} W_j}$$

In the example, for the technical characteristic called "frame material" it is calculated as follows:

$$W_j^* = \frac{3.97}{3.97 + 2.52 + 1.02 + 2.50 + 1.30 + 0.88 + 2.02 + 1.28 + 1.29} = 23.7\%$$

By looking at Fig. 3.5, it is easily noticeable that the Technical Importance Ranking part (delimited by a red line in figure) does not include the four parameters just explained, but also other five rows.
These five rows are present in the lowest part of the matrix and refer to the technical benchmarking which is performed by comparing each and every technical characteristic with the appropriate reference value adopted by competitors, to test the level of competitiveness of the technical characteristic. This is a very important assessment since the firm can really understand which technical characteristic should be improved.
Finally, the target values to be used as input data for designing the new model are determined for each and every technical characteristic according to their importance and to the benchmarking results.
Obviously, it is convenient to improve those quality characteristics that have a higher weight, and those that are poor compared to the competitors'.

3.1.6 QFD – Competitive Benchmarking Assessment & Technical Importance Ranking

The relationship between benchmarking and technical importance ranking is a very strong one in terms of product design and managerial implications. Indeed, the results obtained from the benchmarking analysis on the values of the product technical characteristics are extremely useful because they also allow the development team to discover slight differences in opinions among technical staff.

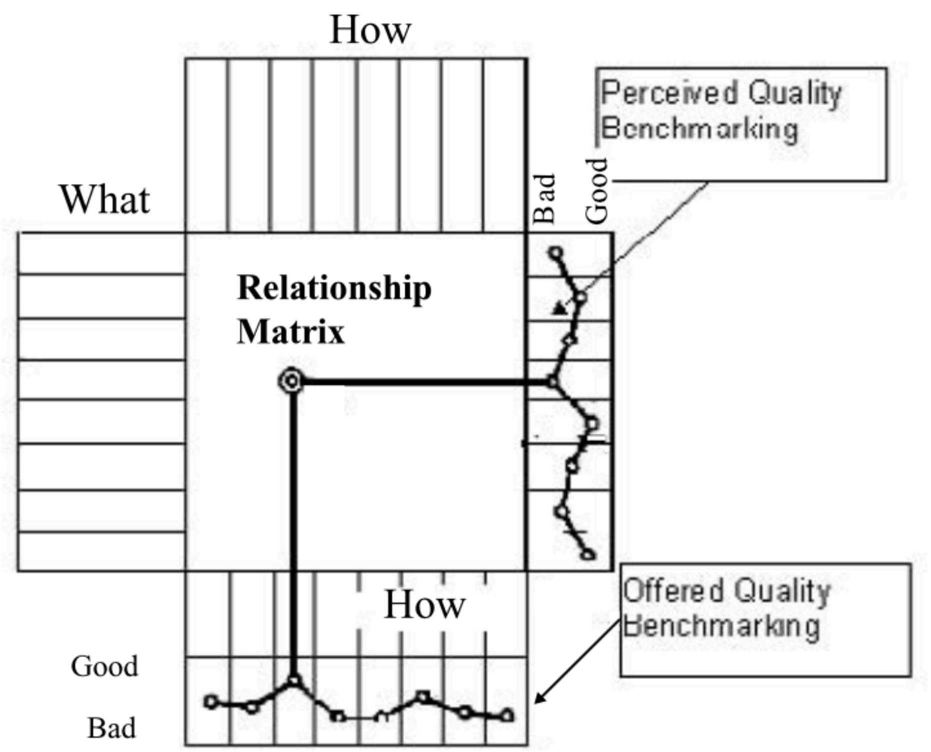


Figure 3.6 Competitiveness analysis and benchmarking. QFD represents an ideal environment for quantifying the concepts of offered quality and perceived quality. (W.E. and Ryan, N.E. [1988])

3.1.7 QFD – Correlation Matrix

Finally, in the "roof" of the House of Quality (namely, above the Relationship Matrix) there is a sort of triangular matrix that contains all the correlations among technical characteristics of the product chosen by the development team. A correlation between two technical characteristics is registered if variations on the first characteristic determine variations on the second one and vice-versa.

The correlation analysis is useful for the following reasons:

1. Positive correlations are generally present when two technical characteristics influence the same customer requirements. In this case a contemporary change of more than one technical characteristic specifications can be obtained through the same action, minimizing the effort in the design process.
2. Analyzing dependencies can be useful for eliminating redundancies and duplications of characteristics (expressed only with different terms).

3. Negative correlations are important to identify situations that may probably require a trade-off/compromise solution.

The correlation matrix can be created in many different ways. One of them is by applying the AHP model (for instance, by using the SuperDecisions software) that will be described in the next subsection of this chapter. However, no further description, not even the methods used to compute the correlation among technical characteristics will be showed in this study since this part of the House of Quality will not be used because the top management of MiaCar SpA is not interested in these values.

3.2 Analytical Hierarchy Process (AHP)

The Analytical Hierarchy Process (also called by its acronym "AHP") is a technique aiding decision makers, perfected by Saaty during the 1970s. It is mostly used because of the difficulty on evaluating in an objective way the weight of qualitative measures of criteria that must be considered when important decisions must be taken, such as strategic relevance of a project.

Basically, this methodology is adopted when it is needed an assessment of very different alternatives that are quite difficult to be evaluated since they are characterized by a relatively high number of decisional attributes, where subjective criteria are involved too.

As described by Saaty (1986) and highlighted by Franceschini F. (2002), the three main phases of this methodology are:

- The initial decisional problem is divided into many sub-problems that might be more easily understood and evaluated through the use of a hierarchy of criteria, sub-criteria, alternatives, etc., on which the decision is based.
- A scale of priorities is determined for each and every level of this decisional hierarchy against which to compare the various elements.
- The evaluation of the consistency of evaluations is formerly expressed.

Different softwares are used for applying this methodology; the most used and the one that will be adopted in this study is "SuperDecisions" that will be described in the following subsection.

3.2.1 SuperDecisions software

The way SuperDecisions software operates in order to perform the AHP methodology is composed by three main phases.

First of all, there is the definition of goal, criteria and alternatives:

- the goal usually is to determine the best alternative, or the set of the best alternatives,
- the means by which determine the best alternative(s) are the criteria of evaluation that can be qualitative or quantitative,
- the alternatives are the subjects of evaluation, such as the choices of buying or producing a product, whether or not to undertake an investment or to start (and invest on) the development of a project.

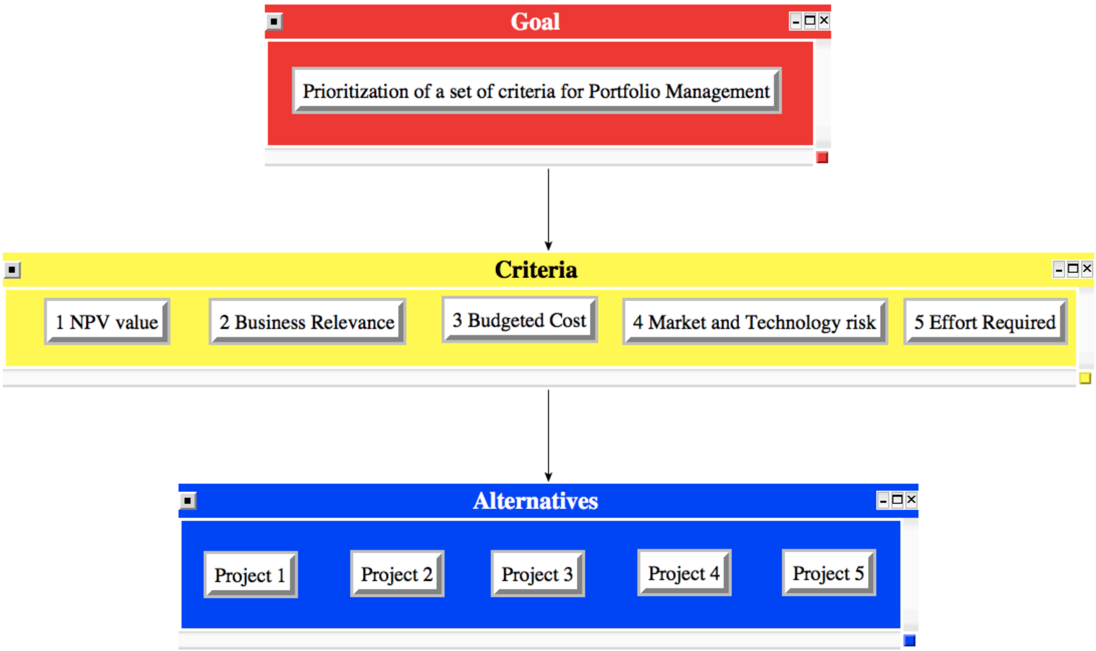


Figure 3.7 Goal, criteria and alternatives in SuperDecision

In Figure 3.7 is shown an example of this first phase that refers to creation of the goal (that in this case is to "demonstrate the criteria strategic alignment to portfolio objectives"), criteria and alternatives, that in this case are different projects to analyze and then be selected (i.e., from "Project 1" to "Project 5").
It is easily noticeable that both qualitative (i.e., business relevance) and quantitative measures of criteria (i.e., NPV value, budgeted cost, Market and Technology risk and effort required) are used in this example.
The second step is to perform the so-called "pairwise comparisons". Basically, in this phase comparisons among alternatives (or criteria) are performed in a 1-9 scale in order to establish the importance degree of each alternative with respect to each and every criterion. Here, individual decision makers are asked to judge how important project X is compared with respect to project Y in terms of criteria Z. Figure 3.8 shows the pairwise comparison of the alternatives with respect to the criteria "NPV value". As you can notice, some percentage

values for every alternative are present on the right-hand of the figure. These values refer to the percentage value of the degree of preferability of an alternative over all the other ones by considering just one criteria of selection (i.e., “NPV value”).

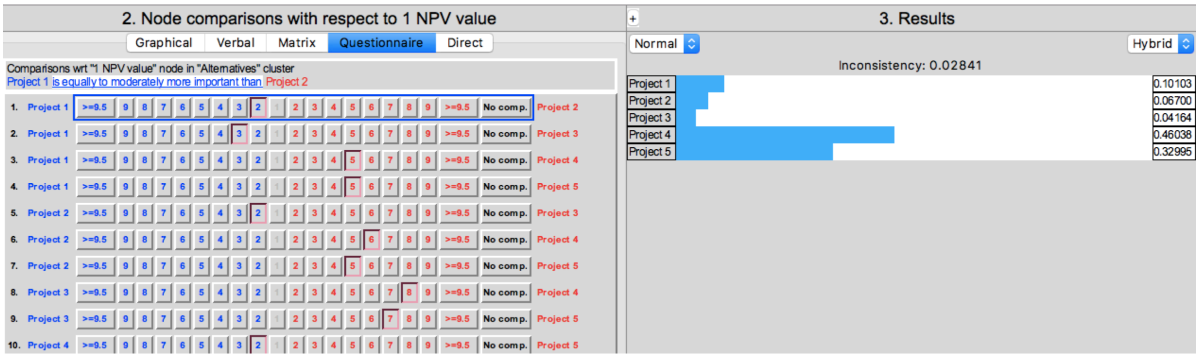


Figure 3.8 Pairwise comparisons in Super Decision

In the example, it is pretty clear that projects 4 and 5 are the most probable to be undertaken if considering just NPV as criteria of selection.

This work is done as many times as the number of criteria in order to have a complete view of the global importance of the alternatives. Moreover, the pairwise comparisons are used also to establish the relative importance of each alternative.

The third and last phase simply consists on the evaluation of the final results (see Fig. 3.9). Here, the global degree of importance is shown in percentage values and decision to take a project, buying a product instead of another one, etc. should be taken with respect to these results if AHP method is used in the decision process.

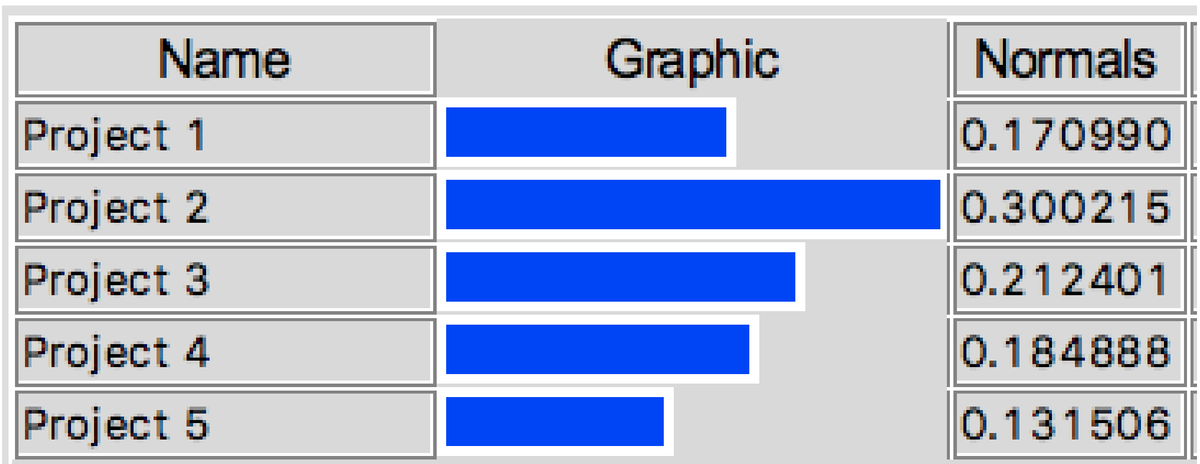


Figure 3.9 Super decision - Final results

In the example, project 2 is the most probable project to be undertaken since it has a global degree of importance (here shown in percentage values) that is clearly higher than the other ones. In my case, this final result will not be meaningful in any way since I am not looking for a decision to which alternative to choose, but I just want to see the relative importance degree between customer requirements and technical characteristics.
This is the main reason why the “final results” that will be considered will be the ones present in the Super Matrix that will be showed and explained in Section 5.
In a nutshell, in my study SuperDecisions will be used to generate a meaningful degree of importance to the customer in the prioritization of technical and engineering/design requirements making use of the AHP 1, 5, 9 scale to denote weak, medium, and strong relationships between pairs of customer and technical/design characteristics. Namely, it will be used to determine the values in the Relationship Matrix of the House of Quality.

Chapter 4

CRITICALITIES IN MIACAR

This chapter will focus on the way the business is carried on by MiaCar. In particular, it will be given a very brief description of how things work in MiaCar and eventual criticalities in it that will at least tried to be solved in the next sections. As already mentioned when talking about the innovative business model adopted by MiaCar, the value proposition stands mainly on three factors: the quality of the website www.miacar.it, the competitive prices of the cars offered and reducing/avoiding waste of time and money of customers such as transaction costs when looking for a car. While the top management thinks that the last two factors should just lead to positive outcomes in terms of value proposition offered to the customer (both car buyers and car dealerships), some concerns characterize the performance of the former one.

Is the quality of the service really at an acceptable level of customer satisfaction? The information gave in the car profiles are always correct or errors characterize it? With which frequency these errors happen? And is this easily improvable? If so, which is the optimal way to proceed?

These are just some of the questions that will be partially answered in this chapter and partially in the next two chapters (in the last one corrective actions to be pursued will be determined, if possible).

4.1 The importance of service quality

Customer satisfaction has been a subject of great interest to organizations. The principal objective of organizations is to maximize profits and to minimize costs. Profit maximization can be achieved through increase in sales with lesser costs. One of the factors that can help to increase sales is customer satisfaction, because satisfaction leads to customer loyalty, recommendation and repeat purchase (Wilson et al., 2008, p. 79). Thus, it is obvious that customers are important stakeholders in organizations and that their satisfaction is a priority to management.

In recent years, organizations are obliged to render more services in addition to their offers. Indeed, the importance of service quality has gained much concern in many fields such as the hospitality industry, banking, the sales and marketing industry, the construction industry and healthcare. Excellent service quality has been recognized as a medium of competitiveness and supremacy in terms of service (Essays, 2013).

Moreover, the quality of service has become an aspect of customer satisfaction. Indeed, it has been proven by some researchers that service quality is directly related to customer satisfaction (Agbor, J.M & Eriksson, J., 2011).

In other terms, quality customer service is a vital ingredient in a company's ability to maintain profitability and continued success in business. Not only does quality customer service build loyalty for both company and product above all other forms of marketing, it almost guarantees a company's viability in today's diverse and competitive market (Bullard, R., 2017).

These are the main reasons why the top management of MiaCar has asked me to further analyze and assess the level of service quality offered to the customer through their website.

4.2 Service quality in MiaCar

4.2.1 What works in MiaCar

As already said, the top management is sure that what works in MiaCar in terms of quality is the completeness and clarity of information. Namely, in MiaCar "it is possible to compare online different brands, models, contents and prices (with the savings with respect to the list price in evidence)" (GQ Inc., 2017).

In particular, by talking directly with customers by means of phone calls and webchat, the sales team discovered that the information quality aspect of this platform that mainly liked to them was the information clarity of car components and the transparency of their costs. In fact, in the car profiles each and every car component is present in two different lists ("standard equipment" and "optional add-ons") and it is shown if and how much the customer is going to pay for it (right-hand area in Fig. 4.1), obviously in the case he or she is going to buy the car. Moreover, information clarity and completeness are also tangible when computing other type of costs, the customer would incur when buying the vehicle. Indeed, each kind of tax (such as "contributo eco pneu" in Italy in case of new cars) and other costs such as the change of ownership of a zero-miles car are directly computed on the website in order to give the best service possible to the customer that in this way would not claim about the "added-on-click costs" phenomena that characterizes other platforms. Namely, an initially car price is usually summed up with other costs, such as taxes, when clicking

"continue" buttons in order to go step-by-step to the buying act. Thus, each step (therefore each "click") would constitute an additional cost.
Other aspects relevant to information quality offered are the relatively high number of car pictures showed in the car profiles (usually at least six showing both external and internal views of the car) and the fact that each one of them are in accordance to the optionals of the car (it is not showed just a "basis model" of the car as it happens in many other online platforms).

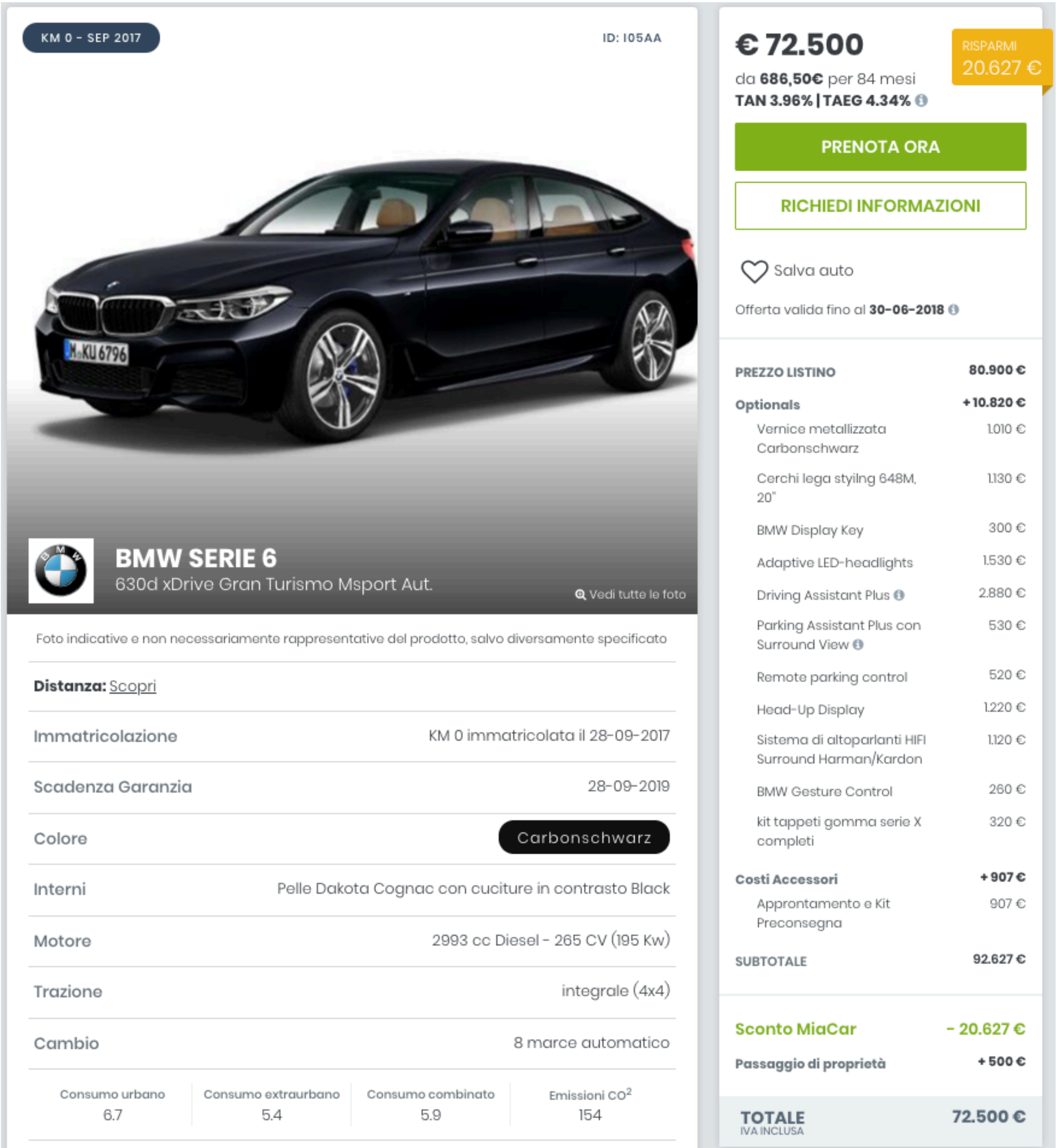


Figure 4.1 **Example of car profile on miacar.it (Source: https://www.miacar.it/it/dettaglio-auto/bmw/serie-6/630d-xdrive-gran-turismo-msport-aut./5aa946ab8ead0ecd52baadb9)**

All these aspects helped until now MiaCar in its relatively rapid process of growth because they allowed an increase of customer satisfaction on this type of service.
However, some drawbacks (mainly in the data entry process) have been found and will be further described in the next subsection.

4.2.2 What does not work in MiaCar

The main problem that affects directly the performance of the website in terms of service quality is the fact that the data entry process is performed almost entirely manually.
It is pretty intuitive to understand that this leads to a relatively high number of mistakes that, at least theoretically, would be totally avoidable by automatizing totally and in an efficient way this process.
Basically, an internally ad-hoc developed software called “Black” is used for charging cars profile on the website of MiaCar. Many key information is put manually by data entry operators. This set of information includes the following elements:

- car price,
- standard and optional equipment,
- showroom data (i.e. name, location and manager/seller),
- car codes,
- if it’s a new or zero-miles car,
- brand and model of the car,
- pictures of the car (directly taken from the official configurator),
- MiaCar discount and other costs such as taxes and change of property fees.

Figure 4.2 shows how some elements of this list are saved on the software “Black” (thus, on the car profile seeable on the website www.miacar.it).
Since in this process a high amount of information must be managed, it is pretty intuitive to understand that it is very easy to make mistakes. In fact, during my internship in MiaCar, it happened relatively many times that prices, pictures and/or optional and standard equipment of cars shown on the website were not correct.
It is quite intuitive to understand that these are issues of key importance for a startup like MiaCar since errors in this type of information would decrease the quality of information offered by the website platform, thus directly affecting sales and the diffusion of this service over the time. This is the main reason why in the following chapter the study will focus on the real quality of the product perceived by the technical development team with respect to customers’ needs and to competitors (as already said, this will be seen by using the QFD method), while in the last chapter the focus will be on the possible alternative solutions to the issues explained just above.

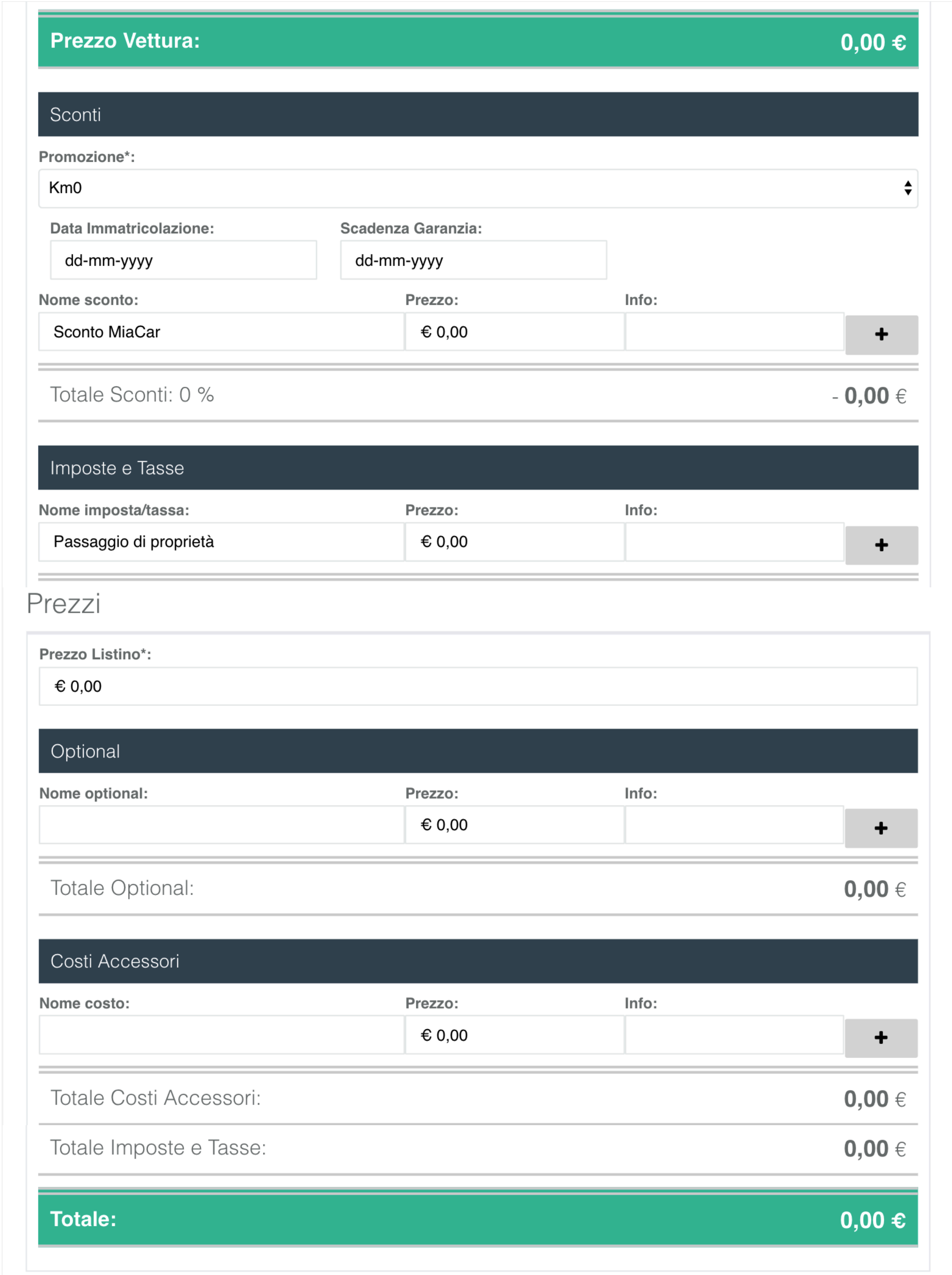


Figure 4.2 Black software. Unfortunately, it has only an Italian version. It is shown how car price, optional equipment, accessories costs, discounts and taxes are charged in the car profile. The last line shows the final price of the car.

4.3 Practical mistakes

To reinforce the concepts explained in the previous subsections, some practical mistakes examples made in the data-entry process will be shown and briefly described in this subsection.
The sample car profile that will be considered ("Fiat 1.2 Lounge") shown in Figure 4.3 and Figure 4.4 with all the right information about prices, car pictures, color, optional equipment, standard equipment (notice that in figure is shown just a part of the standard equipment because it already includes the standard component that will be analyzed), etc.

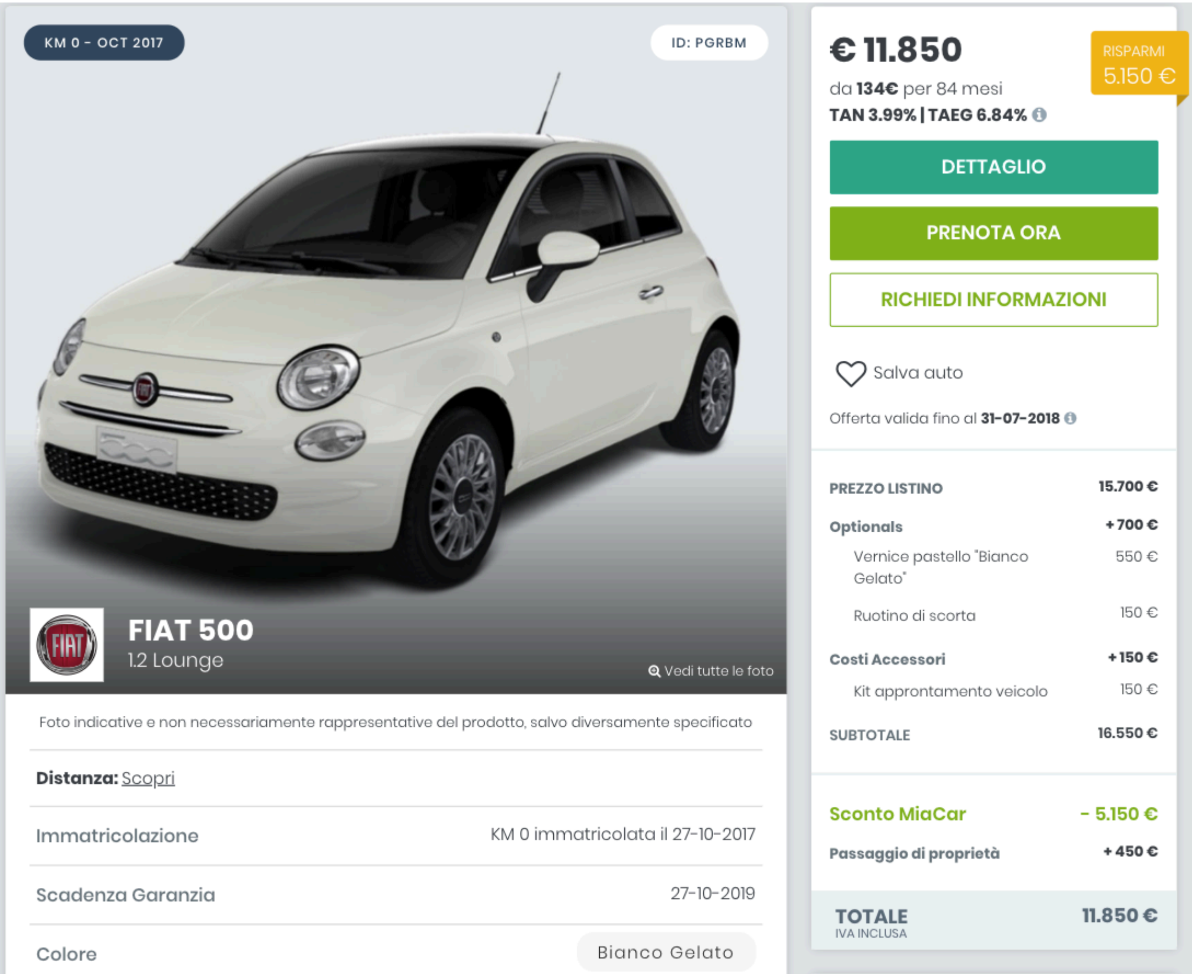


Figure 4.3 **Car profile of "Fiat 500 1.2 Lounge" including profile image, color, costs, optional equipment and other information (Source: https://www.miacar.it/it/dettaglio-auto/fiat/500/1.2-lounge/5b55949f8ead0e552d076937)**

Among the many typologies of mistakes related to car profiles information, just three of them will be described in order to have at least a basic idea of how errors can be made in the data entry process and which impact could have on the sale of the car. These three types of errors are listed just below:

- The car profile shows images of a car with a different color than the one written in the car characteristics below the image and in the car optionals.
- No picture is present in the car profile.
- Car-items related errors (errors concerning standard and optional equipment of the car, in terms of costs and/or type of equipment).

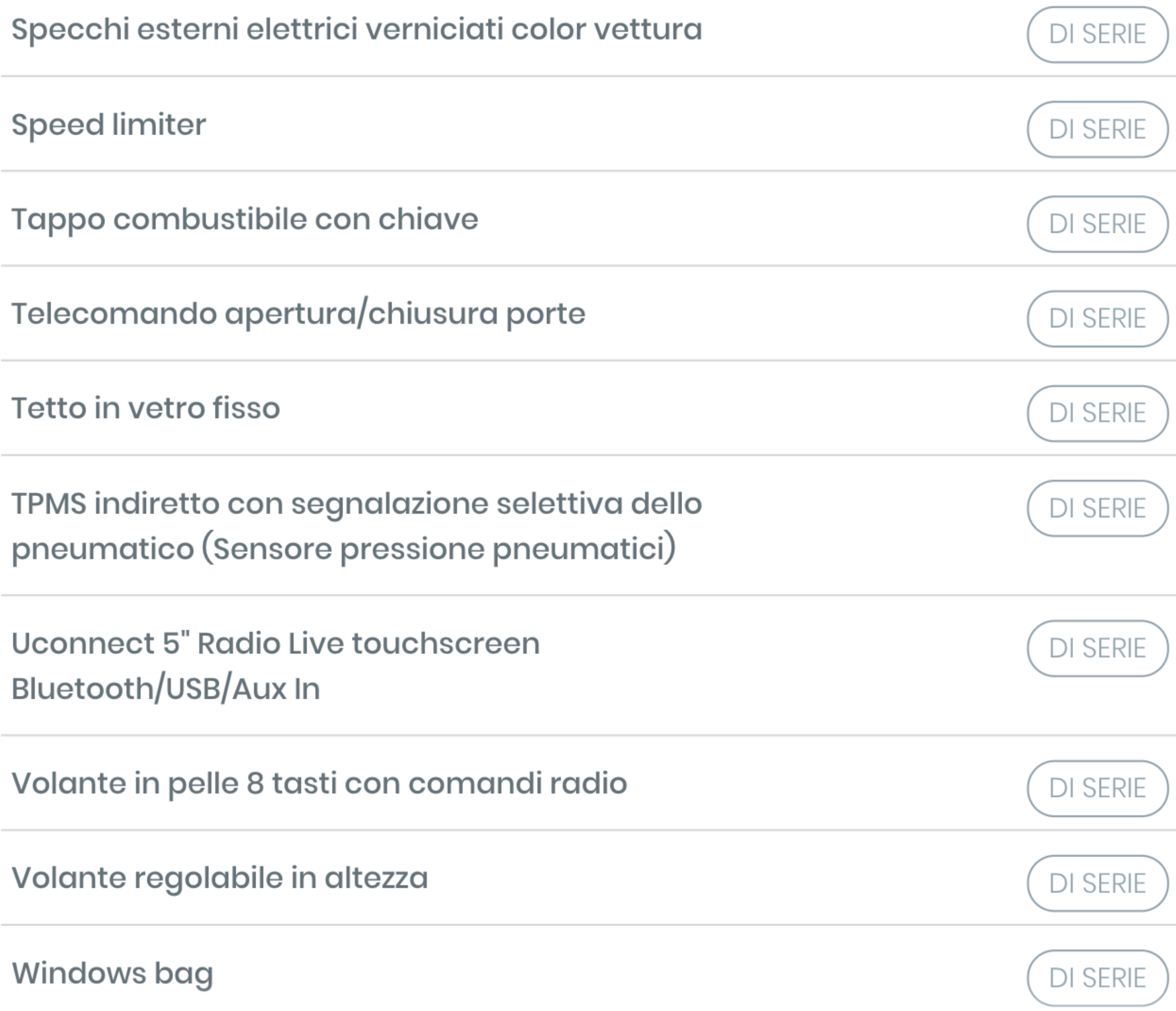


Figure 4.4 Part of standard equipment of "Fiat 500 1.2 Lounge"

4.3.1 Incorrect car color

As just said, the first typical error made by the data entry operators of MiaCar when charging car profiles in the website that will be discussed refers to car profiles that show a different external color between the car profile picture and the information below and on the right of it. In this case, the profile picture shows a “Fiat 500 1.2 Lounge” that has a white external color, called “Bianco Gelato” since the website is only in Italian language (Figure 4.3), while below the picture it is clearly stated that the color of the car is black (by looking at Figure 4.5, the voice “Colore” has the value of “Black Metallic”). The same goes for the optional equipment list shown on the right-hand side of the figure where the voice “Black Metallic” is present too.

Fortunately for MiaCar, this is an error that is usually corrected with a relatively good timing since it is very easy to be recognized by other data entry operators or by the sellers of the firm that constantly look at the website in order to help customers to find the right car for them.

However, having cars with an incorrect information of such relevance can directly affect the reputation of the website since it would easily confuse customers on the quality of the service, thus indirectly affecting sales.

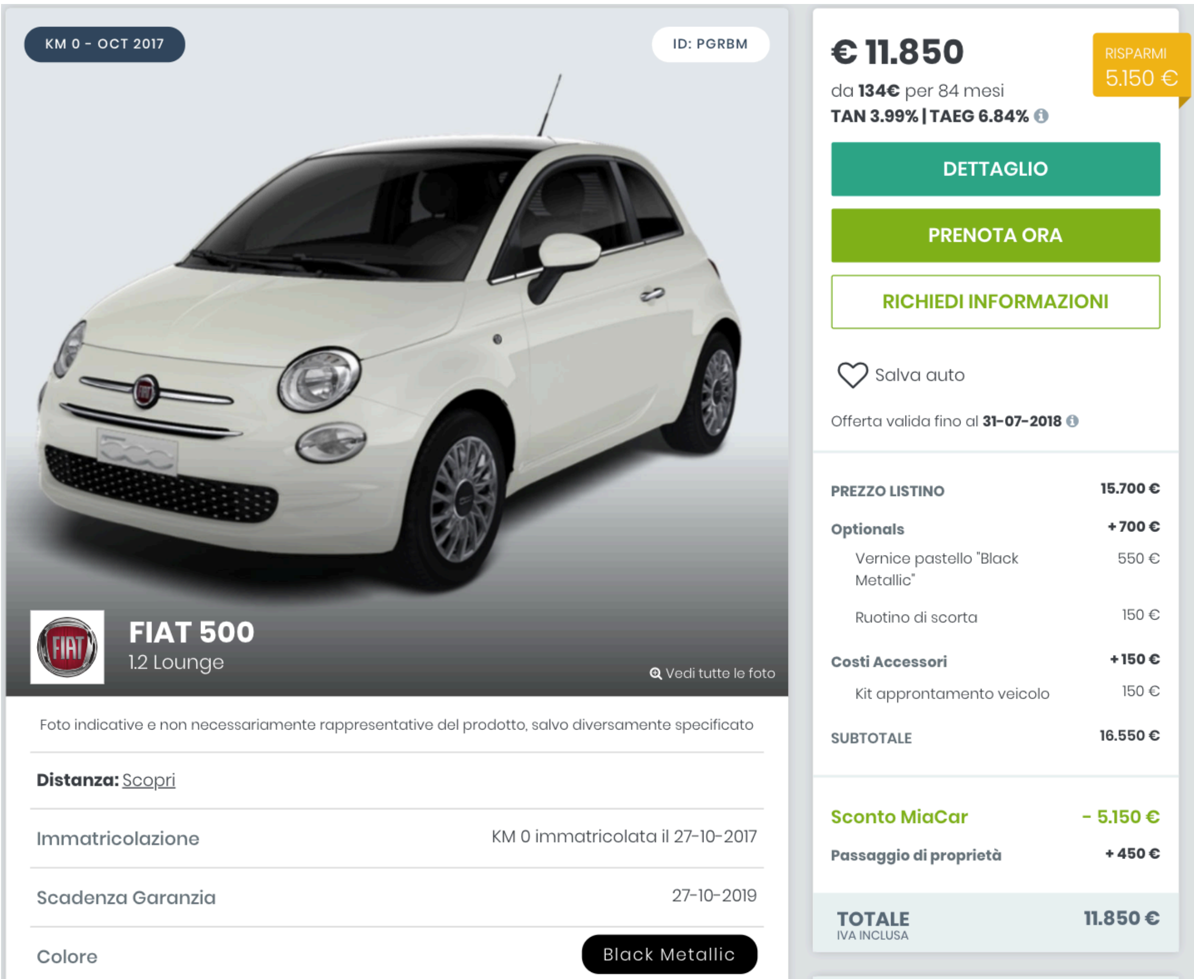


Figure 4.5 **Car profile with the color-error**

4.3.2 No car picture in the car profile

This is an error that happens quite rarely, but it is the one that most irritate customers (after price errors of course) since the first customer need about car profiles is to see the car with as many pictures as possible in order to feel like "having the car at home and feel as being even able to touch it".
Moreover, this is also the type of mistake that irritates the most the top management too. Indeed, according to firm policies about the data entry process, car profiles can be charged into the website only if (the right) pictures are present in it.
Figure 4.6 shows the car profile of the car "Fiat 500 1.2 Lounge" without a profile picture (notice that the default profile picture is not a simple blank picture).

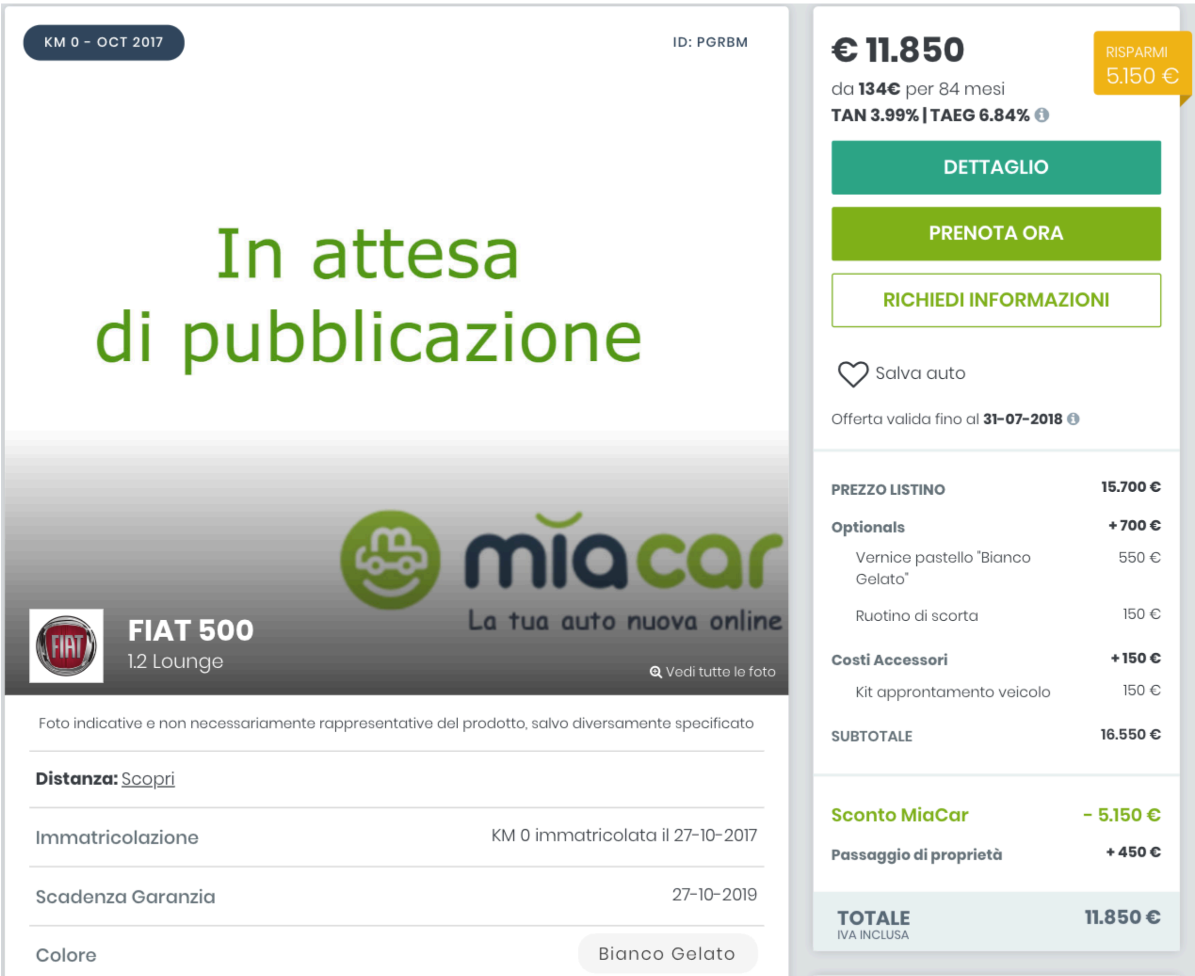


Figure 4.6 **Car profile without a profile picture**

4.3.3 Car items related errors

Errors about car features are for sure the most common ones in the data entry process because a very high quantity of information must be managed in a relatively small time period.

They can be grouped in five main types of errors related to car features:

- A car item that should/should not be present in the standard equipment list is not/is present in it.
- The optional equipment of the car include/do not include an optional that does not appear/does appear in the “optional equipment” voice shown in the car profile.
- The price of an optional is different from the value specified by the car dealership.
- Not only a standard car item does not appear in the standard equipment list shown below the car profile picture, but it is even shown as an optional feature of the car, therefore it becomes an additional cost for the customer while it should be given for free with the car offer.

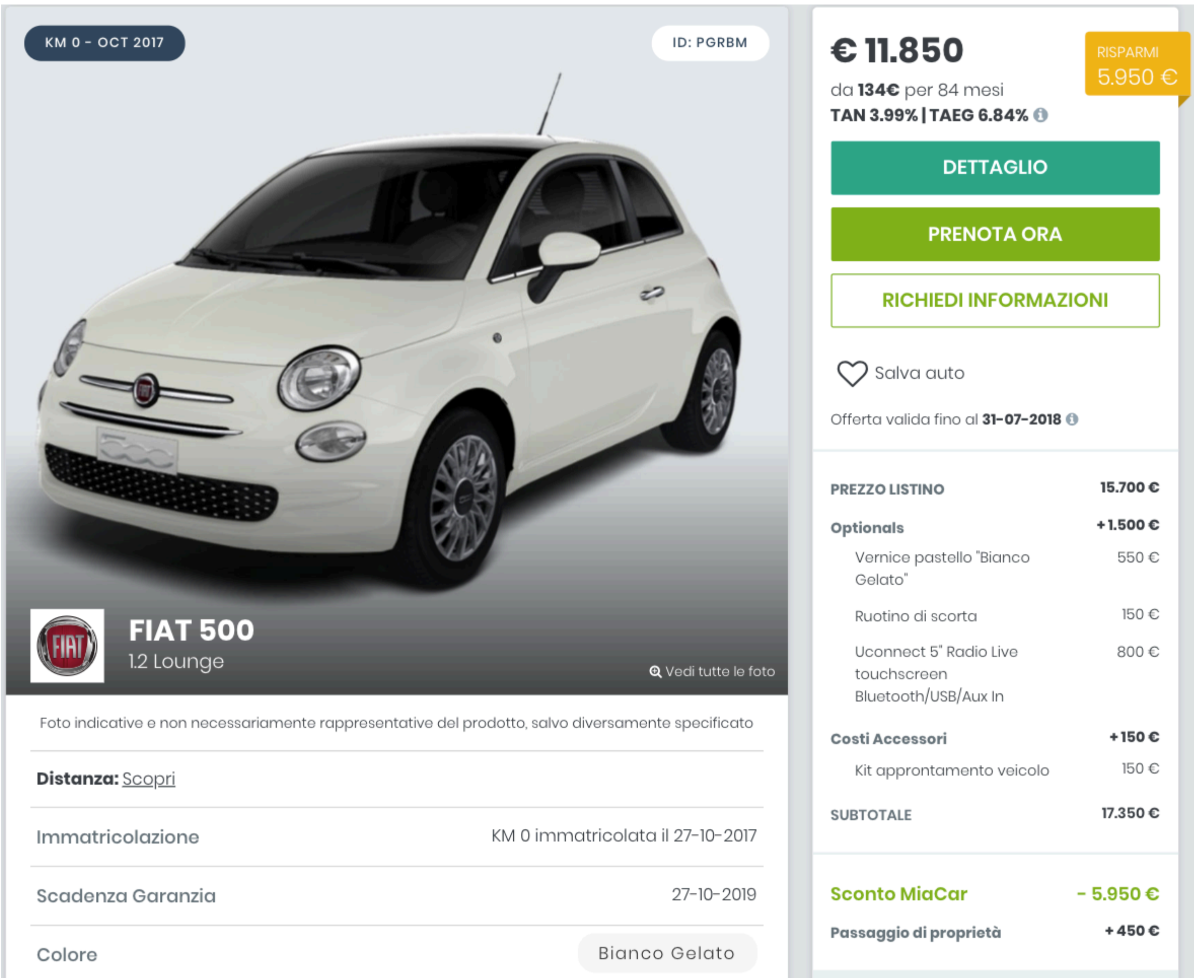


Figure 4.7 **Car profile with an additional optional item**

- A car equipment is present in both standard equipment and optional equipment lists in the car profiles. This highly confuses the customer (“should I pay for it or not?”, “if it is a standard item, why should I pay for it?”).

It is very intuitive to understand that these errors are all of high relevance to the decision of whether or not to buy a car. In particular, the last three ones usually lead to lose a customer that have previously booked a car.
The last type of error listed above will be also seen in the example of the car “Fiat 500 1.2 Lounge”. Indeed, in Figure 4.7 is shown the same car profile of the previous figures with an additional optional car item, ‘Uconnect 5" Radio Live touchscreen Bluetooth/USB/Aux In’ that appears also in the standard equipment list of the car (Figure 4.4). In cases like this, the possibility to sell the car can be easily reduced (this usually depends on the additional cost of the optional item). For instance, by furtherly analyzing the case shown in Figure 4.7, having or not ‘Uconnect 5" Radio Live touchscreen Bluetooth/USB/Aux In’ as an optional could be a determinant factor in the buying choice of the customer since usually people who want to buy a “Fiat 500” are quite price-sensitive. Indeed, the cost of this (potential) optional car feature would be of 800 euros, this means that the optional equipment costs would be more than doubled with respect to the case where this item is considered as a standard feature of the car.

Chapter 5

DEGREE OF SERVICE QUALITY IN MIACAR

This chapter deals with the actual work performed to assess the value of the service quality offered by MiaCar to its customers.
I have already said that this work will be accomplished by using the QFD method in order to assess this value both in terms of quality perceived by the customers and with respect to the service quality offered by competitors' websites that are in the market.

5.1 QFD on MiaCar.it

5.1.1 Customer Requirements

Information about customer needs and requirements have been gathered on a day-by-day basis mainly by asking directly to the customers through phone calls (obviously, with the main goal of selling the product). From these customers' answers, the sales team individualized not only the main customer requirements inherent to the service characteristics, but they have been able to give a qualitative appraisal on the degree of importance of each and every one of them by ranking them according to a scale from 1 to 10 (where 1 stands for "a requirement of negligible importance" and 10 stands for "an indispensable requirement"). The main customer requirements and their relative importance that have been found are listed below:

- ease of use of the interface and simple layout - relative importance: 8
- easy product selection- relative importance: 7
- easy to compare cars - relative importance: 7
- fast search engine - relative importance: 3
- quantity of information given (optional equipment, prices, number of car pictures in car profiles, etc.) - relative importance: 10

- quality of information (i.e., degree of errors, precision in actual costs of the loan) - relative importance: 9
- web design style - relative importance: 2

The relative importance of these customer requirements has been determined by using the geometric average of the of the judgments expressed by n customers. Namely, if *n* customers made a judgment on requirement *i* (x_i), the final relative importance assigned to this requirement (X_i) will be:

$$X_i = \sqrt[n]{\sum_{j=1}^{n} x_j}$$

where i=1,…,9 and $x_j \in [1,10]$.
Then, the values of X_i have been rounded to the closest integer number.

5.1.2 Technical Features

While customer requirements have been determined and their importance has been assessed by customers, the technical features of the service offered by MiaCar through its online platform have been entirely defined by the internal workforce of the firm.
More specifically, features regarding car profiles have been asked to data entry operators that each and every day perform the activity of charging car profiles on the website and therefore know very well what can be more important to them to make simpler and easier their work, the sales team has determined features concerning the way they interact with the customers and finally the software developers have defined features about the way the website works.
These engineering/design characteristics are listed below with their relative degree of importance suggested by that three categories of employees in MiaCar:

- easy list of product categories
- detailed product information
- no advertisement
- usability (for instance, MiaCar “sellers” operate by looking at the website to find the best solutions for the customers while talking on the phone)
- easy-to-find website to attract more customers
- number of products present in the website

5.1.3 Relationship Matrix

As already explained, the relationship matrix shows how much customer requirements (the "WHATs") are correlated to the engineering/design characteristics (the "HOWs").
Each of these values will be obtained by using the software called "SuperDecisions", therefore following the AHP methodology. It must be mentioned that the following steps have been highly influenced by the work of Moliterni, R. and Martin, J. (2008).
Basically, pairwise comparisons will be performed on technical features with respect to each and every customer requirement. This dependence is symbolized in the SuperDecisions model by an arch headed from the customer requirements to the technical characteristics cluster (see Fig. 5.1).

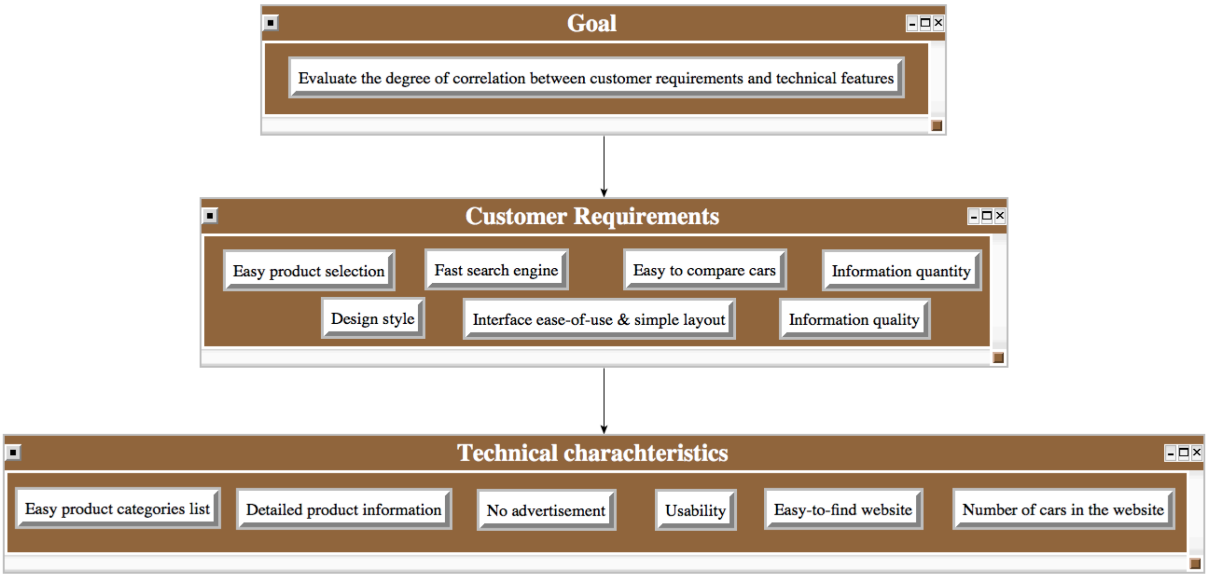


Figure 5.1 AHP hierarchy adopted

The pairwise comparisons will be performed with respect to an evaluation scale from 1 to 9. In this case, the scale will be managed in the following way: equal importance (1), moderate importance of one criterion over another one (3), essential or strong importance (5), very strong importance (7), extreme importance (9). The even values will be used to express the intermediate values between two adjacent judgments.
Figure 5.2 shows how the pairwise comparisons are performed with respect to the customer requirement called "interface ease-of-use and simple layout". For example, here the technical characteristic "easy product categories list" is obviously extremely more important (nine times) than "number of cars in the website" since it affects directly and in a positive way the ease of use of the platform interface, while the number of cars should not have any positive outcome in terms of this customer requirement.

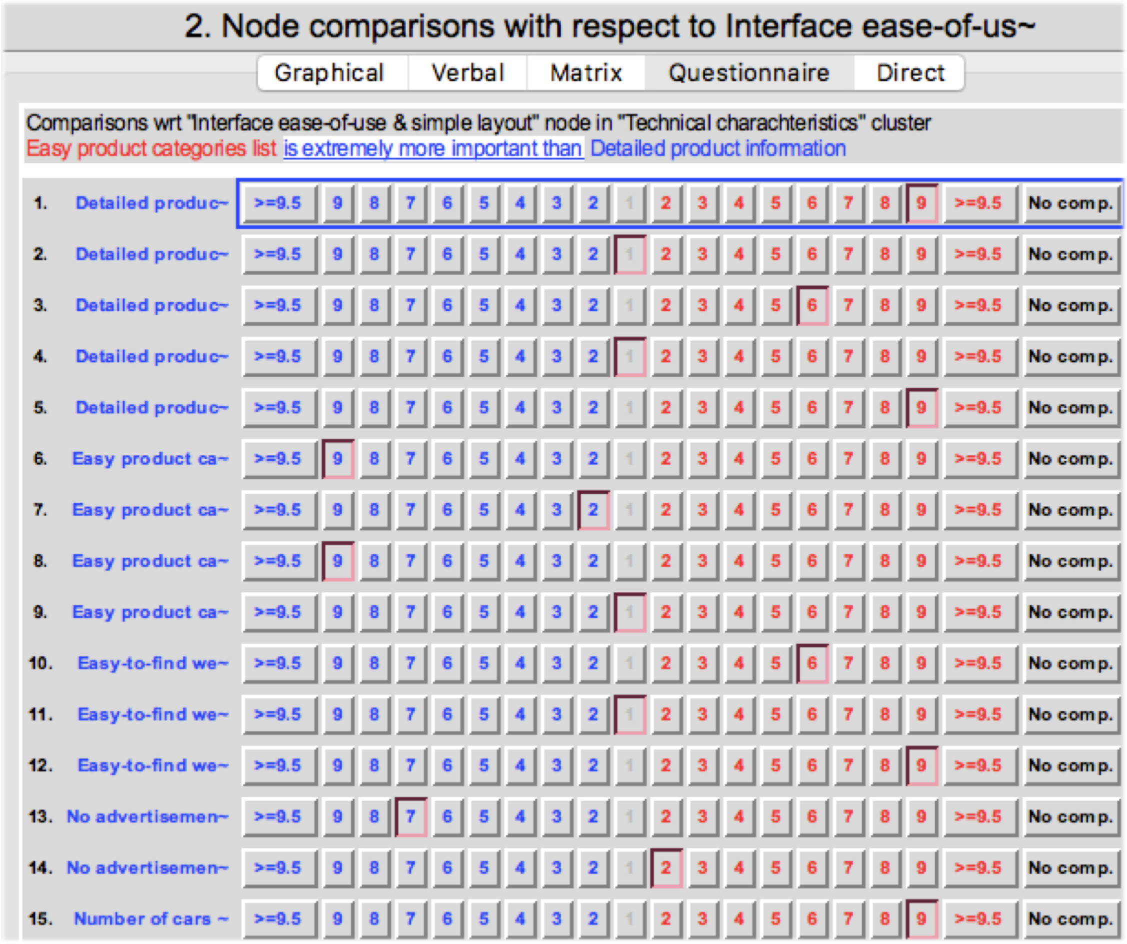


Figure 5.2 Pairwise comparisons of the technical characteristics with respect to the customer requirement "Interface ease-of-use"

Unfortunately, for many reasons (mainly for time constraints) these values have been decided mostly in a qualitative way by considerations made by Lorenzo Sistino, Jacopo Liotta (the main marketing responsible in MiaCar) and me. Obviously, as already mentioned, these considerations have considered feedbacks from both internal technical teams and customers.

To see if the pairwise comparisons results make sense, a check on the degree of inconsistency must be done.

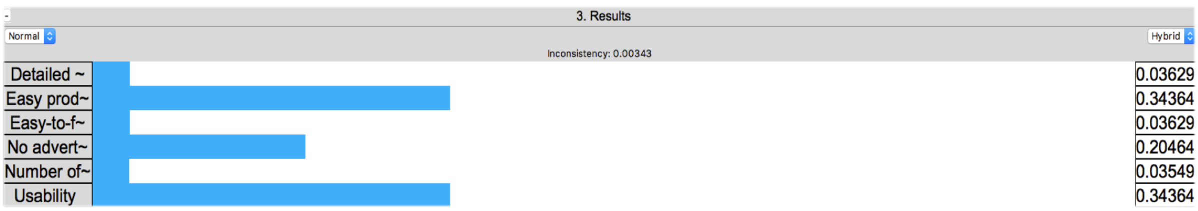


Figure 5.3 Results of pairwise comparisons

Figure 5.3 shows the inconsistency level for the pairwise comparisons of the previous example and the general level of importance (in percentage terms) of the six engineering/design requirements with respect to the customer requirement "interface ease-of-use" (namely, the "results" of the pairwise comparisons).

Cluster	Node Labels	Customer Requirements						
		Design style	Easy product selection	Easy to compare cars	Fast search engine	Information quality	Information quantity	Interface ease-of-use & simple layout
Technical charachteristics	Detailed product information	0.114452	0.296198	0.382185	0.047634	0.494443	0.399080	0.036295
	Easy product categories list	0.278557	0.339962	0.378280	0.047634	0.219824	0.047006	0.343644
	Easy-to-find website	0.033233	0.027069	0.026358	0.047634	0.035310	0.046083	0.036295
	No advertisement	0.264342	0.098605	0.028088	0.047634	0.037717	0.047006	0.204638
	Number of cars in the website	0.056358	0.026263	0.033869	0.566497	0.126045	0.414743	0.035485
	Usability	0.253058	0.211904	0.151220	0.242967	0.086661	0.046083	0.343644

Figure 5.4 SuperMatrix values in the Super Decisions software

In this case, the results clearly show that the technical characteristics "usability" and "easy product categories list" are the ones with the highest correlation value with respect to the customer requirement "interface ease-of-use".

Noticeable is also the value of the technical characteristic "No advertisement". This relatively high correlation value can be justified by the fact that the absence of advertisements can decrease evident distractions and waste of time while looking for the right car on the online platform.

As already explained in chapter 3, the values that will appear in the Relationship Matrix of the House of Quality will be the ones present in the SuperMatrix of the SuperDecisions Software (Fig. 5.4).

In the Relationship Matrix of the House of Quality, all of these values will be multiplied by a factor of ten and then they will be approximated to the closest integer value. This is done in order to obtain a scale of importance from 1 to 5.

Symbols are used to represent these integer values (see the legend in the highest part of the left-hand side of Figure 5.5.1).

It is easy to notice that there are blank cells in this matrix. This is the case in which the number value of correlation was pretty close to the zero.

5.1.4 Competitive Benchmarking Assessment

According to a definition by Camp (Zairi, 1992), benchmarking can be considered as “the continuous process of measuring our products, services, and business practices against the toughest competitors or those companies recognized as industry leaders”.

The assessment of the competitors’ performances, in terms of service quality, has not been obtained by means of questionnaire done by customer (as common practice in the field). Instead, internal evaluations have been used to determine them. These internal evaluations have been highly influenced by practical benchmarking assessment performed by looking at the websites of the competitors.

Relationships:
- •• Strongest= 5
- • Strong = 4
- ⊙ Fair = 3
- ○ Weak = 2
- △ Very weak = 1

Customer Requirements	Degree of importance	Relative importance	Technical Characteristics: Detailed product information	Easy product categories list	Easy-to-find website	No advertisement	Number of cars in the website	Usability
Design style	8	17%	△	⊙		⊙	△	⊙
Easy product selection	7	15%	⊙	⊙		△		○
Easy to compare cars	7	15%	•	•				○
Fast search engine	3	7%					••	○
Information quality	10	22%	••	○			△	△
Information quantity	9	20%	•		△		•	
Interface ease-of-use and simple layout	2	4%		•		○		•

Figure 5.5.1 Customer requirements, Technical characteristics and the Relationship Matrix of the Ho

The main competitors of MiaCar are:

- AutoScout24, with its online platform www.autoscout24.it where customer can compare different new, zero-kilometers and used cars of many official and unofficial car dealerships.
- brumbrum SpA. It has an online website (www.brumbrum.it) where many offers of zero-kilometers, and rental cars
- are showed and can be directly bought from official or unofficial car dealerships.

By looking pretty carefully at these two websites, we performed a qualitative assessment of the level they satisfy each customer requirement listed before by assigning them a numeric value according to a 1 to 5 scale and the same was performed with respect to the current situation MiaCar is in. Figure 5.5.2 shows all of these values in the orange part on the right-hand of the relationship matrix of the HoQ.

			Technical Characteristics													
Customer Requirements	Degree of importance	Relative importance	Detailed product information	Easy product categories list	Easy-to-find website	No advertisement	Number of cars in the website	Usability	Current model of MiaCar	AutoScout24	brumbrum SpA	Targets of the new model	Improvement Ratio	Strength	Absolute weight	Relative weight
Design style	8	17%	△	⊙		⊙	△	⊙	7	4	8	8	1.14	1.0	9.1	14.7%
Easy product selection	7	15%	⊙	⊙		△		○	9	7	6	9	1.00	1.2	8.4	13.6%
Easy to compare cars	7	15%	•	•				○	7	6	3	7	1.00	1.2	8.4	13.6%
Fast search engine	3	7%					••	○	6	7	5	6	1.00	1.0	3	4.9%
Information quality	10	22%	••	○			△	△	9	2	3	10	1.11	1.5	16.6	26.9%
Information quantity	9	20%	•		△		•		10	2	2	10	1.00	1.5	13.5	21.9%
Interface ease-of-use and simple layout	2	4%		•		○		•	7	9	8	8	1.14	1.2	2.7	4.4%

Figure 5.5.2 HoQ with Competitive Benchmarking Assessment on the right

The right part of the House of Quality showed in figure is then completed by the columns referring to the following voices:

- Improvement Ratio. This ratio stands for “how much should the firm improve the way it satisfies a certain customer need”. For instance, the customer requirement called “design style” is already being satisfied from MiaCar with a degree of satisfaction of 7 over 8, that can be already considered as an acceptable value. However, while Autoscout24 has a quite lower degree of satisfaction (4), the degree of importance given by the customers and the degree of satisfaction assigned to brumbrum S.p.A. are both higher (8). Therefore, these are the main reasons why the target of the new model with respect to this customer requirement have been decided to be assigned equal to 8 over 10. Then, the improvement ratio of “Design style” is equal to 1.14 since it is given by the division of the target model value (8) over the current model value of MiaCar (7).
- Strength. As already explained, the voice “strength” refers to the service’s potential strengths useful to improve the image of MiaCar and strictly depends on the evaluations made by the firm based on the following scale: 1.0 (not considered as strength), 1.2 (possible strength) and 1.5 (very important strength). It is easily noticeable that, according to MiaCar, the most important customer needs are “information quality” and “information quantity” with the maximum strength value (1.5), then followed by “easy to compare cars”, “easy product selection” and “interface ease-of-use and simple layout” with a strength value of 1.2.
- Absolute weight. It is a rough measure of how much is really important a customer requirement and it is calculated by multiplying the degree of importance by improvement ratio and strength. For instance, the absolute weight of the customer requirement “design style” is equal to 9.1 because it has been computed as the product of its degree of importance (8), its improvement ratio (1.14) and its strength (1.0).
- Relative weight. It is just the absolute weight converted in percentage value of all the weights. For instance, for “design style” it is 14.7% since it is computed by dividing its absolute weight (9.1) over the sum of all the weights (namely, 61.7.

By looking at the right-hand side of the House of Quality, it is easy to get that the most important customer needs to be satisfied in order to have a more than acceptable level of service quality offered are “information quality” and “information quantity”, at least according to MiaCar considerations.

Information quantity is already considered as unimprovable since it has a satisfaction level of the current model equal to 10 over 10.

Consequently, it has an improvement ratio of 1.00. Information quantity instead, can be still be improved despite its quite high satisfaction level (9), that is clearly the highest in the market (brumbrum SpA and AutoScout24 values are respectively 3 and 2). In fact, the target value to be achieved has been decided to be 10 over 10. This implies that its relative improvement ratio corresponds to 1.11.

The actions that can be pursued to improve the current information quality will be very briefly discussed in the last chapter.

5.1.5 Technical comparison

This phase of the Quality Function Deployment method is present just below the Relationship Matrix.
As shown in Figure 5.5.3, this part of the HoQ can be divided into two different phases: pure technical comparison and benchmarking assessment of technical characteristics.
It has already been explained that the first phase is composed by the computation of four parameters: "technical importance", "technical relative importance", "absolute weight" and "relative weight". This part is pretty simple to perform, since it just needs the use of trivial formulas. For instance, the technical importance of the technical characteristic called "detailed product information" can be computed as the sum of the products between relative importance of customer needs and its relative value on the relationship matrix. In this case:

$$Technical\ importance = 0.17 \cdot 1 + 0.15 \cdot 3 + 0.15 \cdot 4 + 0.22 \cdot 5 + 0.20 \cdot 4 = 3.12$$

In this case, the technical relative importance is equal to 33% since it is given by the ratio between its technical importance (3.12) and the sum of the technical importance values of all the technical characteristics (9.43).
Then, the absolute weight can be found as the sum of the products between the relative weight of the customer requirements (last column on the right-hand side of the HoQ shown in Fig. 5.5.2) and the values in the Relationship Matrix (the "r_{ij}" described in chapter 3). For the technical characteristic "detailed product information", this value can be found as:

$$Absolute\ weight = 0.147 \cdot 1 + 0.136 \cdot 3 + 0.136 \cdot 4 + 0.269 \cdot 5 + 0.219 \cdot 4 = 3.32$$

Finally, the relative weight can be computed as the relative normalized weight of each engineering technical characteristics. Namely, it is given by the ratio of the absolute weight of the technical characteristic and the sum of the absolute weights of all the technical characteristics. Thus, the value of the relative weight of the technical characteristic "detailed product information" shown in Figure 5.5.3 has been calculated as:

$$Relative\ weight = \frac{3.32}{3.32 + 2.11 + 0.22 + 0.67 + 1.54 + 1.53} = \frac{3.32}{9.39} = 36\%$$

The results of this phase show that, from an internal perspective view, the most important technical characteristics (thus, the first ones to be improved) are "detailed product" and "product categories list" with respectively 36% and 23% of relative weights.
The most particular implication of these results is that the technical characteristic called "usability" is not the most important factor of quality.
As already anticipated, the second part of the Technical Comparison phase of the QFD analysis is about the benchmarking assessment of technical characteristics. Namely, a comparison between MiaCar and its two main competitors (i.e., brumbrum SpA and

AutoScout24) will be performed with respect to the technical characteristics previously listed. Since the QFD method has been developed with the goal of studying the quality of products (in this case, the quality of a service), usually a row referring to "unit of measurement" is present in this phase because the technical characteristics taken into consideration are usually technical properties of the product such us physical, chemical,

Customer Requirements	Degree of importance	Relative importance	Technical Characteristics					
			Detailed product information	Easy product categories list	Easy-to-find website	No advertisement	Number of cars in the website	Usability
Design style	8	17%	△	⊙		⊙	△	⊙
Easy product selection	7	15%	⊙	⊙		△		○
Easy to compare cars	7	15%	•	•				○
Fast search engine	3	7%					••	○
Information quality	10	22%	••	○			△	△
Information quantity	9	20%	•		△		•	
Interface ease-of-use and simple layout	2	4%		•		○		•

Technical importance	3.12	2.16	0.2	0.74	1.54	1.67
Technical relative importance	33%	23%	2%	8%	16%	18%
Absolute weight	3.32	2.11	0.22	0.67	1.54	1.53
Relative weight	36%	23%	2%	7%	16%	16%
Current Model (MiaCar)	10	7	8	10	4	9
AutoScout24	3	10	9	10	9	6
Brumbrum SpA	6	1	6	10	3	8
Targets of the new model (MiaCar)	10	9	8	10	8	9

Figure 5.5.3 Technical comparisons in HoQ

mechanical and electrical properties and dimensions. For instance, in Figure 3.5 the unit of measurement of the technical characteristic “lens thickness” is in millimeters (“mm”).
However, since the technical characteristics chosen for evaluating the service of MiaCar cannot be amenable to any unit of measurement, qualitative measures based on a 1 to 10 scale will be adopted for the case.
To better understand how this scale-based assessment of technical characteristics has been made, the way they have been chosen for “detailed product information” and “easy product categories list” will be described.
For the first technical characteristics, the focus of the evaluation is on the car profiles present on the websites of MiaCar, brumbrum SpA and AutoScout24.
By looking at the car profiles present in brumbrum online platform, it is easy to notice that just general information is given to the customer, such as: technical characteristics of the car (i.e., color, type of fuel system, number of seats and doors, power, etc.), standard and optional equipment (with detailed description if needed), financing options and just the final price of the car and the relative discount. It is noticeable that this car profile includes a high number of car pictures and also a brief text description of the type of car to help the customer to understand whether or not this is the car right for its needs. However, since the price of no optional equipment is shown (the customer will not precisely know what he/she is paying for and how much!) and no information about how much will the customer taxes and other costs, this technical characteristic has been rated for brumbrum SpA with 6 over 10 points.
Autoscout24 has the lowest grade on this technical characteristic (3) since its online platform does not even make a distinction between standard and optional equipment (obviously, their relative prices are not shown too) and many times taxes and other costs are not shown too. Most of the times it is not even specified that the price shown in the car profile refers just to the case in which the financing option is chosen.
MiaCar detailed product information level has been evaluated as a 10 over 10. Indeed, in the car profiles of MiaCar online platform all the information present in car profiles of the competitors are present (except for the brief description of the car present in brumbrum SpA online website). Moreover, the price of each and every optional equipment is specified as well as the amount to be paid for taxes and other costs such as change of ownership for zero-kilometer cars. Information about financing is very detailed and if needed further description of standard and optional equipment is present too. For instance, the car “BMW 2 series 216d Active Tourer Advantage” can have the optional equipment called “Urban Connect Pack”. In the car profile, it is clearly shown that this optional includes components such as head-up display, WLAN hotspot Wi-Fi and BMW remote services. In this case, the target has to remain at the same level of the current one since MiaCar has already achieved what can be called the maturity level of improvement of this technical characteristic.
Categories list to be used to filter research results when looking for a product in MiaCar website are:

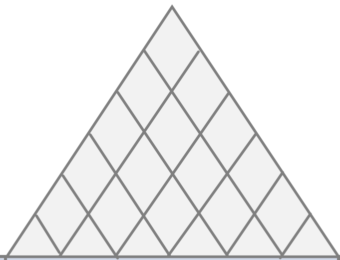
- car brand and model (for instance, brand “Citroën” and model “C3 Aircross”),

- type of car (i.e., city car, station wagon, SUV, etc.),
- type of fuel system (i.e., diesel, gasoline, hybrid, etc.),
- promotion type (namely, if the price refers to a zero-kilometer or a new car, or if it is possible to buy it just in the case the customer has an old vehicle to scrap),
- type of car shift (automatic, manual or sequential gearbox),
- type of wheel-drive car (rear-wheel drive car, front-wheel drive car and four-wheel or all-wheel drive car),
- color of the car,
- intervals of price budget,
- installment loan level,
- city where the car dealership (or car showroom) is in.

The categories by which cars can be filtered in the online platform of AutoScout24 is very large. Just some of them are listed below:

- car brand, model and version (for instance, brand “Citroën”, model “C3 Aircross” and version “PureTech 110 S&S EAT6 Shine”),
- type of car,
- car model year interval (for example, customers can search just for cars produced just between 2015 and 2017),
- type of fuel system,
- bargain level (customer can find cars by the level of discount),
- country and city where the cars are in (AutoScout24 differs from MiaCar also because it is not present just in the Italian market),
- distance in kilometers the car has been driven until now (it is quite important for AutoScout24 cars since also used-cars are present in the website),
- number of seats and doors,
- equipment (both optional and standard),
- type of car shift (automatic, manual or sequential gearbox),
- type of wheel-drive car (rear-wheel drive car, front-wheel drive car and four-wheel or all-wheel drive car),
- color of the car,
- intervals of price budget.

The worst one is clearly brumbrum SpA since the only mean of filtering is the promotion type (new, zero-kilometer or used cars). Then, a list of all the cars present in these categories is present and if the customer wants to find in an “easier” way the car he is looking for, he/she can always send an e-mail to the firms’ operators.
Since AutoScout24 recover all the possible car categories its evaluation has been equal to 10 over 10, whereas MiaCar has obtained a 7 because of the lack of some of them, while 1



Customer Requirements	Degree of importance	Relative importance	Detailed product information	Easy product categories list	Easy-to-find website	No advertisement	Number of cars in the website	Usability	Current model of MiaCar	AutoScout24	Brumbrum SpA	Targets of the new model	Improvement Ratio	Strength	Absolute weight	Relative weight
			Technical Characteristics													
Design style	8	17%	△	⊙		⊙	△	⊙	7	4	8	8	1.14	1.0	9.1	14.7%
Easy product selection	7	15%	⊙	⊙		△		○	9	7	6	9	1.00	1.2	8.4	13.6%
Easy to compare cars	7	15%	•	•				○	7	6	3	7	1.00	1.2	8.4	13.6%
Fast search engine	3	7%					••	○	6	7	5	6	1.00	1.0	3	4.9%
Information quality	10	22%	••	○			△	△	9	2	3	10	1.11	1.5	16.6	26.9%
Information quantity	9	20%	•		△		•		10	2	2	10	1.00	1.5	13.5	21.9%
Interface ease-of-use and simple layout	2	4%		•		○		•	7	9	8	8	1.14	1.2	2.7	4.4%

Technical importance	3.12	2.16	0.2	0.74	1.54	1.67
Technical relative importance	33%	23%	2%	8%	16%	18%
Absolute weight	3.32	2.11	0.22	0.67	1.54	1.53
Relative weight	36%	23%	2%	7%	16%	16%

Figure 5.5.4 Final QFD matrix for MiaCar quality assessment

over 10 is the assessment for brumbrum SpA in terms of the level of “easy product categories list” because it has almost no category to be used for filtering the products in the platform. The results of the technical benchmarking assessment give some important managerial implications. For instance, “no presence of advertisements in the website” cannot be related to what John Berra defines “the competitive advantage coming from quality” (Automation

World, 2013), since none of the three online platform analyzed have any kind of advertisement in it. It can be seen more as a standard required by the customers in order to stay focused on the research of a car instead of looking at advertisements that can easily distract and sometimes even irritate them.

Moreover, by looking at both the first and the second phases of the technical comparison phase just performed, it comes out that the priority is to improve the technical characteristic "easy product categories list" since it is not at the highest quality level of the market (AutoScout24 has clearly a better performance) and, as already seen, it has a relative weight very high. A very important strategic goal in terms of quality has already been achieved by MiaCar since the technical characteristic with the highest relative weight ("detailed product information" with 37%) has already the highest, and theoretically unimprovable, value in the market (10 over 10).

It is important to notice that, despite of the fact that AutoScout24 has the highest value in the benchmarking assessment, the target of the new model with respect to the technical characteristic "easy-to-find website" has been kept equal to the current model value since its relevance is pretty low (its relative weight is 2%).

For what concerns the number of cars present in the website, it can be easily noticed that both MiaCar and brumbrum SpA have a very low quantity of products with respect to AutoScout24. For instance, in 14th July 2018 the number of cars of MiaCar amounted to 1904, while in the website of AutoScout24 there were more than 50,000 cars available.

However, it must be said that it can be considered as an acceptable level since this is mainly due to the fact that both are startup. Obviously, startups have the need to grow fast (and faster than incumbents like AutoScout24) in order to survive by exploiting network externalities, therefore the number of cars in the website must increase dramatically in the next 2-3 years.

Finally, for "usability" it can be said almost the same concepts utilized when talking about "detailed product information" since it has a high relative importance (16%), MiaCar has the highest value (with respect to its main competitors) and the target value has been kept equal to the one of the current model.

Notice that the final QFD matrix for the MiaCar case is shown in Figure 5.5.4.

Chapter 6

AHP MODEL: METHOD VALIDATION AND ROBUSTNESS

The choice to apply the AHP method for finding the values in the relationship matrix has been guided by the high robustness of the method itself. Indeed, this method has been widely utilized to support the creation of the QFD matrix. A practical case study that uses it and does a first analysis of robustness of the method has been conducted by Bakshi, T., Sarkar, B. and Sanyal, S. K. (2012).
In this subsection, a sensitivity analysis of the method will be performed in order to have a basic assessment of its robustness.

6.1 Sensitivity assessment

The sensitivity analysis will be done with respect to the values of the pairwise comparisons to see how much the overall result is affected by (how much it is "sensitive" to) changes in the importance value of the customer requirements with respect to the technical characteristics of the relationship matrix.
Basically, little changes in the pairwise comparisons values will be applied in order to see if small alterations do cause big variations in the relative weight values for the technical characteristics found in the subsection 5.1.5 (shown in Figure 5.5.3). In such a case, the AHP method would be considered as not robust, therefore another method should be adopted for the study.
Thus, it is quite relevant to better define what "big variations" means in this case. In this context, "big variations" in the values of interest (relative weights for engineering/design requirements) stand for all the numerical values that are not inside of a certain "interval of confidence".

These confidence intervals have been determined in such a way that gives them a width equal of the 5% of the total value. Thus, for a general percentage value x, the confidence interval will be:

$$Confidence\ interval = x \pm 0.05$$

For instance, if referring to the technical importance of the technical requirement "Detailed product information", the confidence interval that will be considered is computed as:

$$Confidence\ interval = 0.36 \pm 0.05$$

Namely, the confidence interval will be [31%; 41%].
The sensitivity analysis will be performed in the three different ways:

- changes in the pairwise comparisons will be applied just on the variables with the highest relative weights ("most relevant variables") in order to see if they keep the highest values,
- the same will be done for the variables with the lowest values ("least relevant variables") to check if they still have low percentage values,
- variations to the values in the pairwise comparisons will be performed on both relevant and irrelevant variable to check if they keep the highest and the lowest percentage importance values respectively.

The following subsections of the chapter will give a deep description of these three analyses, with the aid of the SuperDecisions software for looking at the final results to be discussed in order to check whether or not the AHP model is enough robust for the creation of the values inside the Relationship Matrix

6.1.1 Sensitivity assessment on the most relevant variables

The first sensitivity analysis will be done on the most relevant variables, in terms of relative weights of customer and engineering/design requirements (namely, the ones with the highest percentage values).
Therefore, the variables of the study will be:

- "detailed product information" and "easy product categories list" as technical requirements for a total of 59% of the technical relative weights,
- "information quality", "information quantity" and "design style" as customer requirements (63.5% of the customer relative weights).

With respect to the SuperDecisions software, this simply means that some values of the node comparisons with respect to "design style", "information quantity" and "information quality" will be changed in order to see how much a little variation of these value affects the final results (technical relative weights) shown in the lowest part of the QFD matrix.

More precisely, it has been decided that every pairwise comparison between one of the two customer requirements of interest ("detailed product information" and "easy product categories list") and the others will be increased by 1 unit with respect to them, while the comparison between them will be kept the same as before.
For instance, in the example of Figure 5.6.1, the value of the pairwise comparison between "detailed product information" and "number of cars in the website" (that refer to the values chosen in the subsection 5.1.3) will be moved from the neutral value (1) to a value that is closer by one unit to "detailed product information" (the blue value of 2 in left-side of the "questionnaire matrix" shown in figure 5.6.1).

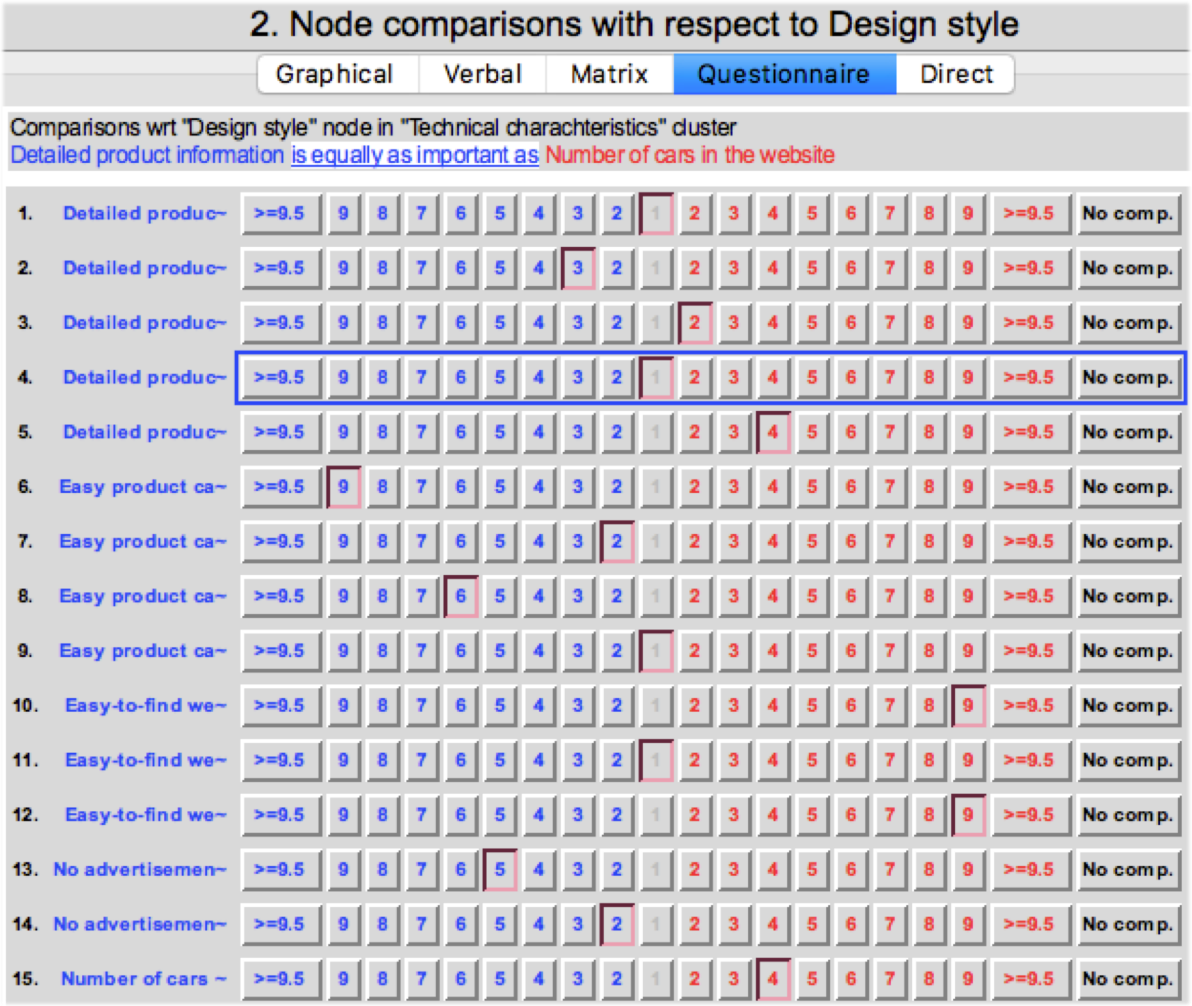


Figure 5.6.1 **Pairwise comparisons of all the customer requirements with respect to the technical characteristic "Design style"**

Obviously, also the values in the SuperMatrix, shown in Figure 5.4, will be directly affected by these small variations (see Figure 5.6.2). By converting these values in the appropriate way for the relationship matrix (described in the previous subsection of this chapter), the relative weights can be found for technical characteristics. These results can be seen in Figure 5.6.3.

Notice that some columns and rows have been omitted, this means that the values inside of them did not change with respect to the ones found previously (see Figure 5.5.4).

As foreseeable, the absolute weights of the technical characteristics "detailed product information" and "easy product categories list" increased, while for the others they decreased (except for usability, since the value in the relationship matrix with "easy product selection" has dramatically increased from 2 to 5).

Cluster	Node Labels	Customer Requirements						
		Design style	Easy product selection	Easy to compare cars	Fast search engine	Information quality	Information quantity	Interface ease-of-use & simple layout
Technical charachte ristics	Detailed product information	0.152688	0.190892	0.382185	0.047634	0.506238	0.455000	0.036295
	Easy product categories list	0.334541	0.197058	0.378280	0.047634	0.249684	0.066623	0.343644
	Easy-to-find website	0.030817	0.024621	0.026358	0.047634	0.033143	0.039787	0.036295
	No advertisement	0.218882	0.074463	0.028088	0.047634	0.034241	0.039787	0.204637
	Number of cars in the website	0.045939	0.023425	0.033869	0.566497	0.110128	0.359015	0.035485
	Usability	0.217133	0.489540	0.151220	0.242967	0.066565	0.039787	0.343644

Figure 5.6.2 SuperMatrix after variations in the pairwise comparisons

Nonetheless, all these variations in the absolute weights can be considered as relatively small since the relative weights of the technical characteristics did not register any noticeable change. Indeed, "detailed product information", "easy product categories list" and "easy to find website" have been subject of an increase in their relative weights of about less than 1% with respect to the previous values.

The technical requirement called "no advertisement" registered a very decrease in its relative weight (from 7% to 6%), while for "number of cars in the website" it decreased by 2%. The most noticeable result in this analysis has been the change in the relative weight of "usability". In fact, it decreased by around 3%.

Therefore, since none of these percentage changes has been higher than 5% and according to the width of the confidence interval of these values, this first sensitivity assessment can be considered as positive.

Thus, it has been demonstrated that the AHP method has a high robustness if changing values of the technical characteristics and customer requirements that have the highest impact in terms of relative weights.

		Technical Characteristics							
		Detailed product information	Easy product categories list	Easy-to-find website	No advertisement	Number of cars in the website	Usability	Absolute weight	Relative weight
Customer Requirements	Design style	○	⊙		○		○	9.1	14.7%
	Easy product selection	○	○		△		••	8.4	13.6%
	Easy to compare cars	•	•				○	8.4	13.6%
	Fast search engine					••	○	3	4.9%
	Information quality	••	○			△	△	16.6	26.9%
	Information quantity	•	△	△		•		13.5	21.9%
	Interface ease-of-use and simple layout		•		○		•	2.7	4.4%
	Absolute weight	***3.33***	***2.19***	***0.22***	***0.52***	***1.34***	***1.79***		
	Relative weight	***36%***	***23%***	***2%***	***6%***	***14%***	***19%***		

Figure 5.6.3 Relationship matrix with relative weights of the first sensitivity analysis

6.1.2 Sensitivity assessment on the least relevant variables

As done for the variables with the highest relative weights, the sensitivity assessment will be performed for the customer requirements and the technical characteristics with the lowest relative weights (namely, the least relevant variables).
Therefore, these variables will be:

- "easy-to-find website" and "no advertisement" are the technical characteristics selected for the assessment (9% of the overall relative weights),
- the customer requirements chosen are "fast search engine" and "interface ease-of-use and simple layout", corresponding to the 9.3% of the total relative weights.

By following the same steps made when dealing with the most relevant variables, the Super Matrix has been modified in order to find the final relative weights whose values are shown in Figure 5.7.
increased) as well as for “usability”.

		Technical Characteristics							
		Detailed product information	Easy product categories list	Easy-to-find website	No advertisement	Number of cars in the website	Usability	Absolute weight	Relative weight
Customer Requirements	Design style	△	⊙		⊙		⊙	9.1	14.7%
	Easy product selection	⊙	⊙		△		○	8.4	13.6%
	Easy to compare cars	•	•				○	8.4	13.6%
	Fast search engine			○	△	•	⊙	3	4.9%
	Information quality	••	○			△	△	16.6	26.9%
	Information quantity	•		△		•		13.5	21.9%
	Interface ease-of-use and simple layout		•		○		•	2.7	4.4%

Absolute weight	***3.32***	***2.11***	***0.23***	***0.76***	***1.34***	***1.58***
Relative weight	***36%***	***23%***	***2%***	***8%***	***14%***	***17%***

Figure 5.7 Relationship matrix with relative weights of the second sensitivity analysis

The results clearly show that the analysis has brought only positive outcomes, confirming the robustness of the method with the least relevant customer requirements and technical characteristics. Indeed, despite the fact that the absolute weights registered some variations (noticeable is the increase for the technical characteristic “number of cars in the website” that goes from to 1.54 to 1.34), the relative weights clearly show that there is no significant variation. As before, the percentage changes of “detailed product information”, “easy product categories list” and “easy-to-find website” are less than 1%, while for “no advertisement” it changed by 1% (in this case it increased instead of decreasing). The relative weight of the technical characteristic called “usability” increased just by a factor of 1%. With respect to the values shown in Figure 5.5.4, the highest percentage variation that has been registered is the one for “number of cars in the website” (it decreased by a factor of 2%) that is even lower than the highest one found for highly relevant variables (3%).

6.1.3 Sensitivity analysis to high and low relevant variables at the same time

The last analysis of sensitivity will be performed on both variables with low and high relative weights at the same time.
In this case, for the variables with the highest relative weights their values in the pairwise comparison will be decreased by a factor of 1 unit, except when they are compared to each other (in these cases, their value is kept the same as the initial one). The opposite is done for the variables with the lowest relative weights: they will be increased by a factor of 1 unit if not compared to each other.
Instead, when comparing the most relevant variables to the least relevant ones, the values will be shifted by one unit in the direction of the latter ones. Therefore, the pairwise comparisons that will be changed will be the ones containing at least one of the following technical characteristics: “detailed product information”, “easy product categories list”, “easy-to-find website” and “no advertisement”.
These changes will affect the pairwise comparisons of the customer requirements “information quality”, “information quantity”, “design style”, “fast search engine” and “interface ease-of-use and simple layout”. Figure 5.8 shows the relationship matrix with the final relative weights obtained by changing the values in the pairwise comparisons of the SuperDecisions software, in the way just described.
The results are very positive. Indeed, despite the fact that more diversified variations are present in this third sensitivity analysis (absolute and relative weights changed for all the technical characteristics except for “detailed product information” who are still 3.32 and 36% respectively), the percentage changes are still not enough significant to state that the AHP method has a low degree of robustness. In particular, the results can be highlighted as follows:

- “easy product categories list” registers a considerable decrease in absolute weight (from 2.11 to 1.93), but a very low variation in its relative weight (2%),
- both absolute and relative weights of “easy-to-find website” double,
- “number of cars in the website” and “usability” decrease by a factor that has not reached an alarming level (2%),
- “no advertisement” is the technical characteristic with the highest percentage change (3%), but it is still lower than the constraint given by the confidence interval (5%).

Customer Requirements	Detailed product information	Easy product categories list	Easy-to-find website	No advertisement	Number of cars in the website	Usability	Absolute weight	Relative weight
	Technical Characteristics							
Design style	△	⊙		⊙		○	9.1	14.7%
Easy product selection	⊙	○	△	△		○	8.4	13.6%
Easy to compare cars	•	•				○	8.4	13.6%
Fast search engine			△	△	••	○	3	4.9%
Information quality	••	○			△	△	16.6	26.9%
Information quantity	•		△	△	•		13.5	21.9%
Interface ease-of-use and simple layout		⊙		⊙		⊙	2.7	4.4%

Absolute weight	***3.32***	***1.93***	***0.40***	***0.97***	***1.34***	***1.34***
Relative weight	***36%***	***21%***	***4%***	***10%***	***14%***	***14%***

Figure 5.8 Relationship matrix with relative weights of the third sensitivity analysis

6.1.4 Sensitivity analysis: overall result and conclusions

The sensitivity assessment of the AHP model that has just been performed in three different steps, has brought different outcomes. The aim of this subsection is that of analyzing the overall impact of all these outcomes in order to be able to say whether or not using the AHP model with the aid of the Super Decisions software has been the right decision for this study. If not, other methods can be used. For instance, surveys with a 1 to 5 or 1 to 10 importance scale are widely used in this field.

As already highlighted, the outcome of the first sensitivity analysis on the most relevant variables has been quite positive. In fact, no relative weight has been subjected to a percentage variation that was more than the confidence interval width (5%). By looking at these data, it can be also noticed that the maximum variation has been 3%, the mean of all the variations has been 1.5% and the mode has been 0.5% since three technical requirements over a total of six have registered this value.

Notice that all these values are quite lower than 5%. For simplicity, the variations lower than 1% will be taken as equal to 0.5% when computing the mean.
Even better has been the outcome coming from the second sensitivity analysis made on the least relevant customer requirements and technical characteristics. Indeed, the maximum value among all the percentage changes of the relative weights has been just 2% (for the technical characteristic called “number of cars in the website”). The mean has been just 1.1%, while the mode has been 0.5% as in the previous sensitivity assessment because also in this case three technical requirements have been subject to this increase of their relative weights.
The last sensitivity assessment has brought almost the same outcomes of the first one. Indeed, also in this case the highest percentage variation of the technical relative weights has been equal to 3% (for the engineering/design requirement called “no advertisement”). However, it must be said that in this case, mode and mean have registered quite higher values than for both previous analyses. In fact, the mean has been equal to 2.3% and the mode has been 2% with even four technical characteristic that have had this percentage variation of their relative weights.
By looking at these results in a broader perspective, it can be said that the overall maximum, mean and mode of percentage changes of the relative weights for the technical characteristics have been 3%, 1.63% and 0.5% respectively. This means that, since none of these values is higher than (and not even close to) 5% and according to the sensitivity analysis performed, it can be stated that the AHP model can be considered as a robust method to be used for the QFD analysis of this study and no other method is needed in order to assure total trustworthiness of the values shown in the relationship matrix.

Chapter 7

Final conclusions and managerial implications

By performing the Quality Function Deployment analysis, with the aid of SuperDecisions software for applying AHP model in order to create the Relationship Matrix, this thesis has helped the startup company called MiaCar S.r.l. to make a technical and as objective as possible assessment to the degree of quality perceived by the customer and the technical team. The results obtained clearly have shown that the overall level of service quality offered by the online platform of MiaCar is high both in terms of quality perceived by the customers and with respect to competitors in the market.

However, it has been also demonstrated that some technical requirements should be improved in order to increase customer satisfaction on the service. In particular, by looking mainly at a technical perspective of the service, what should be firstly improved is the possibility to allow the customers to list in an easy and simple way the products (i.e., cars) by different categories. Improving this performance should not be a very trivial task since what should be done is just to add other filters of car selection, such as “car model year interval” and “bargain level”.

By taking into consideration in a more direct way the customer needs, it has been discovered that the most important website characteristic is information quality. It has been also showed that MiaCar has already a very high level of information quality (the highest in the market), since in its online platform many different information are given in a quite clear way.

Despite of that, some improvements should be made in the way information is generated. Indeed, as highlighted in chapter four, the data entry process (where car profiles are charged on the website) is a quite manual one. That means that mistakes in information happen very frequently, then directly affecting the quality of information. The top management of the firm has given priority to this task and is currently deciding what actions should be

undertaken. In particular, three main possible paths to follow arose: outsource the data entry process to another firm, dramatically change the process by making a very quick automatization or gradually automatize the process.
Since choosing one of them is not a trivial task as it could seem, these three possible solutions will be briefly analyzed in the following subsections of the chapter by taking into accounts both their benefits and drawbacks.

7.1 Outsourcing of the data-entry process

Outsourcing is one of the most effective activities in contemporary business, because many companies try to use all innovations of science, techniques and technologies to issue qualified and competitive product which will satisfy consumer. This situation is very usable for both parts, because each of them can concentrate its resources on development of core competencies and prospective directions of activity (Tayauova, G. 2012).
Outsource the process of data entry in MiaCar is becoming a feasible solution since a firm expert in this sector has recently made this proposal.
Despite the fact that the initial idea was just to figure out which way to automatize the process should be followed, the benefits of this opportunity have to be at least considered. In fact, by looking at it in pure economic terms it seems reasonable if considering the trade-off with organizational benefits. Indeed, this solution would allow MiaCar not to care anymore about this process and to focus in other processes such as customer relationship management (both car customers and car dealerships/showrooms).
However, many drawbacks can be registered in this case. Indeed, the loss of control over the data-entry process would inevitably and drastically change the operational and strategical importance of data entry operators that accumulated experiential knowledge on the process over the time. This allowed the arising of gatekeeper figures always available to solve problems concerning the data-entry process. Thus, in this case all their knowledge would become useless and therefore they would immediately shift from being a strength to a burden for the firm.
Then, by choosing this solution the firm would incur in more costs and would have the issue to manage the new situation the data-entry operators would be in. Moreover, the outsourced firm should need also time to learn how to efficiently perform this task.
Mainly for these reasons, this option should not be undertaken.

7.2 Quick automatization of the data-entry process

This solution would surely affect in a positive way the speed of the process. Therefore, more cars would be available in less time.

However, two main drawbacks would arise in this case:

- Data-entry operators would lose their importance.
- In order to obtain a quick automatization, the firm should hire new software developers (until today MiaCar has just two software developers) that would mean more costs with respect to a gradual automatization (in which the hiring of new software developers would not be necessary).

Deciding whether or not to undertake this project strictly depends on the firm’s priority. If the priority is to improve immediately information quality the project should be undertaken, while if budget constraints are very tight it should be chosen another solution.

7.3 Slow automatization of the data-entry process

The best solution that would solve both organizational and budget issues seems to be the gradual and slow automatization of the data-entry process.
In fact, it would give enough time to data-entry operators to acquire new competencies (such as in the marketing field or in making phone-calls to car customers and/or car dealerships) while still being of relevant importance to the firm daily activity of charging car profiles into the online platform.
The cost of this slow automatization would be relatively low (surely lower than in the case of a quick automatization) since just the two already hired software specialists should be needed for the process since there is no rush.
The only drawback that can be considered in this case is the relative high number of mistakes that will be still present in the process. Nonetheless, they will be gradually decreasing with the development of the process.
Again, choosing between a slow and a quick automatization of the data entry process depends just on the firm’s priorities. Despite of that, undertaking a project that would lead to a gradual automatization surely seems the most reasonable solution with respect to the current situation MiaCar is in.

7.4 What can be done in the future?

This brief subsection has the aim of giving personal suggestions on what Miacar should do in the future in order to improve its actual situation.
Firstly, even if the study suggests that the current level of service quality of Miacar can be considered as relatively high with respect to its competitors, I would personally suggest the top management to focus more on this task since in my view, the actual quality level should give just a competitive advantage that is not sustainable. This thought is also supported by

the fact that many other firms are looking quite interested at this market and new entries are very probable. Moreover, it must be mentioned also the fact that Amazon is (still) in this market (Corriere della Sera, 2015) despite of what can be defined as a “first failure”.

The second suggestion that will be given is exclusively about the type of products that should be shown in the online platform. I personally think that the choice to help car dealership on selling just new and zero-kilometer cars has been quite acceptable in strategic terms until now. Indeed, the majority of cars sold in the market are new and zero-kilometer cars, while the used-cars sales are decreasing (La Stampa, 2018). At the same time, dealing with just new and zero-kilometer cars allows the firm to achieve more easily customer trust do to a lower level of defected cars than the one that can be registered when dealing with used cars. However, I think that dealing also with used cars is a must in this sector for two reasons: it can be used to avoid that competitors make too much profits in this niche of market that could be used to promote new and zero-kilometer cars in the future and to hear even more the Voice of the Customer (VoC) since people that would like to buy these cars are still relevant.

The third and last suggestion is merely about the design style of the car profiles. In particular, what I would suggest is to give more than just profile pictures by showing cars in a 3d model. Indeed, many car configurators already use 3D car picture models that allow the customer to see almost the same car features that could be seen by going physically to the car showrooms and car dealerships.

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