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Does customer satisfaction impact linearly on loyalty and retention levels?

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by

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ABSTRACT

Considering the highly competitive telecommunications market, Mobile Service Providers need to understand the concepts of customer satisfaction, loyalty and retention since they have become important keys to help creating strategies to retain their customers. This dissertation intends to have a deeper knowledge about the impact (linear or nonlinear) of satisfaction on loyalty and retention levels, in other words, to understand what persuades a satisfied customer with prior consumption experience to become loyal to the respective company or service and remain loyal even if, in the future, the company/service does not always live up to expectations. Moreover, it is essential to understand which are the determinants influencing these two main variables. After a review of the literature on the most important antecedents, it is presented an adaptation of the ECSI model, introducing one new variable, Trust, and eliminating one variable, Claims. Regarding the methodology, it was used an online questionnaire and it was obtained a final sample of 371 participants. Data processing was done through a statistical analysis with SPSS, followed by an analysis of structural equations using the SmartPLS3 program and an analysis of the adjustment of the model in R software. The results showed that, in general, the respondents were satisfied with their mobile service. It was also concluded that satisfaction has a positive impact on loyalty as well as the antecedents of satisfaction. However, there is evidence to affirm that this relationship between customer satisfaction and customer loyalty is not linear and tends to have a better fit with models that have curvatures. Furthermore, it was proved that the variable Trust has a mediator influence on the Customer Satisfaction-Customer Loyalty relationship. This study contributes to the telecommunications market in order to understand possible points of improvement where respondents are less satisfied with. Additionally, it may help to better understand how satisfaction affects loyalty and how that relation evolves with the increase of satisfaction.

KEYWORDS

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LIST OF ABBREVIATIONS

CS   Customer satisfaction

CL   Customer loyalty

MTS   Mobile Telephone Service

ESCI   European Satisfaction Customer Index

SEM   Structural Equation Modelling

PLS   Partial Least Squares

OLS   Ordinary Least Squares

AVE   Average Variance Extracted

VIF   Variance Inflation Factor

GLM   Generalized Linear Model

GAM   Generalized Additive Model

1. INTRODUCTION

1.1. BACKGROUND AND PROBLEM IDENTIFICATION

The telecommunications industry has developed significantly over the last decades with the improvement of all the current technologies. Mobile phones have become essential these days and people from any generation can no longer spend a day without using it, whether it is to talk to a family member or friend, to check social media networks and/or emails or to access the internet. People can do everything through their mobile phone and it is a daily need for almost everyone.

As in every industry, telecommunications' consumers are demanding more and becoming more critical regarding the quality of the services as technology evolves. Companies must keep up with this constant change in order to remain competitive. Due to this competitive market, all mobile telecommunications service providers are willing to implement competitive prices and attractive promotion packages with the purpose of attracting new consumers or at least retaining the existing ones (Lim et al., 2018). A rise of 5% in customer retention levels can generate an increase by almost 100% in the profit of the company (Reichheld and Sasser, 1990).

Nowadays, with such competitive market, there is an enormous probability of losing customers and attracting new ones has a big cost. According to Kotler (2000), it is between five to seven times more expensive to attract a new customer than to retain an existent one. Therefore, companies are looking for strategies to retain their current customers.

Ahrholdt et al. (2016) defend that organisations started to give more attention to the level of the service they provide to their customers in order to be able to get more satisfied customers, which can lead to better loyalty from them. Due to this, there have been many researchers studying the quality of the service and trying to understand which are the factors that affect customer satisfaction and loyalty in order to improve the performance of the service industry (Parasuraman et al., 1988).

In accordance with Ahrholdt et al. (2016), Oliver (1997) state that the primarily objective for these companies is or should be the construction of loyalty from their consumers. Behind the achievement of customer loyalty there are several factors and determinants. There is a higher chance of customer loyalty being achieved if the customer's satisfaction is earned (Oliver, 1999), since satisfaction leads to a rebuy and a positive word of mouth (Kumar et al., 2013; Hallowell, 1996; Oliver, 1997) and, consequently, to an expanded customer base. Spreading a positive word of mouth matters significantly because even though people may have different tastes and opinions, if a family member or a friend recommends and praises a service or product, people will be more curious and tempted to try it and confirm that opinion. For this reason, it is relevant to satisfy as many customers as possible, in order to achieve a positive word of mouth which leads other people to also try and/or buy the service/product. Both Jones and Sasser (1995) and Oliver (1999) defend that loyal customers are not necessarily satisfied customers, whereas satisfied customers tend to be loyal customers. Moreover, satisfaction is considered the foundation for the success of any company (Hallowell, 1996; Oliver, 1997). In any business is necessary to put the customers and their satisfaction before the profit, since only with the customers' satisfaction achieved will the company succeed and remain in the top position in the market. Moreover, an organisation cannot exist without customers, thus it is very important to give priority to their customers' satisfaction.

Understanding whether improvements in customer satisfaction influence customer loyalty and how to hold it is crucial for companies across an extensive range of industries. There are different opinions about how and in what ways customer satisfaction affects customer loyalty and retention levels although knowledge about these aspects remains theoretically and empirically ambiguous. Companies are struggling to understand how to increase their profit margins through customer satisfaction and loyalty. The best way is to understand how they relate and how one influences the others in order to know what to improve in the company according to customers' opinions.

1.2. STUDY RELEVANCE AND IMPORTANCE

Compared to other industries, the telecommunications industry is one of the most demanding of customer loyalty, since it is a very competitive market and customers can easily change the service provider (Muhammad et al., 2016). The telecommunications sector is decisive and plays an increasingly important role not only in society but also in the economy of the countries. Understanding how customer satisfaction influences customer loyalty helps organisations to evaluate how they can improve the services they offer to clients and lead to sustained success in the long term.

This study will provide real feedback on how consumers are feeling about their mobile service provider and present possible factors that customers are dissatisfied with, which will allow the companies from this sector to improve their weaknesses, their customers' satisfaction and hence, get their loyalty. It will also complement the existing literature about the relationship of customer satisfaction with customer loyalty and retention since I will study how much customer satisfaction impacts both of them.

Although my study is more useful to companies from the telecommunications industry, given the high importance this subject has to some competitive markets trying to improve their profits and success, it may be also relevant to companies that seek to grow and remain competitive (Joudeh and Dandis, 2018) and are interested in improving the satisfaction of their customers and understands how it affects their loyalty. The relationships of these three variables are relevant to other industries since they have great importance to corporate management.

1.3. STUDY OBJECTIVES

The aim of this thesis is centered on the analysis of the relationship of customer satisfaction with both customer loyalty and customer retention, where the major objective is to investigate the shape of that relationship and try to refute that this is not a linear relationship and prove an s-shaped relationship. In a first phase, the customer is experimenting the service and its loyalty levels are still low, as he/she does not yet have a formulated opinion about it and, therefore, cannot be a loyal customer to the brand. On a second phase, after they have tried and if pleased with the product, they continue to buy/use it and the loyalty levels to the brand, or company if they were motivated to try another product/service, increase over time. On a third and last phase, the customer is highly satisfied with the service. However, if the service itself is not further developed, the customer's level of loyalty will eventually stagnate. In this advanced phase, when the customer already knows the products/services and tends to repurchase them, it means there are higher levels of loyalty and when something less

favorable happens the levels of loyalty of the customer do not tend to decrease considerably because there is already confidence in the brand.

In order to better accomplish the research objective, it is necessary to set more specific objectives I will want to achieve:

1. Determine the level of customer satisfaction with the mobile service through the questionnaire. This may allow the mobile service operators to have a better perception of the level of satisfaction of their customers. This will also allow the operators to understand whether or not they should make improvements in the service provided in order to improve customer satisfaction and better satisfy their needs, as it is a competitive and easy to change market.

2. Identify the most important factors that may influence customer satisfaction and, indirectly, customer loyalty. Therefore, the operators will be able to improve the competitiveness between them and the results obtained may help to identify which aspects must be maintained and/or improved in order to achieve satisfaction and consequently, the loyalty of most of the customers.

3. Analyse the relationship between customer satisfaction with both customer loyalty and retention levels, and the impact it causes by checking to what extent satisfied customers stay more or less loyal to a brand or service. The intention is to confirm or disconfirm not only the significant influence of customer satisfaction on customer loyalty but also the non-linear impact of customer satisfaction on customer loyalty.

1.4. STRUCTURE OF THE DISSERTATION

The dissertation is organized as follows:

➢ *Introduction*. This chapter provides the general introduction where it includes the background and problem identification, the relevance of the study and the objectives.
➢ *Contextualization of Mobile Telecommunications Market*. Here, the mobile telecommunications market in Portugal is described, the importance of the mobile phone and the main operators of this service are designated;
➢ *Literature Review*. The literature review is carried out on the more relevant concepts to this study, namely satisfaction and loyalty and the antecedents of these concepts such as image, expectations, perceived quality, perceived value and trust;
➢ *Methodology*. The adopted model is presented here, as well as the methodology and model estimation to be used and how the data collection was made operational;
➢ *Discussion of the Results*. This chapter analyses and discusses the results obtained from the data collected from the questionnaire for this research;
➢ *Conclusion*. The main conclusions that meet the results and the respective discussion highlighted in the previous chapter are discussed;
➢ *Limitations and Recommendations*. Some limitations found in the present study will be pointed out as well as some recommendations considered to be fundamental for the elaboration of future studies in this area;

➤ *Bibliography* and *Appendix*. These two last chapters present all the bibliography used and the annexes needed for the study, respectively.

2. CONTEXTUALIZATION OF MOBILE TELECOMMUNICATIONS MARKET

2.1. IMPORTANCE OF THE MOBILE PHONE

Similar to the fixed-line telephone networks, the mobile phone was invented with the potential to revolutionize many of the everyday life aspects (Green et al., 2001). The introduction of these small and portable telecommunications devices has completely changed the ways that people establish their social relationships, both at home and at work. Nowadays, the fact that people can always be contactable and resolve professional problems or situations through the mobile phone, provides less quality time for family and leisure. Therefore, the mobile phone has come to change the way people relate in their day-to-day. The mobile phone, together with the house keys and the wallet, are considered to be the three essentials that people cannot leave home without.

Since the appearance of the first mobile phones until now, many have been the developments at the technological level, at the level of services provided and at the level of pricing plans offered to consumers. The new generation of mobile phones already allows access to different goods and services online, where the mobile phone owner gathers almost all features that people would only have access from their computers before. Currently, we can access everything through our mobile phones, we can access the internet, the bank account, social media and we can also shop online or watch television. The mobile phone has brought many advantages but also disadvantages.

On the one hand, mobile phones and technology have enabled people to get closer even though they are separated by the ocean with the possibility of being in contact 24/7 and making video calls. The invention of the mobile phone allowed people to have a real time conversation at distance, this was a huge mark. It also facilitates planning and coordination of everyday aspects, being always "contactable" to others (Katz and Aakhus, 2001). Not that long ago, people did not know where another person was or what he/she was doing until you can reach them personally. Children and teenagers used to play on the streets and the parents could not know if it was everything okay until they got home. Nowadays, we live a completely different reality since almost all the population has a mobile phone and is reachable. People can feel less lonely because they can easier talk and virtually see their loved ones.

On the other hand, it has weakened social relations since people have become much dependent on the mobile phone and disconnect from the world around them when they are using it. It is possible to see families, couples or groups of friends in a restaurant, a cafe or elsewhere each on their mobile phones. Nowadays, it is rare to really see two people together enjoying the moment without caring to what is going on their mobile phone and social media. People meet with friends or family but is communicating through mobile phone with other people. People leave home to go somewhere and if they go on foot or by public transportation, they will spend the whole time looking at the phone, sometimes people don't even know what to do or see at the phone anymore but they still wasting time looking at them. This led to the loss of face-to-face conversations and being even present living the moment. People are losing sight of reality a bit and watching what is going on around them. Children nowadays play differently, instead of going out to play, they prefer to stay at home playing games on the internet on their mobile phones or computers. They are addicted to internet and mobile phones as the other generations. It is disturbing the process of people developing certain social competencies, such as the reaction to encounters unexpected or the participation in conversations whose topics are

unknown (Geser, 2004). Moreover, Katz and Aakhus (2001) defend that the mobile phones are accused to be the cause to lose control of life as it provides that barriers between public-private sectors are broken.

2.2. MOBILE TELECOMMUNICATIONS IN PORTUGAL

Today, telecommunications play an important role not only in society but in the economy of countries. In Portugal, during 2004 the mobile phone penetration rate had already exceeded 100%, that is, there is more equipment than Portuguese inhabitants (ANACOM, 2009). This led to, once more, the mobile telecommunications operators to figure out the best way to retain their customers.

With new technological developments and the increase in mobile phone penetration in Portugal, customers are more demanding, therefore, rising the number of mobile operators constantly and offering new products and services.

At the national level, the mobile communications market has been able to maintain a certain degree of competitive dynamism, thanks to innovative solutions in terms of promotions and campaigns, and consequent widespread use of mobile phones, where the main beneficiary is the customer. The offers from the service providers are, in general, very diverse being very suitable to the various consumption profiles of Mobile Telephone Service (MTS) users. The tariffs made available by the mobile network operators are characterized by the payment options and the type of users they are intended for. Thus, there are prepaid offers characterized by the existence of an advance payment for the provision of the service; postpaid offers characterized by the payment of consumptions after they have been made and there are also hybrid tariffs that combine different forms of payment.

The Portuguese mobile communications market has historically been distinguished by the high incidence of pre-paid tariffs. Portugal was pioneering of this form of payment and it allowed the acquisition of MTS to be more appealing to the consumer, being considered as one of the main reasons for the high penetration rate of MTS in Portugal, since it allows customers to pay according to their needs having better control of their expenses.

2.2.1. MTS providers

The development of telecommunications in Portugal is currently mirrored in four main operators with the most varied services available to all people in mainland Portugal and islands. These four network operators in activity in the national territory are as follows.

➢ **MEO**
MEO has been operating since 2007 and is a subsidiary of Altice. MEO is the telecommunications operator with the largest market share and the only one that uses all optical fiber, ADSL and satellite to offer its services. MEO used to be called TMN and became MEO in 2014.

➢ **Vodafone**

Vodafone is a global telecommunications operator, headquartered in United Kingdom and present in Portugal since 1992. Provides its services through optical fiber and ADSL. The Vodafone advantages are the access to the fastest optical fiber in the market and the accumulation of discount points in the Viva club. Vodafone used to be Telecel until the change of name in 2001.

➢ **NOS**

NOS is a communications and entertainment group that has been operating since 2013 and offer its services through optical fiber and satellite. NOS was originated in 2014 through the merger of OPTIMUS and ZON TV Cabo Portugal.

➢ **NOWO**

NOWO is the most recent operator being in the market since 2016 and is strongly committed to technological development. Its telecommunications services are the cheapest ones in Portugal and are distinguished by the freedom of choice in the packages it offers in any of the categories: internet, TV, landline and mobile phone. That is one of NOWO advantages and also the possibility to choose only the channels people need.

2.2.2. Penetration rate

According to the report published in March 2021 by the Autoridade Nacional de Comunicações (ANACOM), "Facts & Numbers – 4th trimester of 2020", the penetration rate of mobile service in Portugal at the end of 2020 reached 166.6 per 100 inhabitants which suffered a 4.1% decrease compared to the same period last year. The Portugal penetration rate is above the European Union penetration rate (146.5 per 100 inhabitants). Although if only the accesses with actual use were considered, the penetration rate decreases to 120.0 per 100 inhabitants. Moreover, excluding accesses made by data services and Internet access (cards associated with a computer/tablet/memory stick/router), the penetration rate would be 115.1 per 100 inhabitants. (ANACOM, April 2021)

Table 1 - Penetration rate

		2020	2019	Var (p.p.) 2020/2019	EU average	Deviation from the EU average	Most recent ranking (previous ranking)
MTS	Per 100 inhab.	166.6	170.7	-4.1	146.5	20.1	4th (4th)
MTS with actual use		120.0	120.6	-0.6	n.d.	n.d.	n.d.
MTS with actual use excluding PC/tablet/memory stick/router and M2M		115.1	115.7	-0.5	n.d.	n.d.	n.d.

Unit: %, p.p.

Source: ANACOM

Note 1: In the MTS, Active mobile accesses were accounted for. These are the accesses that are qualified to use the services, but may not have been used.

Note 2: The EU average refers to the values of October 2017.

Note 3: The ranking of Portugal in the EU is determined based on the information available from the countries for the year under analysis.

Note 4: The most recent estimates of the population and classical families, after the 2011 Census, were used.

2.2.3. Active mobile accesses

Regarding the active subscribers, at the end of 2020 there were 17.2 million active mobile accesses associated to post-paid plans, pre-paid plans and combined/hybrid plans, which is a 2.4% decrease compared to the end of 2019 as we can see from Table 2. There are 12.4 million of active subscribers that really used in the last month of the year corresponding to 72.1% of the total, having suffered a reduction of 0.5% compared to the same period last year. Also, if we exclude the number of accesses made through computers, tablets, memory sticks or routers, the number of mobile accesses decrease to 11.9 million. (ANACOM, 2021)

According to INE Portugal, there are around 10 million inhabitants in Portugal. From these values, we can conclude that there are a lot of people with more that only one mobile service.

Table 2 - Mobile Accesses

	2019	2020	Var. (%) 2019/2020
Active mobile accesses	17571	17152	-2.4
Of which associated with M2M	1194	1230	+3.0
Mobile accesses with actual use (excluding M2M)	12421	12359	-0.5
Post-paid and hybrid plans	7294	7605	+4.3
Pre-paid plans	5127	4753	-7.3
Mobile accesses with actual use (excluding M2M and PC/pen/tablet/router)	11910	11855	-0.5

Unit: thousands of mobile accesses, %

Source: ANACOM

Note 1: Active mobile accesses are enabled to use the services, but they might not have been used.

Note 2: Active mobile accesses with actual use are those eligible to use the service and that were actively used during the reporting period, i.e. they recorded traffic in the last month.

In Table 3 it is presented the distribution of the total number of mobile accesses by provider at the end of 2020, where we can see that MEO is the main provider with 40.6% of active mobile accesses with actual use excluding machine-to-machine, followed by Vodafone with 30.2%. MEO registered a decrease when compared to the same period last year of 1.3% while Vodafone registered no variation and NOS an increase of 1.0%.

Table 3 - Distribution of active mobile accesses with actual use (excluding M2M) by provider

	2019	**2020**	**Var. (p.p.) 2019/2020**
MEO	41.9	40.6	-1.3
Vodafone	30.2	30.2	0.0
NOS	25.4	26.4	+1.0
NOWO	1.4	1.7	+0.3
Other providers	1.2	1.1	0.0

Unit: %, p.p.

Source: ANACOM

Note: The variations shown may not correspond to the values in the table due to rounding off.

3. LITERATURE REVIEW

There are a lot of studies around the customer satisfaction and customer loyalty concepts and its relationship, trying to understand how customers' satisfaction influences their loyalty and the shape of that relationship, but the opinions about this subject are very diverse. In this chapter, I present relevant literature to my study from past years defining the concepts needed to include in the model, since behind satisfaction and loyalty, there are factors that create and influence the satisfaction and loyalty.

3.1. CUSTOMER SATISFACTION

3.1.1. Definition of Customer Satisfaction

According to Tse and Wilton (1988), customer satisfaction is "the consumer response to the evaluation of the perceived difference between expectations and the final result after consumption" and according to Oliver (1997) customer satisfaction can be defined as the "consumer's fulfillment response" to the product or service, i.e., customers will be satisfied if the service exceeds their initial expectation and dissatisfied otherwise (Joudeh and Dandis, 2018). According to Kotler, Bowen and Makens (1999) and in line with Tse and Wilton (1988) and Oliver (1997), customer satisfaction is the feeling of pleasure or disappointment resulting from the comparison of the product's perceived performance in relation to consumer expectations.
According to the first law of David Meister, cited by Bogmann (2000) we have:

Customer Satisfaction (S) = Customer Perception (P) – Customer Expectations (E)

Thus, from the confrontation between performance and expectations, customers can experience one of the following situations:
- If the performance falls short of expectations, i.e. P<E, the customer is dissatisfied and disappointed;
- If the performance does justice to expectations, i.e. P=E, the customer is satisfied;
- If the performance exceeds expectations, i.e. P>E, the customer is extremely satisfied.

This evaluation of the performance perceived against the expectations can be carried out with each transaction between the company and the customer when referring to an immediate assessment taking place at the moment after the customer first tried the product/service or it can be a comprehensive assessment of all exchanges between the customer and the company over time, where it includes not only the satisfaction with the purchased products and services, but also other aspects of the relationship with the company being a global or cumulative evaluation (Oliver, 1999; Garbarino and Johnson, 1999; Anderson et al., 1994).
Every time a customer purchases any product or service, he/she inevitably pre-creates an expectation about it (Joudeh and Dandis, 2018). Also, each customer will have a different perception of the product/service according to his/her expectations and previous experiences or needs. Therefore, customer satisfaction is different from customer to customer.

3.1.2. Antecedents of Customer Satisfaction

The identification of the antecedents of Customer Satisfaction has become a necessity in the current market scenario since customer satisfaction became highly important in every business (Leninkumar, 2019) and as mentioned, there are factors that influence the satisfaction of a customer with the service/product, being called the antecedents.

3.1.2.1. Image

The image of a brand or organisation is defined as the exterior perception of the human and physical resources of that organisation, especially traits such as employees' attitudes, behaviors, communication levels and price tolerance (Dahal, 2019). It is considered a result of a process that begins with ideas, feelings and consumption experiences with a company that are recovered from memory and transformed into mental images (Yuille and Catchpole, 1977). The image aims to integrate all types of associations that customers make with the firm. Thus, it can be the overall impression that is in the public's mind about a firm.

The customer, when choosing a supplier even if in an unconscious way, does this choice based on the assessment of the image or positioning he has of the organisation's supplier (Deschamps and Nayak, 1996). The image that a customer creates of an organisation is a global impression that can be formed based on publicity and word of mouth. Thus, whenever possible, companies should try to preserve and improve the image of the organisation and the brands associated to it because it can be considered one of the most precious assets that a company can have.

The image of an organisation is an important factor that can lead to customer satisfaction, for the reason that if a customer has a good image of the company, he is more likely to consume more products and services from it and become more satisfied (Leninkumar, 2019).

Therefore, the image can generate more satisfaction in the consumers and consequently, make customers be more loyal to the brand. The image of a company or service can also be related with the expectations that a customer has about it. Inevitably, a customer pre-creates an image and an expectation towards a certain brand. Due to the expectation a customer creates when he has a good image of the company, there is the possibility for a significant relationship between these two concepts.

Junaid-ul-haq et al. (2013); Dahal (2019) and Leninkumar (2019) studied the relationship between the image and customer satisfaction and confirmed a significant relationship.

The hypotheses will be the following:
    H_1: Image has a positive effect on customer satisfaction
    H_2: Image has a positive effect on expectations

3.1.2.2. Expectations

In a pre-purchase stage, customer expectation is the anticipate impression of a specific product or service. Before the act of buying, every customer pre-creates an expectation about that product/service. According to Al-Msallam (2015), expectation influences the consumer decisions on which brand or type of product/service to buy. The customer expectation comprises the prior experience with the service and the expectation of future performance (Balaji, 2009), meaning that it

includes the information about products or services offered by the company that a customer held in the past and the anticipation they make about the company's capacity to offer quality products/services in the future. Hence, the expectations can influence the customers' perceived quality and the perceived value of the product.

Ofir and Simonson (2007) defend that customers' expectations are a determining factor on their consumption experiences, satisfaction and loyalty. Consumer's expectations have a huge influence on their final evaluation of a product/service since the evaluation that a consumer makes about a product or service depends a lot on their initial expectations. Customers usually pre-create a high expectation about a certain product, and due to such high expectations, when they buy and try it, it can either correspond or disappoint. Therefore, the success of marketing strategies depends on being able to predict in advance what their customers are expecting. It is crucial for the companies to know their customers' expectations because a single failure in meeting these expectations can be enough to lead to dissatisfaction and consequently, disloyalty (Al-Msallam, 2015). The better the ability of the companies in understanding their customers' expectations, the better their satisfaction and the company's performance. Satisfaction occurs whenever consumer expectations are fulfilled or exceeded leading to a reinforced purchase decision.

Al-Msallam (2015) and Iqbal et al. (2008) confirm a significant impact of expectations on customer satisfaction.

The hypotheses are the following:

H_3: Expectations have a positive effect on customer satisfaction

H_4: Expectations have a positive effect on perceived value

H_5: Expectations have a positive effect on perceived quality

3.1.2.3. Perceived Quality

When studying the antecedents of customer satisfaction, perceived quality is one of the most important variables (Leninkumar, 2019). Parasuraman et al. (1988) emphasize that perceived quality, although it is an attitude resulting from the comparison between expectations and the performance and hence it is related to satisfaction, it is not a synonym for it.

Parasuraman et al. (1988) define perceived quality as the consumers' judgement about an entity's overall excellence or superiority while Jiang and Wang (2006) define it as the consumers' evaluation of the service performance received and how it compared with their expectation. Perceived quality can be considered as the degree and direction of discrepancy between the consumers' perceptions and expectations (Parasumaran et al., 1988).

Due to the high competition in the telecommunications industry and the high expectations of customers to a great quality of the service, improvement in the service quality is needed to increase the customer satisfaction. The higher the quality of the service, the greater the customer satisfaction (Leninkumar, 2019). According to Leninkumar (2019) the influence of service quality on customer satisfaction is comparatively higher than other variables. For this reason, telecommunications companies should discover a way to improve the quality of their services in comparison to that of its competitors.

Lovelock and Wright (2002) claim that satisfaction is directly related to the perceived quality by the customer in relation to the offered service. There are other studies proving the significant direct effect of perceived quality on customer satisfaction (Malik, 2012; Leninkumar, 2019; Cronin et al., 2000;

Olsen, 2002; Rizomyliotis et al., 2018; Iqbal et al., 2008; Nasir and Mushtaq, 2014; Balaji, 2009). There are also studies proving an effect of perceived quality on customer satisfaction with perceived value as a mediator, both Balaji (2009) and Malik (2012) confirm the mediating role of perceived value in the perceived quality and customer satisfaction relationship.

In line with the literature mentioned, the hypotheses are the following:

H_6: Perceived quality has a positive effect on customer satisfaction

H_7: Perceived quality has a positive effect on perceived value

3.1.2.4. Perceived Value

Perceived value is defined as the difference between the customers' evaluation of all the benefits and all the costs of an offering and the perceived alternatives by Kotler and Keller (2012) and as the overall evaluation of the benefits received from the provider relative to the costs sacrificed by the customer by Leninkumar (2019). Perceived value comes down to the price a customer is willing to pay for a service.

Bolton and Drew (1991) declare that the perceived value results from the comparison between benefits that a service offers and the monetary costs or other resources (time, energy, effort, among others) related to its use. Zeithaml (1988) defends the same as Bolton and Drew (1991), being this conceptualization of value as a balance between benefits and costs corroborated by several authors. Therefore, if value is created for the customer when he compares the product or service with the alternatives on the market, the customer is likely to tend to repurchase the product or service and to refer to it positively to other potential customers.

The superior customer value that a company can offer is seen as the key to achieve and maintain competitive advantage in the company, since it is cheaper to maintain than to create (Leninkumar, 2019). Parasuraman (1997) is in agreement with Leninkumar (2019), presenting it as being one of the main elements to obtain competitive advantage for the company. The creation of value for the customer involves increasing the benefits for them and/or reducing the sacrifices of acquisition and usage by the customer.

Perceived value is considered by some authors to be an important antecedent of customer satisfaction (Rizomyliotis et al., 2018; Iqbal et al., 2008; Leninkumar, 2019; Cronin et al., 2000; Malik, 2012; Lam et al., 2004).

The hypothesis will be the following:

H_8: Perceived value has a positive effect on customer satisfaction

3.2. CUSTOMER LOYALTY

3.2.1. Definition of Customer Loyalty

Customer loyalty is the willingness and commitment of a customer to repurchase from the same firm on a continual basis (Edvardsson et al., 2000) and is also considered as a promise of customers to keep purchasing certain products or services of an organisation over a consistent period of time, without considering the competitors' new products and innovations and not being interested in switching (Oliver, 1999). Loyalty is formed with the passage of time by maintaining the relationship between the customers and the firm. It is considered to be an evidence of the repeated patronage of a service provider and the recommendations made by a service provider to other possible customers (Lam et al., 2004). The repurchase intention of the customers allows the creation of a continuous relationship with the organisation. However, it is important to note that a customer's loyalty is much more than repeating acts of purchase or remaining a customer of a brand for long periods of time, this can happen due to inertia or resistance to change, which can change at any time. Therefore, according to Reichheld (2003), loyalty should be understood as someone's willingness to make a personal investment, with the aim of strengthening a relationship. This relationship implies that, even if the supplier does not offer the best price on a particular transaction, the customer feels that the supplier treats him well, associating him with good value in the long run. For this reason, loyalty must then be assessed through what the consumer says about the brand to his friends and family, since by speaking positively of a brand with a family member or friend, he can attract new customers to the brand without any cost to the company.

As the competition between organisations or services increases, the need for customer loyalty does too, since there is a permanent improvement and innovation of the services (Kumar et al., 2013). When people feel loyal to a certain service, they are less likely to be influenced by a competitor's advertisements and/or offers. A loyal customer consumes less marketing resources, acquires a greater number of products/services, and is more likely to try new branded products and to support price changes, as long as the quality remains high. Especially in the telecommunications sector where services have little differentiation or competition is fierce, customer loyalty is a top priority (Santouridis and Trivellas, 2010).

Loyal customers are more likely to buy high-margin supplemented services and products (Joudeh and Dandis, 2018) and tend to spread good reviews from the respective service/product to other people (Kumar et al., 2013).

3.2.2. Antecedents of Customer Loyalty

3.2.2.1. Satisfaction

Customer satisfaction has already been defined and as mentioned all along this study, the main objective is to analyse customer satisfaction as an antecedent of customer loyalty. Numerous authors have previously proved that customer satisfaction is one of the most important antecedents of customer loyalty, if not the most important one (Cronin et al., 2000; Olsen, 2002; Lam et al., 2004; Leninkumar, 2017). The relationship of these two concepts is further developed in "*Relationship between Customer Satisfaction and Customer Loyalty*".

Leninkumar (2017); Garbarino and Johnson (1999); Balaji (2009) and Geyskens et al. (1999) reveal a significant positive correlation between customer satisfaction and trust, considering the variable trust as a mediator between customer satisfaction and customer loyalty. Therefore, customer satisfaction can have a direct and indirect (through the variable trust) impact on loyalty. The overall satisfaction of a consumer is proposed to have a positive impact on his trust in the service provider (Leninkumar,

2017) which leads to his loyalty. Only with their satisfaction and trust on the brand, does the customer have more propensity to become loyal.

In order to study both relationships, the hypotheses formed are the following:

H_9: Customer satisfaction has a positive effect on customer loyalty

H_{10}: Customer satisfaction has a positive effect on trust

3.2.2.2. Trust

Trust is considered to be the act and the willingness of the customer to rely on the actions of the service provider, mostly through the confidence in the company's integrity and reliability (Morgan and Hunt, 1994).

It is a relevant element in successful relationships (Garbarino and Johnson, 1999) and it is important for a company to build customer trust in order to make the customer feel confident about the product, as this is a crucial factor that leads to customer loyalty (Leninkumar, 2019). If a company wants to build a real lasting relationship with its customers, obtaining their loyalty, it is of fundamental importance to first earn their trust. Ahmed et al. (2014) highlight that it is not possible for a customer to enter in loyalty levels without trust in the brand.

Trust is one of the determinants of customer loyalty and one of the most valuable assets that a company may have in order to gain that loyalty and to obtain competitive advantage over competitors since it establishes an important bond between the customer and the brand (Morgan and Hunt, 1994). Telecommunications providers can expect to have better results in terms of customer retention and service provision, if they manage to establish a trustful relationship with their current customers (Rizomyliotis et al., 2018). This trust is built from experiences that the customer has with the supplier. Therefore, every moment of contact between these two parties should be used to build and strengthen trust, which will serve as a basis for building customer loyalty (Bitner, 1995).

As mentioned before, both Leninkumar (2017) and Morgan and Hunt (1994) reveal a significant impact of customer satisfaction on trust and of trust on customer loyalty, being a mediator effect in the relationship between customer satisfaction and customer loyalty. Corroborating this idea, Garbarino and Johnson (1999) indicate that trust is a consequence of satisfaction and an antecedent of loyalty, namely for influencing purchase intentions.

The hypothesis is:

H_{11}: Trust has positive effect on customer loyalty

3.2.2.3. Age

Age is a demographic characteristic that has attracted research consideration since younger people are seen to be more willing to test new product brands (Szimigin and Carrigan, 2001). Younger people have more difficulties when evaluating the quality of a product although they tend to better receive the new information provided by the sales personnel or the after sales service comparing to the older people (Homburg and Giering, 2001; Szmigin and Carrigan, 2001). A younger customer tends to more easily understand and examine the product's attributes and to be more critic regarding the attributes.

Besides, a younger customer is more tempted to switch services whenever he finds a better offer than an older one. For this reason, the younger customer tends to be less loyal.

Age is considered a significant moderating variable in the relationship between customer satisfaction and customer loyalty (Homburg and Giering, 2001; Chiguvi and Guruwo, 2015).

The hypothesis will be:

H_{12}: Age has a positive moderating effect on customer loyalty

3.2.2.4. Income

Income is also a demographic characteristic assumed to have a huge impact on choice decisions (Zeithaml, 1985). Szimigin and Carrigan (2001) state that high income earners tend to be more innovative and to change product or service more easily. Therefore, a customer with a higher income tends to be less loyal (Homburg and Giering, 2001). This makes sense because a customer without financial difficulties can better choose what he wants to pay for and which is the product/service that better fits his necessities. According to Schaninger and Sciglimpaglia (1981), higher income earners usually have more choices to evaluate and due to that, they create higher expectations for the product/service. If that customer is dissatisfied, he can more easily switch the service provider than a customer with a lower income. This one will be more limited on his choice because of the price of the products. Thus, a lower income earner will be easier to satisfy and will be more loyal (Chiguvi and Guruwo, 2015).

Homburg and Giering (2001) and Chiguvi and Guruwo (2015) defend that income has a significant moderating effect on customer loyalty.

The hypothesis will be:

H_{13}: Income has a positive moderating effect on customer loyalty

3.2.2.5. Educational Qualifications

Schaninger and Sciglimpaglia (1981) state that highly educated customers are usually more attracted to technological advancement. Fernandes et al. (2014) proved a negative relationship between customer loyalty and education level, that means that the higher the customers' education level the more their loyalty diminishes. Highly educated customers tend to be more informed and aware of the products or services present in the market, having better capabilities to evaluate all the options which makes them more difficult to satisfy. Moreover, highly educated customers are usually associated with higher levels of income (Fournier, 1998) influencing their possibilities to choose the service/product without many price restrictions, thus having lower loyalty levels.

The hypothesis will be:

H_{14}: Educational Qualifications has a positive moderating effect on customer loyalty

3.3. CUSTOMER RETENTION

3.3.1. Definition of Customer Retention

Oliver (1997) defines customer retention as "deeply held commitment to rebuy or repatronize a preferred product or service consistently in the future, despite situational influences and marketing efforts having the potential to cause switching behaviour" and Kassim and Souiden (2007) define it as "the future propensity of the customers to stay with their service provider". Customer retention is critical to business success in today's competitive environments and is a marketing strategy since it involves concentrating on meeting the clients' expectations in order to preserve their loyalty. It is not only giving the customer what they expect but it is also about exceeding their expectations so that they become loyal to the brand. Customer retention is different from loyalty because the first one represents the actual product or service repurchase over time and loyalty represents the intention of that repurchase in the next purchase occasion. As Gets and Thomas (2001) state, customer retention occurs when a customer purchases a product again and again, over an extended period of time. According to Khan and Hussain (2013), customers who are willing to pay higher prices for a product/service tend to be brand conscious and prestige sensitive. There are several ways of retaining customers, for example, when customers renew their subscription, make regular purchases or upgrade to a premium version. These attitudes are considered as customer retention.

3.4. RELATIONSHIP BETWEEN CUSTOMER SATISFACTION AND CUSTOMER LOYALTY

There are several opinions about the importance of customer satisfaction on customer loyalty. Mohsan et al. (2011) defend that customer satisfaction is a crucial influence on customer loyalty and that it is not possible to have loyalty without satisfaction. Although according to Kumar et al. (2013), the link between them is not as strong as commonly presumed. In line with Kumar et al. (2013), Ahrholdt et al. (2019) confirm that satisfaction is not sufficient to explain changes in loyalty.

The best way to have a successful firm is to attend to customers' needs and keep them satisfied. This way, they are more predisposed to repurchase, have a lower price sensitivity and spread a positive word of mouth (Kumar et al., 2013). A positive evaluation of the service/product acquired is the main reason to continue a relationship with the service's company. Highly satisfied customers are willing to pay more to sustain the entire service and would like to repurchase the same broadband service as the satisfaction level increases, having no intention to switch to another service (Iqbal et al., 2008). However, being satisfied with a product or service may not be enough for customers to feel loyal to that service, considering the other variables that are present. Models including other relevant variables as moderators, mediators or antecedent variables are better predictors of loyalty than models considering only satisfaction (Kumar et al., 2013).

Ahrholdt et al. (2019) evidence a nonlinear effect of satisfaction on loyalty. Tuu & Olsen (2010), in agreement with Ahrholdt et al. (2019), prove that an increased unit of satisfaction at different levels of satisfaction can generate an unequal increase in loyalty. Besides that, in a study made by Kotler and Keller (2012), the relationship is proved to be not proportional. They supposed that customer satisfaction is rated in a scale from one to five. Following that scale, at a very low level (level 1) of customer satisfaction, customers are likely to abandon the company and even bad mouth it; in a more advanced level (level 2 to 4) customers are fairly satisfied but still find it easy to switch when a better offer comes along; and at a higher level (level 5) the customer is very likely to repurchase and even

spread a good word of mouth about the company. It is only in level 5 of this hypothetical scale, that the relationship between customer satisfaction and loyalty becomes proportional. When we have a really high level of satisfaction, we tend to create an emotional bond with the brand and not just a mere rational preference.

Dong et al. (2011) find that in 51% of the cases, the linear functional form is the most dominant when it comes to increases in repurchase intentions with satisfaction. Hence, allocating resources to customers at every level of satisfaction is equally important in terms of returns on customer management investment. The two other predominant forms after linearity are the s-shaped and convex forms.

3.5. RELATIONSHIP BETWEEN CUSTOMER SATISFACTION AND RETENTION LEVELS

Both Kassim and Souiden (2007) and Ranaweera and Prabhu (2003) defend that the more satisfied the customers are, the greater is their retention, since they remain buying the same product/service when satisfied. Consequently, the greater is the positive word of mouth generated through them and the financial benefits to the organisation who serve them (Ranaweera and Prabhu, 2003). The retention of the existent customers is used as a driver to increase the revenues and market share and therefore, it is important for the organisation to know who to satisfy and in order to constantly retain its customers in the current competitive market, there is the need to strategically satisfy the customers' needs and understand how to effectively satisfy them (Ibojo, 2013). A satisfied and retained customer will give room for repeated purchases, while an unsatisfied customer may easily decide to switch to a competitor's service or product. Therefore, customer satisfaction is the key to customer retention. In this era of competitive global marketing, organisations seek to manage and increase their customers' satisfaction. Customer satisfaction is considered by Khan (2002) to be the foundation for any firm to retain their current customers, given that a satisfied customer is more likely to have a positive relationship with the organisation. Therefore, and once more, organisations need to make sure that all their activities satisfy their customers, which will lead to the possibility of customers integrating their loyalty with the respective organisation and a continued purchasing and repurchasing of the organisation's products (Ibojo, 2015).

4. METHODOLOGY

4.1. CONCEPTUAL FRAMEWORK

This study aims to identify the determinants for customer satisfaction and loyalty in the services sector. One of the references in the satisfaction study is the ACSI (American Customer Satisfaction Index) proposed by Fornell et al. (1996), which places satisfaction as an important antecedent of loyalty, and where satisfaction has perceived quality, customer expectations and perceived value as antecedents. The determinants which explain the Customer Satisfaction Index according to both ACSI and ECSI Portugal (Índice Nacional de Satisfação do Cliente) model are the Expectations, Perceived Quality and Perceived Value. Moreover, according to the ECSI model Image is also a determinant for customer satisfaction.

Based on all the *Literature Review* presented, the ECSI model was adapted, including and excluding some variables. ECSI includes a variable named Claims, which one does not consider to be relevant in this study since the objective is to study the satisfaction impact on loyalty and I think that the variable Claims would not have such impact in that relationship, for this reason I decided to exclude this one.

It was added the variable Trust because it is thought to be a crucial factor when it comes to retaining customers, Therefore, this model includes the image, expectations, perceived quality, perceived value, satisfaction, trust and loyalty as variables. Moreover, determinants like Age, Income and Level of Education were added as moderator variables since these are demographic variables that have been proved to make a difference when it comes to buy or rebuy a service and are important to analyse.

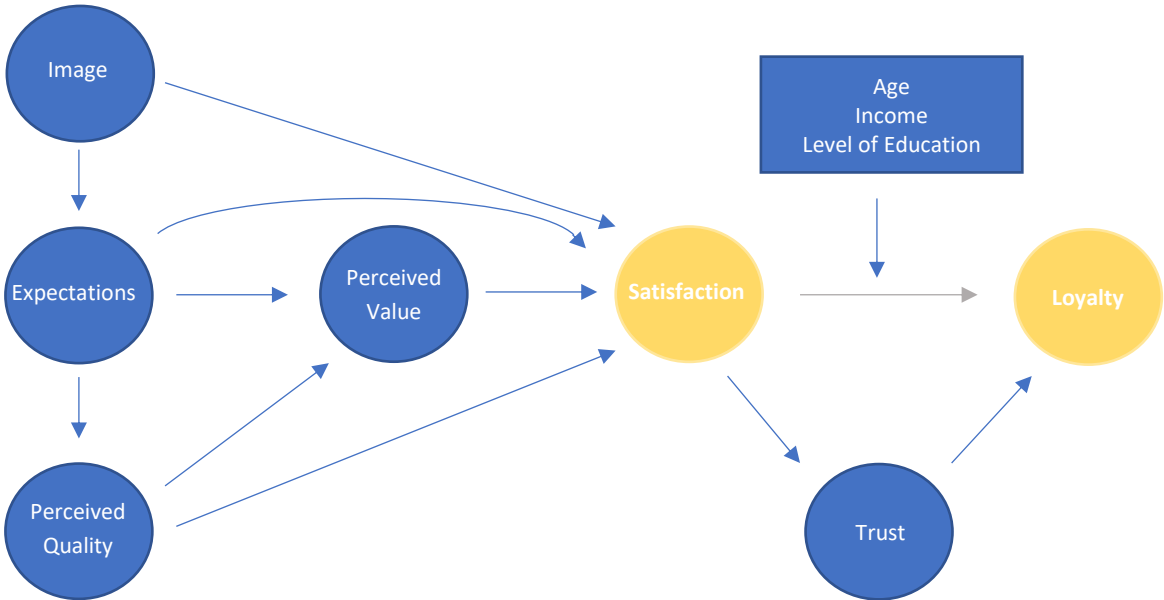My structural model became the following:

Figure 1 – Adapted structural model. Source: Author

Except for the three moderator variables, all the variables presented in this model are latent variables. A latent variable is a variable that cannot be directly measured but is rather inferred from other observed variables. Therefore, these variables can't be subject to direct observation. Each of these variables needs to be associated with a set of indicators, called measurement variables, obtained directly through a constructed questionnaire. The demographic variables Age, Income and Level of education are able to be directly measured.

When we have latent variables, the model that best suits these variables is the structural one. A structural model shows the causal and correlational links among all the latent variables. In recent decades, Structural Equation Modelling has become one of the most useful and advanced statistical analysis techniques which combines aspects of factor analysis and regression, being very suitable for the study of complex phenomena, involving a multiplicity of variables (Hair et al., 2017). Through the SEM methodology, attributes such as customer perceptions, expectations, intentions and satisfaction can be assessed as well as the relationships between them and their influence on organisational performance measures (Hair et al., 2017). Hair et al. (2011) considered path models as "diagrams used to visually display the hypotheses and variable relationships that are examined when SEM is applied". All the hypotheses created in the *Literature Review* chapter are demonstrated in the structural model through the links (arrows) between each pair of variables. The set of relations between the latent and the measurement variables constitutes the measurement model.

The measurement model is composed by the following indicators:

Table 4 – Indicators for the Measurement Model

Latent Variable	Abbreviation of the indicator	Indicator
Image	Image1	My operator is a trusted company in what it says and does
	Image2	My operator is a stable company and established in the market
	Image3	My operator contributes positively to the society
	Image4	My operator shows concern for its customers
	Image5	My operator is an innovative and forward-looking company
	Image6	My operator has a better image than its competitors
Expectations	Expect1	Global expectations about the operator
	Expect2	Expectations about the service quality

	Expect3	Expectations about the operator's ability to offer services that meet your needs
	Expect4	Expectations regarding the operator's reliability
	Expect5	Expectations regarding the service provided by the operator's employees to the customer
	Expect6	To what extent does your service satisfy the initial expectations you had about the operator?
Perceived Quality	Quality1	The overall quality of the operator
	Quality2	The degree of quality of your mobile telecommunications service
	Quality3	I consider my mobile phone service to be reliable
	Quality4	My operator has a good range of services available
	Quality5	My operator transmits the information clearly and transparently
	Quality6	My operator allows easy subscription or change to a service
	Quality7	I consider my operator's customer service professional and efficient
	Quality8	I consider the number of physical stores available enough and with good accessibility
	Value1	Given the quality, how would you rate the price paid for your mobile phone service?
Perceived Value	Value2	Given the price you pay, how do you rate the quality of your mobile phone service?
	Value3	The price charged by my operator is less than the price charged by my competitors for similar services
	Value4	The price charged by my operator for the service I use is fair

	Value5	The price charged by my operator for the service I use is a good deal compared to competitors in the market
Satisfaction	Sat1	Overall satisfaction with the operator
	Sat2	How satisfied are you with the service you use from the operator?
	Sat3	To what extent were your initial expectations met by the service provided to you by the operator
	Sat4	I am very pleased to have subscribed to the operator
	Sat5	My service is the best I've ever experienced
	Sat6	My service meets my needs
	Sat7	Imagining the ideal operator, how close is the current operator to this ideal?
Trust	Trust1	I have complete trust in my operator
	Trust2	I believe that the operator works based on the principle of honesty
	Trust3	My operator is reliable because it is mainly concerned with the customer's interest
Loyalty	Loyalty1	I intend to remain as a customer
	Loyalty2	The current operator would be the first choice in case I need to purchase a new service or product
	Loyalty3	I speak positively about my operator to friends and colleagues
	Loyalty4	I intend to recommend my operator to anyone who asks me for advice

The model to be estimated consists of the set of equations of the structural model and the measurement model. The main difficulties in estimating this model stem from three factors:

- The presence of latent variables that are not observed;

- The frequency distribution of the measurement variables is, in most cases, not symmetrical, although a scale of variation from 1 to 10 is being considered (instead of a smaller scale);
- The existence of multicollinearity between the values of the measurement variables.

Due to these difficulties, ECSI Portugal (2020) defends the use of the method of partial least squares (PLS) which is also a method of simultaneous estimation and is particularly suited to this type of models as it will be mentioned right after.

4.2. MODEL ESTIMATION – PARTIAL LEAST SQUARES

According to Hair et al. (2017) variance-based partial least squares (PLS) method has been the most used in structural equation models. It is a suitable procedure that applies OLS regression for estimating and testing the hypothesized relationships (path coefficients) between the latent variables in the structural model and maximizes the explained variance – the R^2 values - of the dependent latent variables, i.e., it minimizes the unexplained variance. The evaluation of the measurement and structural models' quality focuses on metrics indicating the model's predictive capabilities. PLS-SEM is, therefore, the chosen method when the research objective is theory development and explanation of variance (prediction of the constructs). PLS-SEM allows the estimation of complex models with many constructs and many indicators and the unrestricted use of moderator variables and nonlinear terms. Moreover, since PLS-SEM has a nonparametric nature, distribution assumptions are not that important. (Hair et al. 2017). Due to the frequency of nonnormal data in studies like these, applying PLS-SEM to these types of data is a big reason for its use.

PLS-SEM supports interaction, quadratic and cubic terms in the model (Shmueli et al., 2016) and the analysis of interaction and nonlinear effects will follow a two-stage approach for estimating the models in our study variables (Hair et al., 2017), evaluating first the reflective measurement model intended to collect the latent variables fixed in the research's cause and effect hypotheses and then the structural models (Ahrholdt et al., 2019). PLS-SEM focuses on the discrepancy between the approximated values of the dependent variables and the values predicted by the model in analysis (Hair et al., 2012). The analysis of the adequacy of the model allows measuring the extent to which the model fits well with the fact that it is intended to study and the stability of the estimates obtained for the model parameters. Only the evaluation measures of the PLS methodology will be used here. The proposed measures, the Coefficient of Determination (R^2) and Average Variance Extracted (AVE), are intended to analyse the quality of the adjustment and the forecasting ability of the model while the Bootstrapping technique is intended to test the stability of parameter estimates.

The use of the PLS methodology appears to overcome some of the limitations related to the definition of the sample size found in the analysis of structural equations (Henseler et al., 2009), which also justifies the choice for this estimation method.

The software used to estimate the models will be the SmartPLS3.

4.3. QUESTIONNAIRE DESIGN AND DATA COLLECTION

In order to analyse the effect of customer satisfaction on customer loyalty and retention levels, the first step is to construct a structured questionnaire to collect satisfaction and loyalty data and also analyse its antecedents, namely image, expectations, perceived quality, perceived value and trust about mobile telecommunications consumers. On the one hand, the method used has several advantages: it allows reaching geographically dispersed people at low cost, it allows anonymity of responses, it allows respondents to fill in when it seems most appropriate to them and it does not expose interviewees to the presence of the researcher. On the other hand, it also has some disadvantages: it excludes people who do not understand the use of technologies, prevents the researcher from assisting the interviewee in case of any doubt and makes the investigator unaware of the circumstances in which it was answered. However, the pros outweigh the cons of the use of this method.

The questionnaire is made up of three parts: introduction, main body and conclusion. The introduction presents a brief identification of the investigator and the objective of the questionnaire. The main body is composed mostly of closed questions and two open questions where the person can indicate some price values. The closed questions were presented through a 10-point metric scale to reliably capture substantive variations not only on satisfaction and loyalty levels, but also on the other variables in study. This 10-point metric scale was chosen since a greater number of modalities allows both a greater discrimination of responses and an easier identification of the relationships between the variables. The conclusion includes the collection of sociodemographic information, through the variables gender, age, academic qualifications and monthly income. The gathering of this information was due to the unanimity in stating that this strategy guarantees the initial impersonality and leaves the interviewee more comfortable answering these questions raised since they are already familiar with the questionnaire. The questionnaire was composed of a total of 50 statements and it was administrated online, through social media and email to collect data about the consumer's opinion and attitude when it comes to evaluating their mobile telecommunications service.

The questionnaire could be answered by anyone who is a regular user of the mobile telecommunications service and who has been using that service for more than 6 months. Therefore, the target population of this study was the customers of mobile telecommunications operators in Portugal with access to the internet since the questionnaire was only made available online. The characterization of the Sample and Descriptive Analysis of the results obtained will be done using the SPSS software.

Responses to the questionnaire were collected from December 18th to January 4th. The complete questionnaire can be found in *Appendix*.

4.4. SELECTION AND PREPARATION OF THE DATA

Datta (2018) defines a sample as a subset of the elements of a population. To define the sample of this study, an empirical sampling by convenience was used since people responded voluntarily, which results from a selection determined by subjective criteria, a personal opinion and not by an application of probabilistic mechanisms. This technique made it possible to collect information faster, with fewer costs and required less work in sample planning. However, this technique may lead to less information collected, and the sample may not be representative of the population (Datta, 2018).

Hair et al. (2017) state that "When empirical data are collected using questionnaires, typically data collection issues must be addressed after the data are collected". Those primary issues that need to be analysed include missing data, suspicious response patterns and outliers. Therefore, the first thing to analyse after the questionnaires' results are these possible issues. Only after this, will it be possible to do a statistical analysis.

392 responses were obtained. These 392 responses were analysed in order to detect missing values and suspicious response patterns. From these, 19 responses were considered invalid because of the high percentage of missing values during the questionnaire and 2 responses were considered invalid due to suspicious response pattern always giving maximum evaluation. Therefore, 371 responses were selected to be analysed. In these 371 responses there were some missing values and "I don't know/I don't answer" answers. In order to maintain these responses, the method used to replace those missing values was done by imputation. Through the "mice" package of R, each variable has its own imputation model and the values are drawn from a distribution specifically designed for each missing datapoint. Then, it is possible to analyse the quality of the imputations by checking various diagnostic plots. The before and after imputation plots are very similar in all indicators which is good and acceptable for our analysis. There was only a problem with one of the indicators of Perceived Value which required an inversion of the respective scale since it was giving negative correlations with the other Perceived Value indicators.

4.5. MODEL ADJUSTMENT – REGRESSION ANALYSIS

Regression analysis is one of the most important statistical tools which is extensively used in a lot of sciences, especially in business and economics in order to study the relationship between two or more variables that are related. A model of that relationship needs to be hypothesized and estimates of the parameter values are used to develop an estimated regression equation (Ostertagova, 2012). PLS-SEM is an iterative process where a set of scores for the latent variables of the structural model are estimated after convergence has been reached. The equations of this model are estimated in a last phase after the iterative process. Structural model equations are, generally, multiple regressions, as many as the number of endogenous latent variables. However, and as already mentioned, this study is of particular interest in the equation with loyalty as the dependent variable and satisfaction and trust as the independent variables. Thus, this last step of the PLS-SEM was replaced by estimating with the different functional forms that will be presented next being adjusted to the data, where there is a linear model and a few non-linear models. R software will be used in order to do these regression analyses and try to find the model/regression that best fits the CS-CL relationship.

The measures that will be used to compare and validate the models are R^2 and RMSE (Root Mean Square Error). RMSE is the standard deviation of the prediction errors, which means that it tells how concentrated is the data around the line of the fit. The best model will be the one with a higher value of R^2 and a lower value of RMSE.

4.5.1. Multiple Linear Regression Model

The Simple Linear Regression Model is a statistical technique which predicts the outcome of a response variable through the explanatory variables. It intends to model the linear relationship between the explanatory variables and the response one. In fact, multiple regression is considered the extension of ordinary least-squares regression since it involves more than one explanatory variable. (Investopedia, 2021).

This relationship is represented by the following mathematical equation:

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \cdots + \beta_p x_{ip} + \varepsilon_i, \quad i = 1, \dots, n \quad (1)$$

Where:

- y_i represents the value of the dependent variable Y in observation i, i=1,…,n;
- x_i represents the values of the independent variables X in observation i, i=1,…,n;
- ε_i, i=1,…,n are random variables that correspond to the error with mean 0 and constant variance σ^2 (variable that allows to explain the variability existent in Y that is not explained by X);
- β_0, represents the y-intercept, that is, the point at which the straight line cuts the y-axis when X=0;
- β_p, represents the slope coefficients for each explanatory variable, expressing the rate of change in Y, that is, indicates the change in the average of the probability distribution from Y to an increase of one unit in the respective variable X.

4.5.2. Polynomial Regression Model

Polynomial models can be used in situations where the relationship between the dependent and independent variables does not look linear ad it appears to be curvilinear (Pant, 2019). Also, to approximate a complex nonlinear relationship, polynomials can be very powerful to handle nonlinearity. Sometimes a nonlinear relationship in a small range of independent variable can be modelled by polynomials (Dikov, 2021). Polynomial regression can be treated as a special case of linear regression where each x^k is considered a separate predictor.

The kth order polynomial model in one variable is given by:

$$y = \beta_0 + \beta_1 x + \beta_2 x^2 + \cdots + \beta_k x^k + \varepsilon_i \quad (2)$$

The coefficients β_1 and β_2 are called the linear effect parameter and quadratic effect parameter, respectively, and so on.

4.5.3. Logarithm Regression Model

A logarithm can be defined with respect to a base b where the base b-logarithm of X is equal to y because X equals to the b to the power of y (log(X)=y because X=b^y). Logarithms are essential tools in statistical modelling and analysis and a log transformation is a data transformation method in which it replaces each variable x with a log(x). The base of the logarithm can assume any positive number being the most common ones the base 2, base 10 and natural log. When the original continuous data do not follow the ideal bell curve, it is possible to log transform the data to reduce or remove the skewness of that data so that the statistical analysis results become more acceptable. (Htoon, 2020).

Logarithmically transforming variables are very common in a regression model to handle situations where a non-linear relationship exists between the dependent and independent variables and are also a convenient means of transforming a highly skewed variable into one that is more approximately normal.

4.5.3.1. Linear-log model

$$\hat{Y}_i = \beta_0 + \beta_1 logX_i + \varepsilon_i \quad (3)$$

In the linear-log model, the interpretation of the estimated coefficient $\widehat{\beta_1}$ is that a one-unit increase in logX will produce an expected increase in Y of $\widehat{\beta_1}$ units. (Htoon, 2020).

4.5.4. Regression Splines

Regression Splines is one of the most important non-linear regression techniques that is used to try and overcome the difficulties of the linear and polynomial regression algorithms (Singh, 2018). This regression divides the dataset into multiple bins and fits each bin with a separate model. The points where the division occurs are called Knots. Since there are separate functions that fit the bins, each function is called piecewise step functions. Piecewise step functions can remain constant only over an interval of time and individual step functions can be fit on these bins and thus avoid using one model on the entire dataset (Singh, 2018). Spline modelling can produce curves that even better fit the outcome data than the traditional models.

The equation for a regression spline is the following:

$$y = \beta_0 + \beta_1 b_1(x) + \beta_2 b_2(x) + \cdots + \beta_{K+d} b_{K+d}(x) + \varepsilon \quad (5)$$

Where:

- K is the number of knots the regression has;
- d is the degree of the spline model;
- K+d is the number of degrees of freedom.

4.5.5. Generalized Additive Model

A Generalized Additive Model has the interpretability advantages of a generalized linear model (GLM) where the contribution of each response variable to the prediction is evidently encoded (Larsen, 2015). However, it is significantly more flexible since the relationships between the response and explanatory variables are not assumed to be linear. As a matter of fact, it is not required to know a priori what type of predictive function will be needed. Moreover, the use of regularized, nonparametric functions avoid the pitfalls of having to deal with higher order polynomial terms in linear models. A GAM is composed of a sum of smooth functions of covariates which captures the impact of the predictive variables. Considering the GLM function as the following:

$$y = \beta_0 + \beta_1 x + \varepsilon \quad (6)$$

In this equation, y is the target, x the predictor variable, β_0 and β_1 the coefficients and ε the error. While, for the GAM function it can be specified as the following:

$$g\big(E(Y)\big) = \alpha + s_1(x_1) + \cdots + s_p(x_p) + \varepsilon \quad (7)$$

In this one, some specific additive functions of inputs are being dealt with, which will not require the y to be a linear function of x, where Y is the dependent variable that we are trying to predict, E(Y) the expected value and g(E(Y)) the link function that links the expected value to the predictor variables x_1, …, x_p. The terms $s_1(x_1) + \cdots + s_p(x_p)$ denote smooth and nonparametric functions.

When a model contains non-linear effects, a GAM can provide a regularized, interpretable and flexible solution, while other methods may lack at least one of these features, striking a nice balance between the interpretable, yet biased, linear model and the extremely flexible learning algorithms (Larsen, 2015).

5. DISCUSSION OF THE RESULTS

5.1. CHARACTERIZATION OF THE SAMPLE AND DESCRIPTIVE ANALYSIS

Descriptive statistics aims to provide a brief characterization of the sample. The sample will be characterized from information of sociodemographic nature, such as gender, age, educational qualifications and net monthly income.

The sample used is composed of 153 females and 218 males, representing 41.2% and 58.8%, respectively. We can see the distributions in Figure 2.
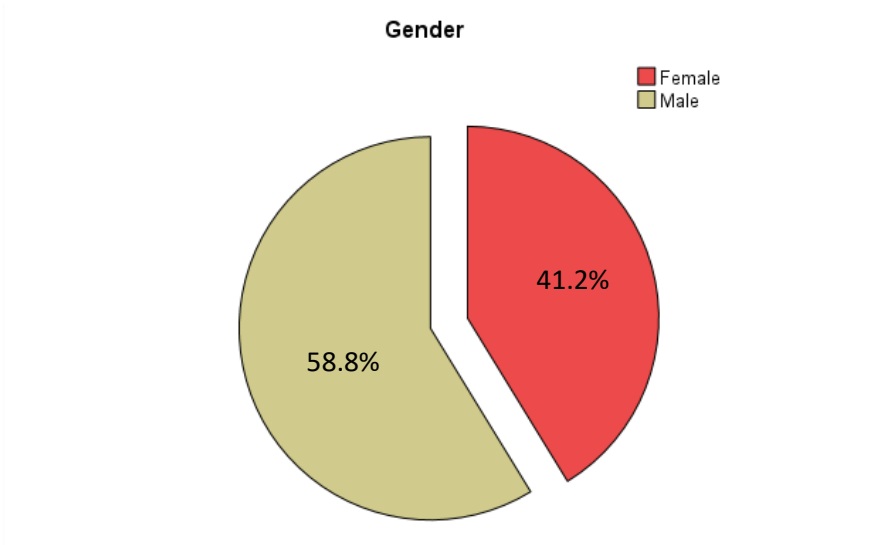

Figure 2: Gender

Regarding the age of the respondents, small groups were established. This is due to the possibility that age could be an important factor in the analysis and could have an impact on customer loyalty. Thus, it is important to have the most separated age groups in order to understand the impact of age more concretely. As we can see from Figure 3, the vast majority of respondents belong to the intervals 45 – 49 years and 50 – 54 years, both with 21.8%. The third group that stands out is the interval 40 – 44 years with 14.8%.
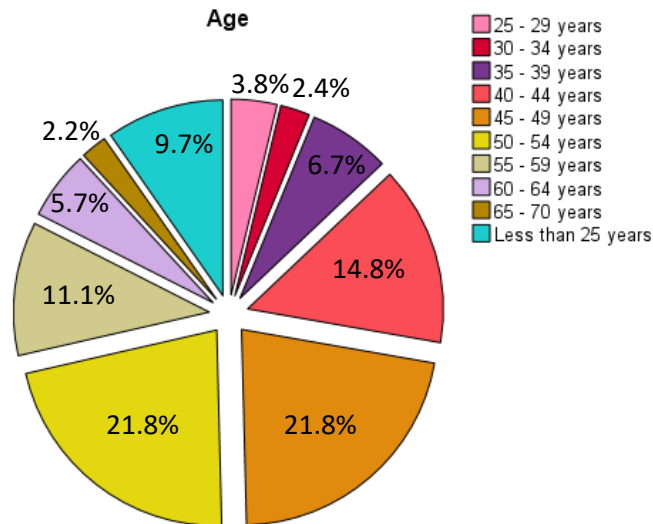
Figure 3: Age

Regarding the level of education, it was found that 40.2% of respondents have a Bachelor and 35.3% concluded the Secondary Education. These are the two main groups, followed by a Master with 11.9% of the respondents and Basic Education with 9.4%. We can conclude through Figure 4, that the majority of the respondents have a Bachelor.
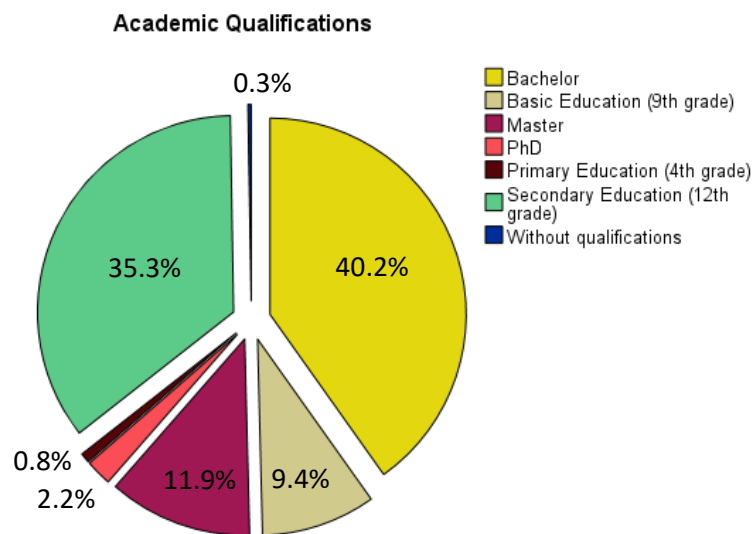

Figure 4: Academic qualifications

From Figure 5, we can conclude that 25.1% of the respondents receive more than 2000€ per month while another 25.1% receive between 1001 and 1500€. These are followed by a 1501 – 2000€ income interval with 16.2% of the respondents and a 801 – 1000€ income interval with 15.1%.
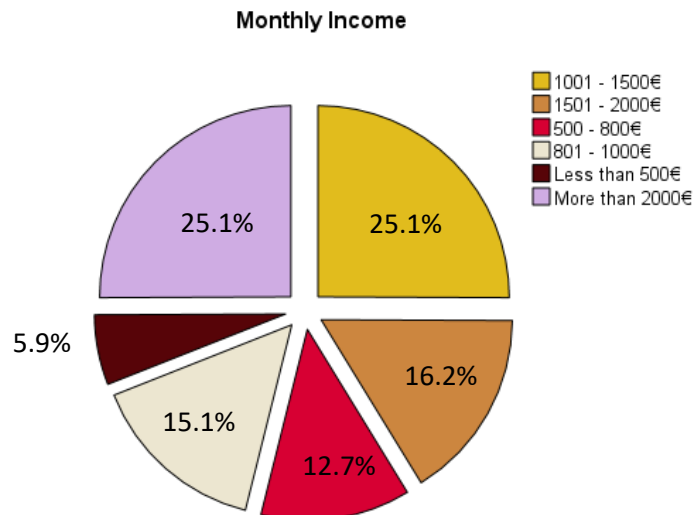
Monthly Income

Legend:
- 1001 - 1500€
- 1501 - 2000€
- 500 - 800€
- 801 - 1000€
- Less than 500€
- More than 2000€

25.1% 25.1% 5.9% 16.2% 15.1% 12.7%

Figure 5: Net Monthly Income

The most chosen mobile service provider by the respondents is Vodafone with 49.6% of the votes, followed by MEO with 26.1%. It should be noted that 9.5% of the respondents have two different mobile operators, however Vodafone is always one of the chosen ones as we can see from Figure 6.

Mobile Operator

Legend:
- MEO
- NOS
- NOWO
- Outra
- Vodafone
- Vodafone and Another
- Vodafone and MEO
- Vodafone and NOS

2.4% 0.8% 6.5% 26.1% 49.6% 12.9% 0.5% 1.1%
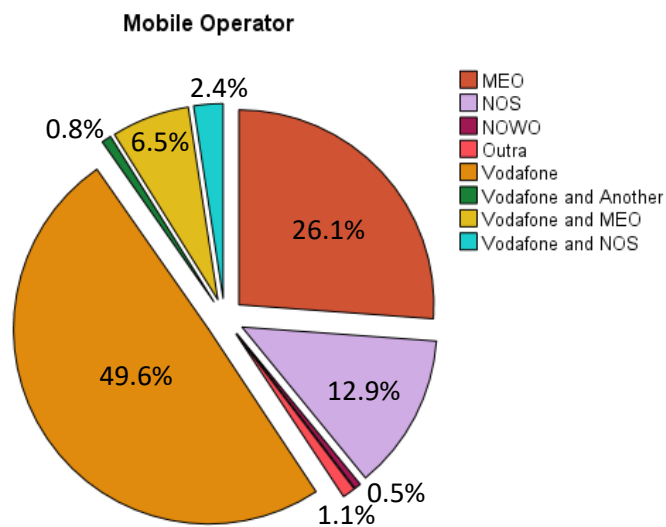
Figure 6: Respondents' Mobile Operator

From Figure 7, we can realize that almost 85% of the respondents have their current mobile service operator over more than 3 years, which is great for this study since we want customers who are able to evaluate their service regarding several aspects. The longer the customers relationship with their service operator, the better their opinion about it and a more complete experience they might have had so far.
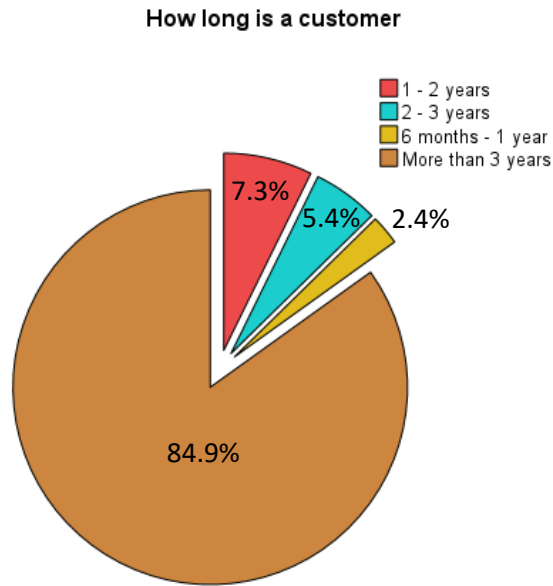
Figure 7: Time as a consumer of the operator

Regarding the retention of customers, 75.5% of the respondents are retained from their operator due to a contract and 23.5% are not. 1.1% did not answer to this question. It is relevant to denote that a customer who is not under a contract with the operator has the possibility to switch operators easily at any time compared to a customer who is under contract. This one needs to wait to the end of the contract to make that change if wanted. This was the way operators found to try to retain their customers because the customers may be able to pay less for the service when under a contract, however they are not allowed to switch operators until the end of that contract.
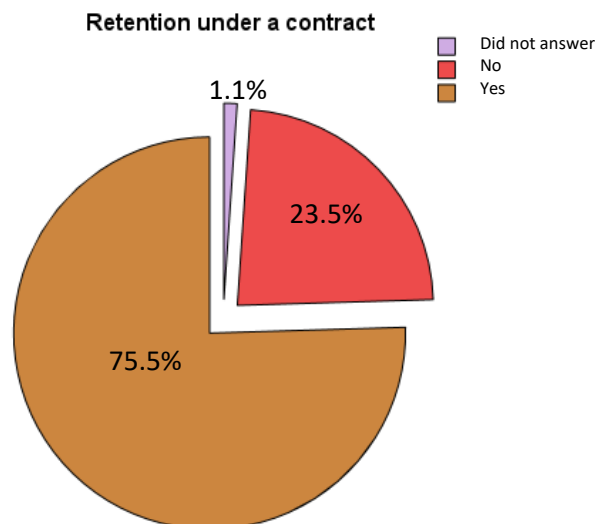

Figure 8: Retention of customers under a contract

After the initial analysis of the respondents' profile and knowing the principal information about which is the operator and for how long, there will be a first approach to the respondents' opinions in relation to each of the variables and indicators under study.

Regarding the indicators, Table 5 presents the mean and standard deviation of each indicator as well as the minimum and the maximum values. It is possible to see from the table that the minimum and maximum is equal in every indicator, which means that both people are very satisfied and very dissatisfied responding to all the indicators, providing very diverse opinions regarding their mobile service. From the mean and standard deviation values, it is possible to see the average of the rates given by the respondents to each indicator and where is it concentrated.

Table 5 - Indicators mean and standard deviation

	N	Mean	Standard Deviation	Minimum	Maximum
Image1	371	7.16	2.12	1	10
Image2	371	8.54	1.55	1	10
Image3	371	6.89	2.15	1	10
Image4	371	6.27	2.40	1	10
Image5	371	7.52	1.92	1	10
Image6	371	6.92	2.18	1	10
Expect1	371	6.87	2.08	1	10
Expect2	371	6.94	2.06	1	10
Expect3	371	6.97	2.14	1	10
Expect4	371	7.23	2.12	1	10
Expect5	371	6.89	2.12	1	10
Expect6	371	6.89	2.03	1	10
Quality1	371	7.29	1.86	1	10
Quality2	371	7.59	1.81	1	10
Quality3	371	7.79	1.87	1	10
Quality4	371	7.66	1.74	1	10
Quality5	371	6.73	2.27	1	10
Quality6	371	6.51	2.38	1	10
Quality7	371	6.70	2.31	1	10

Quality8	371	6.88	2.46	1	10
Value1	371	3.88	1.92	1	10
Value2	371	6.89	1.94	1	10
Value3	371	5.48	2.51	1	10
Value4	371	5.54	2.33	1	10
Value5	371	5.96	2.21	1	10
Satisfaction1	371	7.54	1.81	1	10
Satisfaction2	371	7.52	1.84	1	10
Satisfaction3	371	6.95	2.04	1	10
Satisfaction4	371	6.84	2.17	1	10
Satisfaction5	371	6.63	2.45	1	10
Satisfaction6	371	7.23	2.19	1	10
Satisfaction7	371	6.49	2.09	1	10
Trust1	371	6.74	2.14	1	10
Trust2	371	6.56	2.37	1	10
Trust3	371	5.91	2.41	1	10
Loyalty1	371	7.19	2.51	1	10
Loyalty2	371	6.75	2.59	1	10
Loyalty3	371	6.53	2.62	1	10
Loyalty4	371	6.45	2.65	1	10

From Table 5, it is also possible to conclude that there are higher mean values for some variables' indicators than others. For example, the mean values of Perceived Value indicators are lower than Satisfaction indicators or Loyalty indicators. This explains that the respondents have given lower rates to the indicators of the Perceived Value variable meaning that they are less satisfied with the respective aspects mentioned on the indicators.

Next, it will be presented in more detail the indicators for each variable in order to be able to analyse how are the scores distributed for each indicator and see if it was a satisfied or dissatisfied majority.

5.1.1. Image

Regarding the Image of the operator, the responses are more diverse. We can see from Figure 9, that overall, there are more positive responses, closer to 10 than the other way around. This means that there are more respondents who seems to have a good image of their operator, although there are a little percentage of respondents with a worse image of the operator. The statement where most respondents agree with is in considering that the operator is a stable company and established in the market with 35% strongly agreeing (score 10).
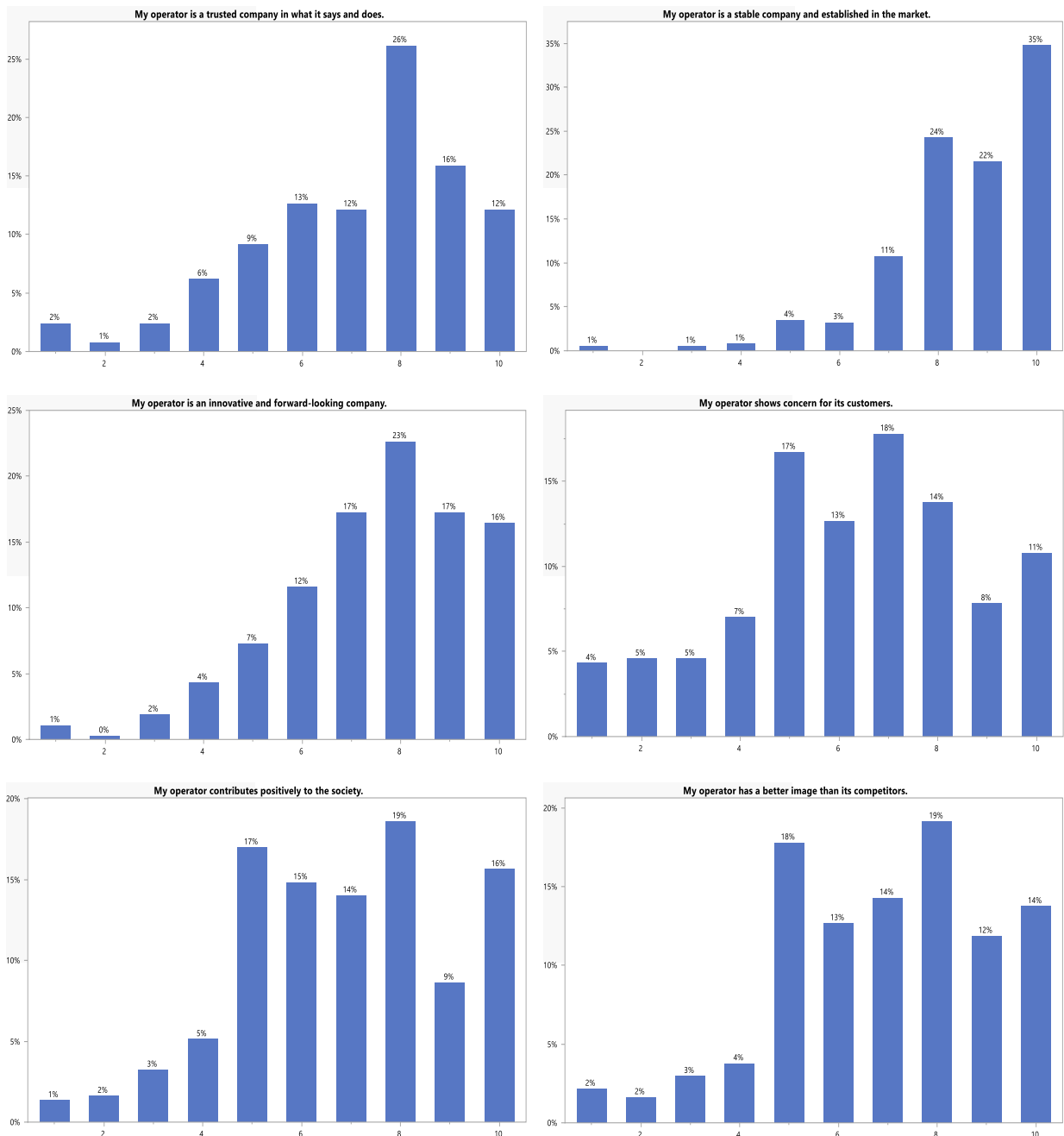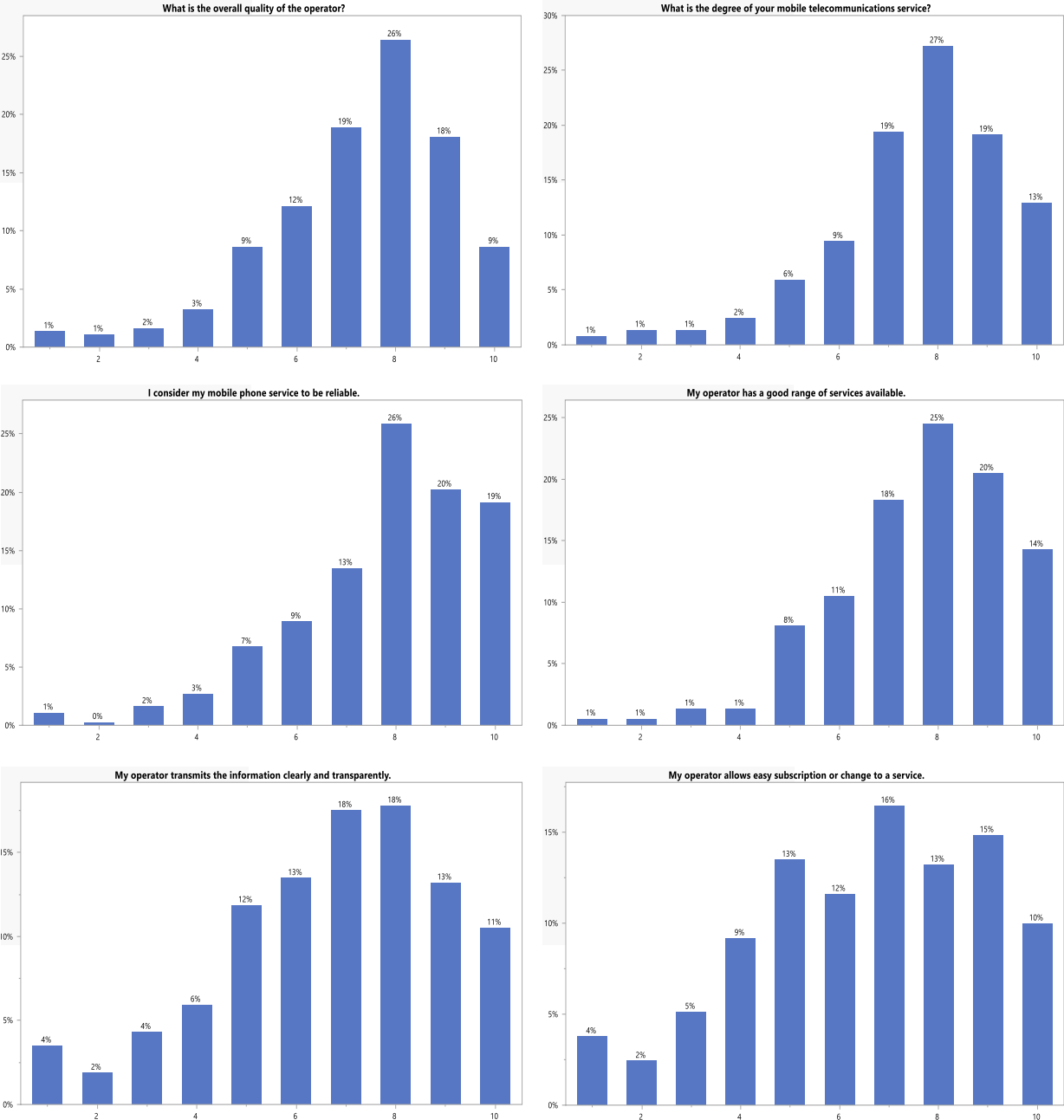

Figure 9: Image statements (a, b, c, d, e, f)

5.1.2. Perceived Quality

Regarding Perceived Quality we can see from Figure 10 that the majority of the respondents rated 7 or above. Therefore, it seems that a vast majority consider their service and operator to have quality and to be reliable. The highest percentage of responses as "Strongly agree" corresponds to the statement where they consider their mobile phone service to be reliable with 19% followed by 20% and 26% for degrees 9 and 8, respectively. In Figures 10 (e), (f), (g) and (h) we have more different opinions and experiences since there are more diverse responses from a range of 1 to 10. The responses are more dispersed, proving the existence of different opinions about the respondents' operator quality. When it comes to change or subscribe some service and the professional and efficient customer service, the respondents have more diverse opinions.
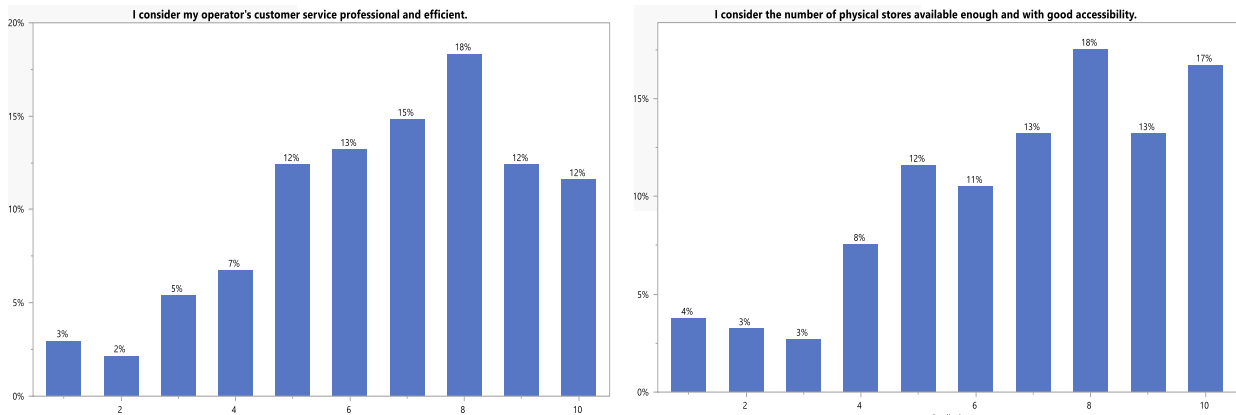
Figure 10: Perceived Quality statements (a, b, c, d, e, f, g, h)

5.1.3. Perceived Value

When it comes to the price, the opinions are the most diverse ones. From Figure 11, respondents do not seem to be satisfied at all with the price they pay having around 90% rated 6 or below. On the other statements of Perceived Value there are also a higher percentage of respondents unsatisfied. In the statement of the fair price charged for the service, there are more respondents disagreeing than agreeing with it. Moreover, there are more people voting for strongly disagree when saying that the price their operator charge is less than its competitors. This means that respondents have consciousness of the prices in the market and know that there exist better offers or at least lowest prices available for similar services.
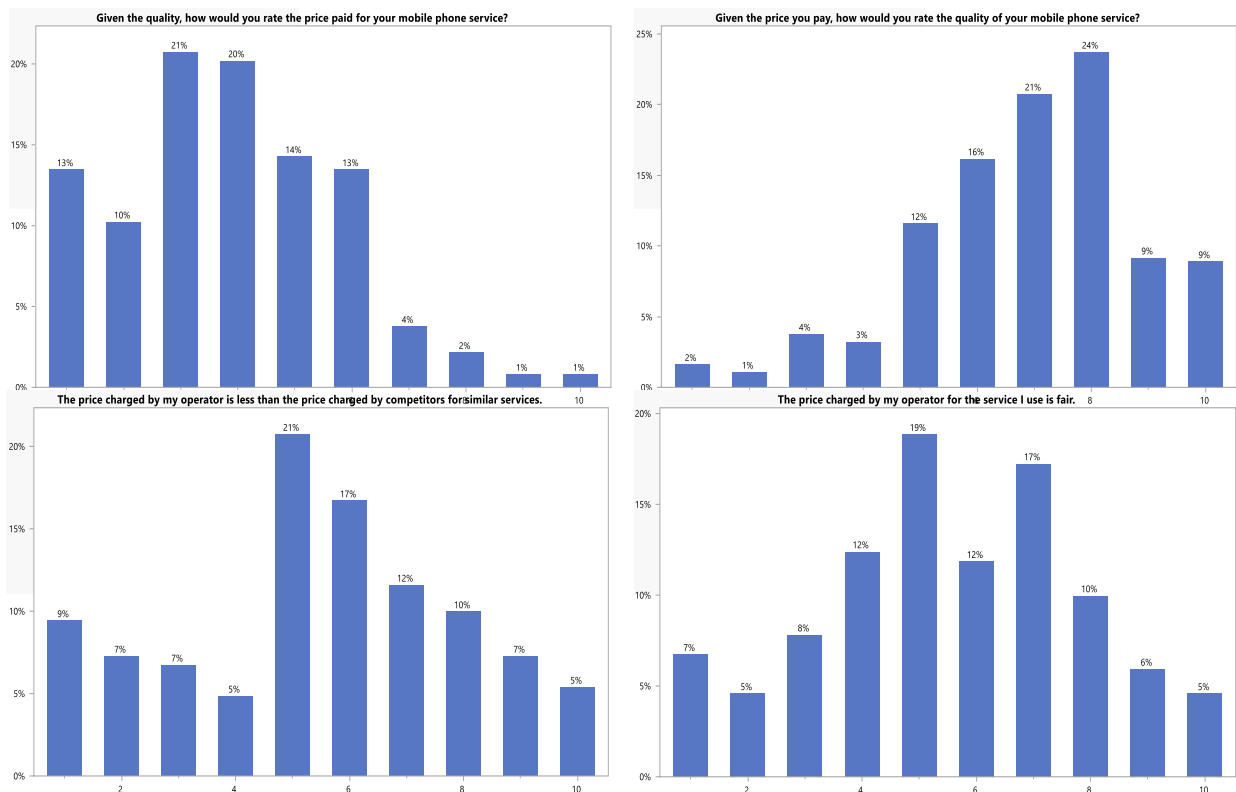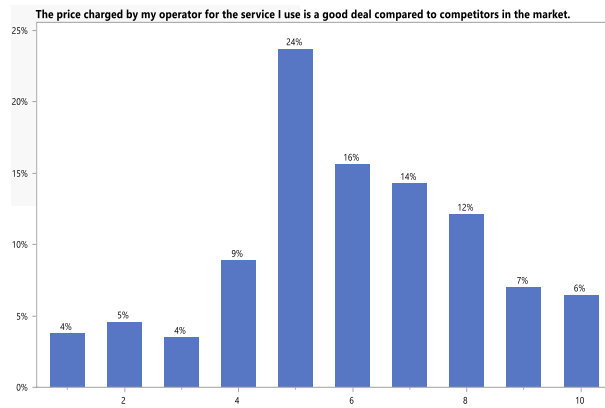
Figure 11: Perceived Value statements (a, b, c, d, e)

5.1.4. Expectations

The overall initial expectations about both the operator and the service appears to be very positive, the majority of the responses are higher than 5, being the scores 7 and 8 the most chosen ones. Regarding the other four statements and according to the respondents' responses, expectations about the operator's reliability were the highest ones, followed by the operator's ability to meet their needs. About 67% of the respondents stated that their expectations were met by the service provided, having voted on the four highest scores.
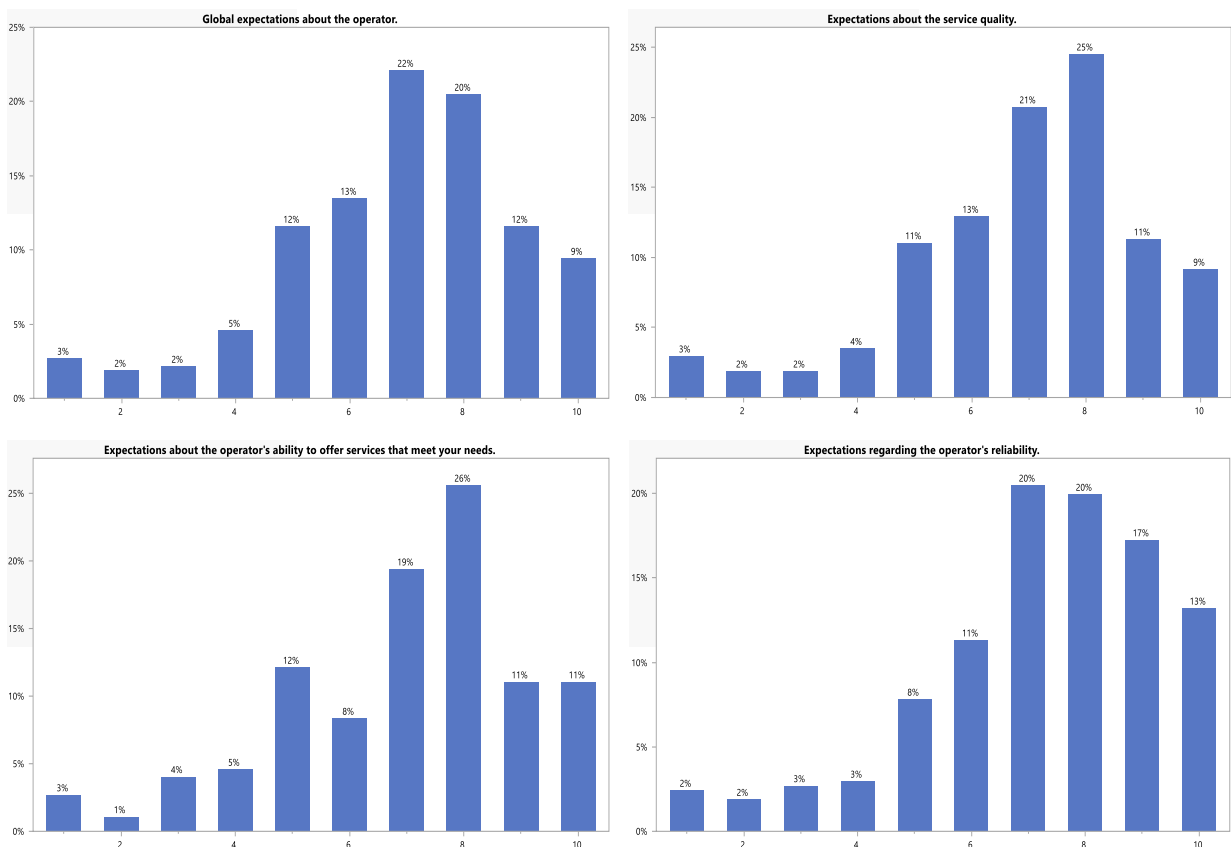
Figure 12: Expectations statements (a, b, c, d, e, f)

5.1.5. Satisfaction

From Figures 13 (a) and (b), most respondents seem to be satisfied with their operator and service being 7 and above the most rated ones. Figure 13 (c), we can see that a big percentage of the respondents (67% rated 7 or above) agree to the fulfillment of expectations being satisfied with their service. Regarding the service to meet the needs (Figure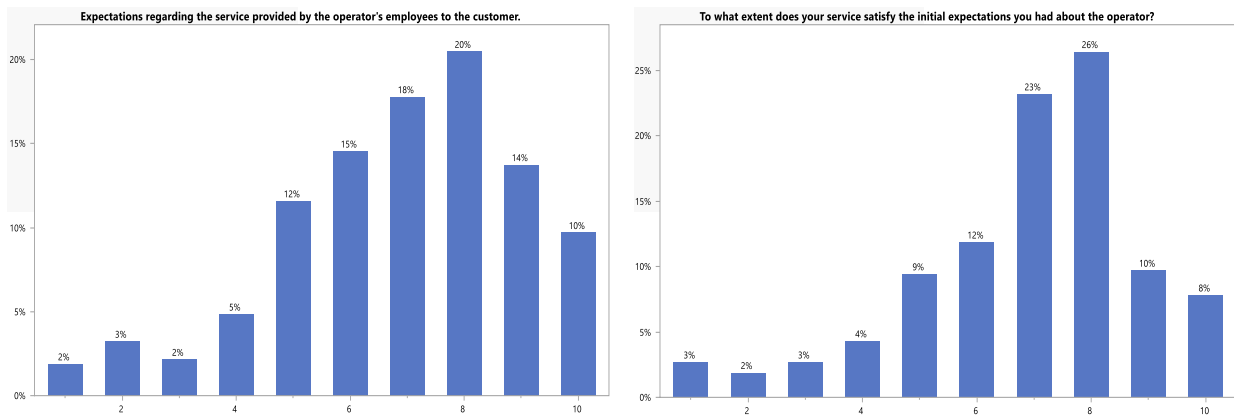 13 (f)), 71% of the respondents rated 7 or more. This means that their service is good enough to satisfy their needs. Contrarily, opinions diverge when it comes to rate the statement of the service being the best they have ever experienced (Figure 13 (e)). The higher scores still being the most voted ones although the lower scores are higher here than in the other statements. It is possible to conclude that there are more people satisfied with the service however there are also people who have already experienced better in the past.

When asked to compare their current operator with their ideal operator (Figure 13 (g)), 71% of respondents rated from 5 to 8. It is not the highest rate but it is not a bad score at all, being aware that they are comparing to their ideal operator and people tend to always create a lot of great expectations in their minds and are very critical of characteristics to improve.
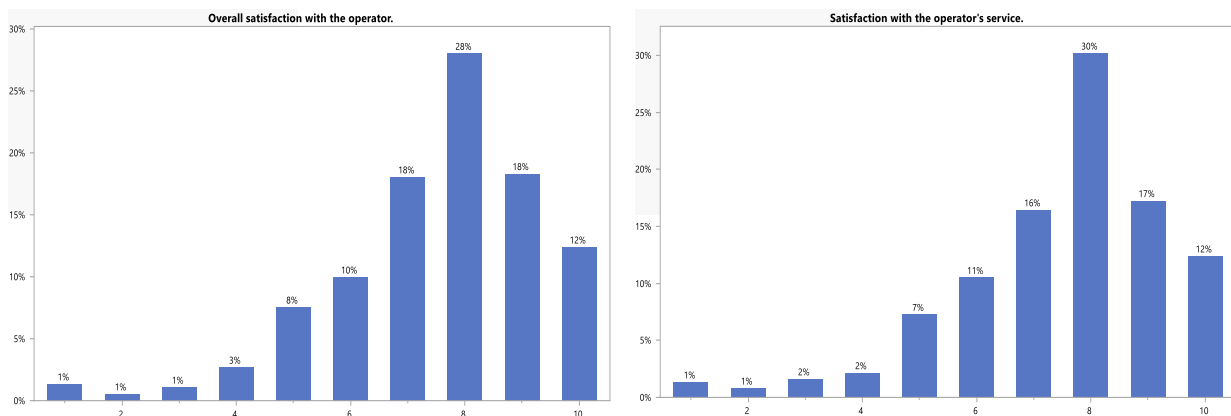
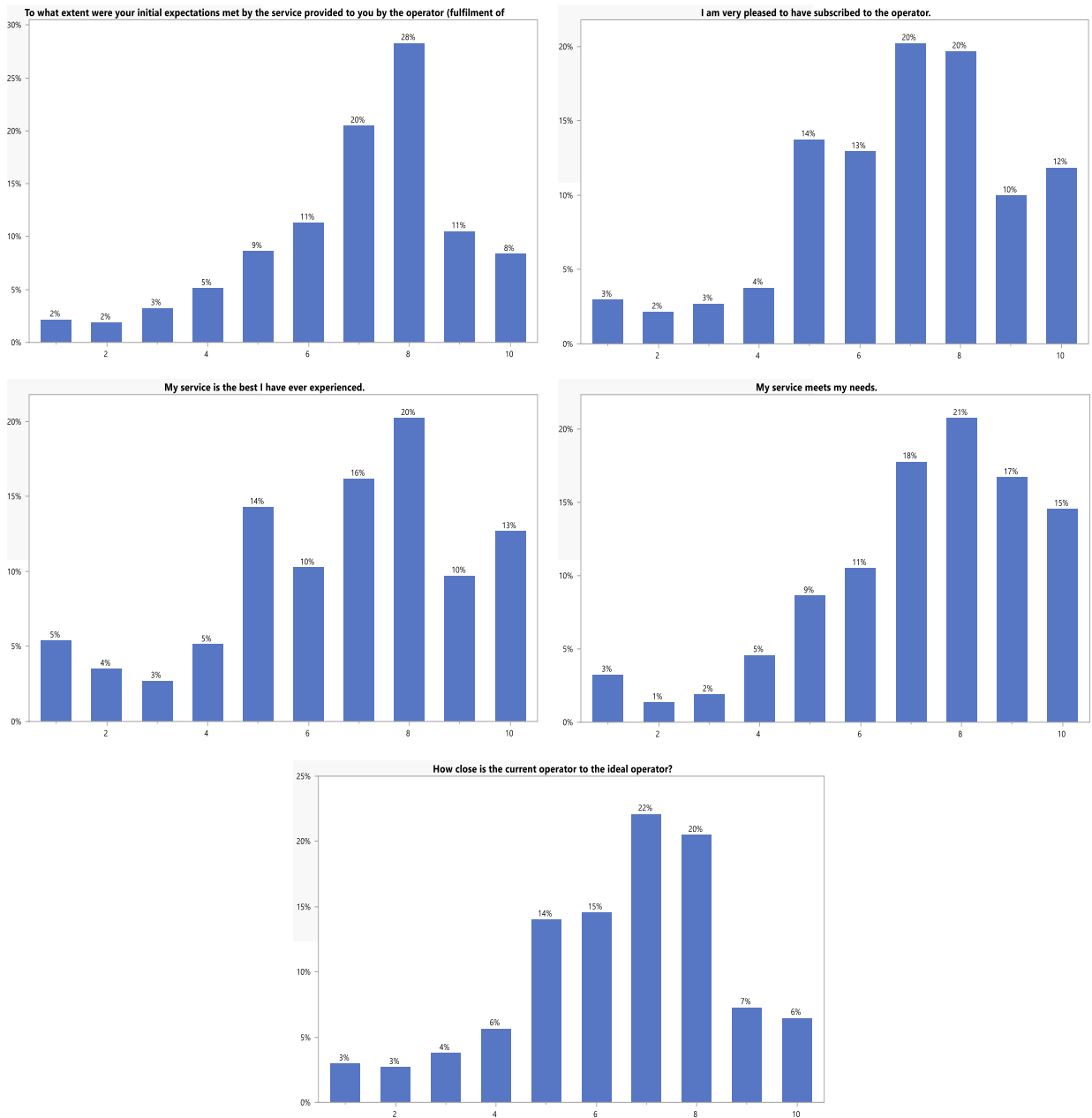**Figure 13:** Satisfaction statements (a, b, c, d, e, f, g)

5.1.6. Trust

From Figure 14(a), it is possible to affirm that more than half percent of the respondents rated 7 or more when evaluating their trust in the operator. 11% of this half have complete trust on it with a rate of 10. From Figure 14(c), we can conclude that the most disagreed statement is the reliability of the operator having as main concern its customers' interest, where the votes are very balanced having almost as many disagreed rates as agreed ones. There are a lot of people who do not believe in the operator's reliability and do not believe their main concern is the interest of its customers. From Figure 14(b), we see that a lot of people believe their operator works on the principle of honesty, having much more good rates than bad ones.
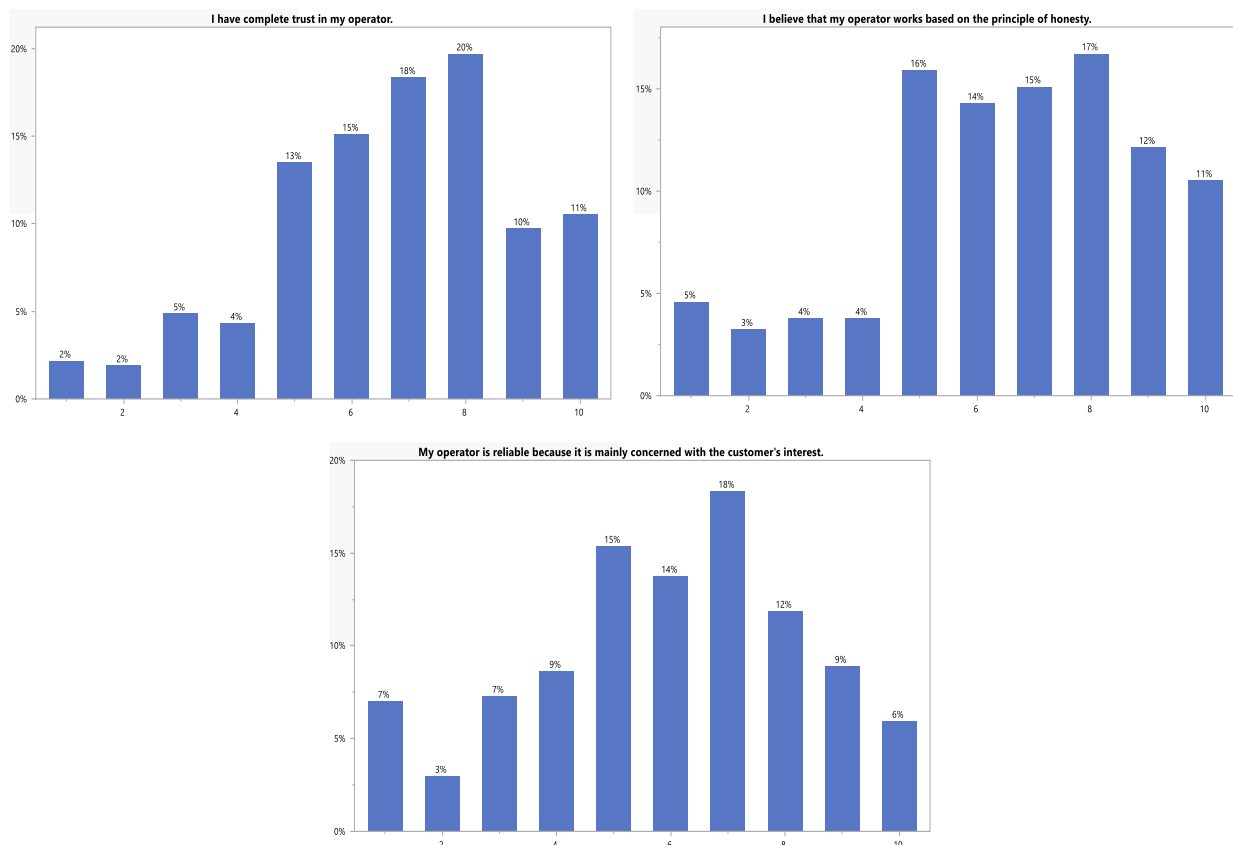
Figure 14: Trust statements (a, b, c)

5.1.7. Loyalty

Regarding loyalty, from Figure 15(a), 21% of the respondents have completely intention to remain as a customer of their operator, followed by 14% and 18%, having rated 9 and 8 respectively which are also high rates while 6% of the respondents demonstrated to be very unsatisfied and do not intend to remain as a customer. When questioned if their operator would be the first choice in case of purchase of a new product or service (Figure 15(b)), there are a diverge opinion having 18% of the respondents who strongly agree and 6% who strongly disagree. The rest of the opinions are dispersed along the scale. Regarding the positive word of mouth and the recommendation (Figures 15 (c) and (d)), there are more positive rates than negative ones although there are more lower rates in these two

statements than in the other two. However, this means that there are more people spreading a positive word of mouth and recommending the service or operator than people spreading a bad word of mouth.

Figure 15: Loyalty statements (a, b, c, d)

5.2. ASSESSMENT OF THE REFLECTIVE MEASUREMENT MODEL

First of all, it should be noted that some of the indicators were eliminated. Value1 was eliminated because it had a very low loading which may indicate that it has a very week and irrelevant influence on the variable Perceived Value. The indicator Image4 was also eliminated and Image1 instead of being associated to Image, it is now associated to the variable Satisfaction due to some correlation problems between Image and Satisfaction.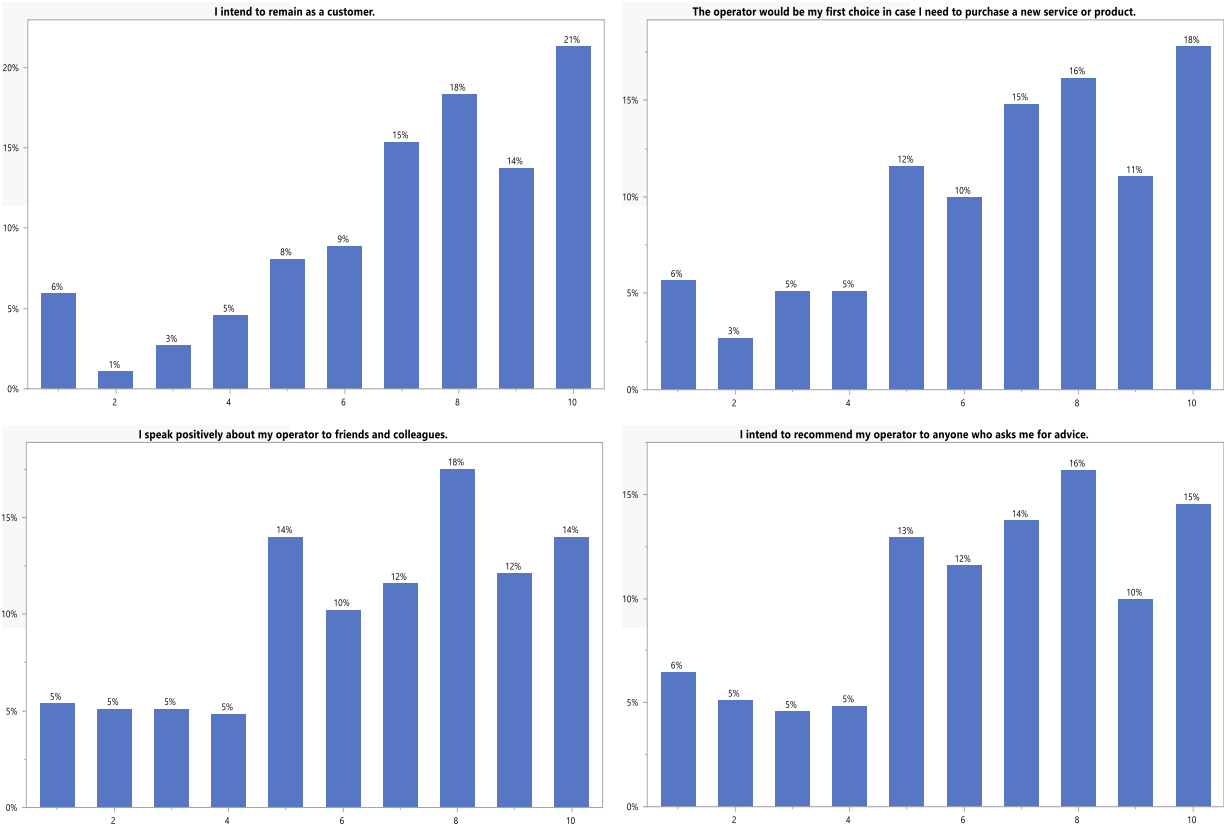 The indicators Quality1, Quality3, Quality5 and Quality7 had to be removed also due to correlation problems between Perceived Quality and Satisfaction. With all these indicators present, in the Fornell-Larcker Criterion that will be analysed later, both Image and Perceived Quality had a higher correlation value with Satisfaction than their AVE value. That is why it was decided to eliminate them and associate Image1 with Satisfaction.

The assessment of the measurement model is essential and it is the first step since it provides the rules of correspondence between the measured and the latent variables (Hair et al., 2010). My measurement model is considered to be reflective for the reason that the presented indicators are a representative set of items which reflect the latent variable they are measuring (Janadari and Ramalu, 2018).

Therefore, the first step in reflective measurement model assessment includes the examination of the indicator loadings (Hair et al., 2018). The loadings represent the correlation between the indicators and the respective latent variables and they are recommended to be above 0.708, as like this they indicate that the construct explains more than 50% of the indicator's variance.

Table 6 - Loadings of each indicator

Construct	Indicators	Loading	Indicator Reliability (loadings^2)
Image	Image2	0.802	0.643
	Image3	0.832	0.692
	Image5	0.871	0.759
	Image6	0.760	0.578
Expectations	Expect1	0.907	0.823
	Expect2	0.907	0.823
	Expect3	0.924	0.854
	Expect4	0.912	0.832
	Expect5	0.858	0.736
	Expect6	0.840	0.706
Perceived Quality	Quality2	0.847	0.717

	Quality4	0.893	0.797
	Quality6	0.800	0.640
	Quality8	0.724	0.524
Perceived Value	Value2	0.721	0.520
	Value3	0.737	0.543
	Value4	0.840	0.706
	Value5	0.865	0.748
Satisfaction	Sat1	0.902	0.814
	Sat2	0.896	0.803
	Sat3	0.897	0.805
	Sat4	0.939	0.882
	Sat5	0.870	0.757
	Sat6	0.850	0.723
	Sat7	0.883	0.780
	Image1	0.852	0.726
Trust	Trust1	0.935	0.874
	Trust2	0.935	0.874
	Trust3	0.935	0.874
Loyalty	Loyalty1	0.930	0.865
	Loyalty2	0.948	0.899
	Loyalty3	0.952	0.906
	Loyalty4	0.950	0.903

According to Hair et al., (2011), indicators with outer loadings below 0.40 should always be eliminated from the construct. The indicator Value1 was extracted as mentioned from the analysis since it presented a negative and really low outer loading value which may indicate that this indicator has a weak influence on the respective variable. The model and the internal consistency got better after that extraction. High outer loadings on a variable indicate that the associated indicators have much in common, which is captured by the variable (Hair et al., 2017). From Table 6, we can see that the

loadings of all indicators are strongly correlated with the respective latent variable with values exceeding the threshold of 0.708, which suggests sufficient levels of indicator reliability.

The next steps are to assess internal consistency reliability, using Cronbach's Alpha and Composite Reliability, the convergent validity of each construct measure and the discriminant validity. Table 7 presents the required measures that will be developed right after.

Table 7 - Reliability and Validity measures

Latent Variable	Cronbach's Alpha	Composite Reliability	Average Variance Extracted
Image	0.834	0.889	0.668
Expectations	0.948	0.959	0.795
Perceived Quality	0.834	0.889	0.669
Perceived Value	0.803	0.871	0.629
Satisfaction	0.961	0.967	0.786
Trust	0.928	0.954	0.874
Loyalty	0.960	0.971	0.894

5.2.1. Internal Consistency Reliability

The internal consistency is measured through the traditional criterion Cronbach's alpha which provides an estimate of the reliability based on the intercorrelations of the observed indicator variables. Although, due to some of Cronbach's alpha's limitations and given this being a conservative measure of reliability (it results in relatively low reliability values), it is appropriate to also apply a different measure, the Composite reliability, which takes into account the different outer loadings of the indicator variables. This one results in comparatively higher reliability estimates. Therefore, the best option is to consider and report both of them. (Hair et al., 2017)

From Table 7, we can confirm that all the latent variables have a high value of Cronbach's alpha, being the lowest values 0.803 for Perceived Value and 0.834 for both Image and Perceived Quality. The other variables have all a Cronbach's alpha value above 0.9 where Satisfaction and Loyalty have the highest values with 0.961 and 0.960, respectively. Results between 0.8 and 0.9 are classified as good values and above 0.9 are excellent, indicating a strong internal consistency between the scale items. When it comes to the Composite reliability, all the values are above 0.7 as it should be, having once more the lowest value for Perceived Value (0.871) and the highest value for Loyalty (0.971). Overall, there is a strong internal consistency reliability since the values of Cronbach's alpha and Composite reliability are high. Therefore, it is possible to affirm that the scale is reliable and also that it is consider to indicate that the variables are being well measured by the respective items.

5.2.2. Convergent Validity

The indicator reliability and the average variance extracted (AVE) are the measures used to evaluate convergent validity of reflective constructs. The indicator reliability corresponds to the square of the outer loadings of the indicators and it is considered to be the variance extracted from the indicator, representing how much of an indicator's variation is explained by the latent variable. The variable should explain at least 50% of the respective indicators. The AVE measure is defined as the main mean value of the squared loadings of the indicators associated with the construct and it should be 0.5 or higher which means that it explains more than half of the variance of its indicators.

From Table 6, the squared outer loadings should be above 0.5. All indicators have high squared outer loadings (above 0.5). The high values of the outer loadings of the indicators prove the similarities between the indicators of each construct. From Table 7, it is possible to observe the AVE values which are all above 0.5, where the lowest value is 0.629 for Perceived Value. This means that each construct explains more than 50% of the variance of its indicators. The construct that most explains the variance of its indicators is Loyalty having an AVE value of 0.894.

5.2.3. Discriminant Validity

Discriminant Validity is defined as the extent to which a construct is truly distinct from other constructs in the structural model (Hair et al., 2017; Hair et al., 2018). Therefore, this implies that a construct is unique and captures phenomena not represented by the other constructs presented in the model. Fornell and Larcker (1981) defend that the square root of each construct's AVE should be higher than the squared correlation values of that construct and all other constructs of the model. This is called the Fornell-Larcker criterion. Having this rule fulfilled, it is possible to affirm that the discriminant validity is established.

Table 8 - Fornell-Larcker Criterion values

	Image	Expectations	Perceived Quality	Perceived Value	Satisfaction	Trust	Loyalty
Image	**0.817**						
Expectations	0.762	**0.892**					
Perceived Quality	0.765	0.821	**0.818**				
Perceived Value	0.554	0.710	0.645	**0.793**			
Satisfaction	0.780	0.877	0.816	0.704	**0.887**		
Trust	0.744	0.809	0.746	0.641	0.850	**0.935**	
Loyalty	0.781	0.781	0.708	0.652	0.876	0.844	**0.945**

From Table 8, it is possible to observe that each variable's AVE value (the ones in the diagonal of the table) is higher than the squared correlation values of that variable with all other variables of the model. Therefore, it is possible to confirm that the discriminant validity is established.

Another measure to assess discriminant validity is the Cross-Loading values. Discriminant validity is established when an indicator's loading is higher on the respective construct than on the cross-loadings with the other constructs.

Table 9 - Cross-Loadings

	Image	Expectations	Perceived Quality	Perceived Value	Satisfaction	Trust	Loyalty
Image1	0.761	0.781	0.731	0.579	**0.852**	0.785	0.744
Image2	**0.802**	0.601	0.613	0.443	0.600	0.516	0.530
Image3	**0.832**	0.664	0.636	0.477	0.661	0.692	0.620
Image5	**0.871**	0.671	0.686	0.471	0.713	0.674	0.658
Image6	**0.760**	0.545	0.558	0.418	0.564	0.534	0.543
Expectations1	0.680	**0.907**	0.739	0.679	0.772	0.713	0.695
Expectations2	0.655	**0.907**	0.711	0.623	0.750	0.701	0.666
Expectations3	0.687	**0.924**	0.778	0.645	0.750	0.710	0.682
Expectations4	0.715	**0.912**	0.750	0.625	0.769	0.711	0.683
Expectations5	0.641	**0.858**	0.660	0.573	0.741	0.743	0.696
Expectations6	0.694	**0.840**	0.747	0.646	0.876	0.747	0.753
Quality2	0.638	0.730	**0.847**	0.560	0.730	0.596	0.627
Quality4	0.730	0.738	**0.893**	0.575	0.736	0.643	0.613
Quality6	0.573	0.623	**0.800**	0.540	0.647	0.654	0.588
Quality8	0.550	0.581	**0.724**	0.423	0.536	0.550	0.474
Value2	0.591	0.634	0.594	**0.721**	0.637	0.554	0.568
Value3	0.268	0.397	0.373	**0.737**	0.400	0.352	0.373
Value4	0.404	0.559	0.490	**0.840**	0.553	0.541	0.537
Value5	0.426	0.604	0.537	**0.865**	0.585	0.533	0.542
Satisfaction1	0.719	0.765	0.708	0.599	**0.902**	0.738	0.754

Satisfaction2	0.713	0.754	0.724	0.578	**0.896**	0.698	0.733
Satisfaction3	0.660	0.814	0.747	0.659	**0.897**	0.750	0.755
Satisfaction4	0.734	0.852	0.775	0.681	**0.939**	0.829	0.866
Satisfaction5	0.677	0.727	0.663	0.586	**0.870**	0.741	0.805
Satisfaction6	0.573	0.740	0.717	0.651	**0.850**	0.684	0.748
Satisfaction7	0.688	0.778	0.721	0.654	**0.883**	0.791	0.797
Trust1	0.753	0.815	0.757	0.635	0.862	**0.935**	0.835
Trust2	0.692	0.731	0.677	0.568	0.755	**0.935**	0.753
Trust3	0.637	0.716	0.653	0.590	0.759	**0.935**	0.774
Loyalty1	0.659	0.749	0.682	0.622	0.838	0.772	**0.930**
Loyalty2	0.679	0.736	0.661	0.609	0.826	0.807	**0.948**
Loyalty3	0.696	0.730	0.672	0.615	0.823	0.800	**0.952**
Loyalty4	0.696	0.740	0.661	0.620	0.824	0.813	**0.950**

Table 9 presents all the loadings and cross-loadings for every indicator. All the indicators have the highest level for the respective loading while all cross-loadings with the other constructs are lower. It should be remembered that the indicator Image1 is now associated with Satisfaction as previously mentioned due to collinearity problems. These results provide evidence for the constructs' discriminant validity.

5.3. ASSESSMENT OF THE STRUCTURAL MODEL

Once established the reliability and validity of the latent variable measures, the next step consists on the evaluation of the structural model results. I will start by presenting the structural model with the respective R^2 and path coefficient values.
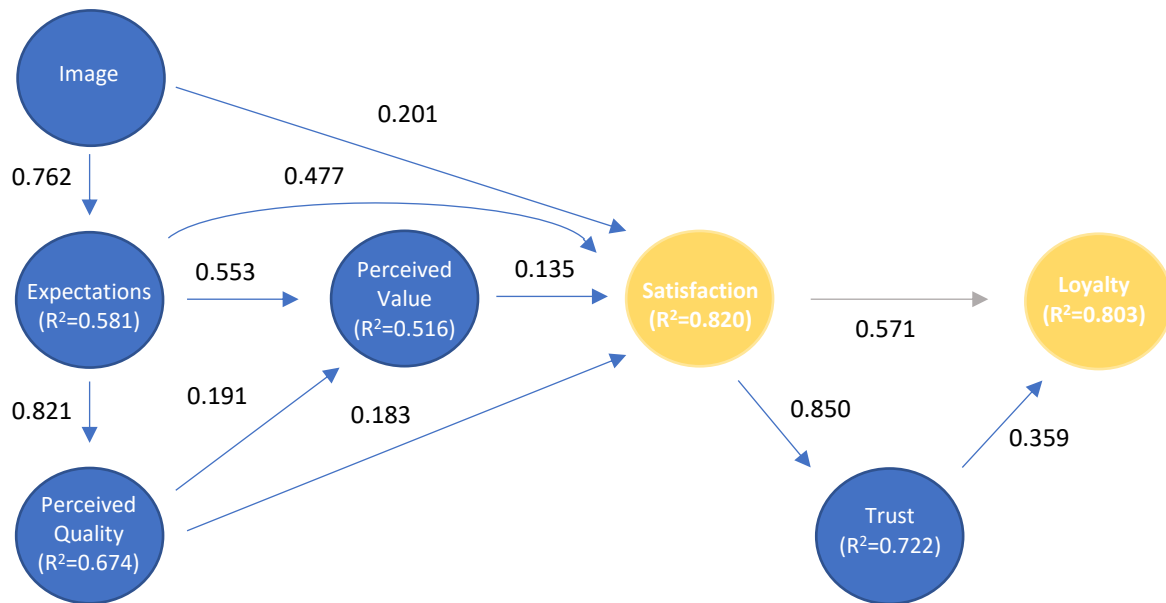
Figure 16: Structural model Results

Regarding the moderator's age, income and academic qualifications, none of them have proved to be statistically significant. Therefore, the hypotheses about the moderators age, income and academic qualifications being significant to the Satisfaction-Loyalty relationship is refuted. In this study, they have no prove of influence on this relationship. One possible explanation for the failure to prove their impact on loyalty may be due to. As already mentioned before, the respondents be very concentrated in two or three age groups. There are not enough variety in the respondents' sample to be able to carry out this analysis. In terms of the variable age, as shown by Figure 3, the majority of the respondents belong to the 45-49 years, 50-54 years and 40-44 years intervals. Therefore, there is not enough spectrum to be able to analyse its influence. The same for qualifications, where respondents are mostly divided between having a Bachelor and Secondary Education. For this reason, there are not enough respondents with other qualifications level in order to analyse the difference between their loyalty. Regarding income, respondents are mostly concentrated in the ranges 1001-1500€, 1501-2000€ and more than 2000€, which also do not allow the analysis of the effect of income on the satisfaction-loyalty relationship due to the lack of variety in the respondents' income level. Therefore, the moderator variables were removed from the model since they had no effect on the intended relationship, they do not need to remain present in the model.

Before assessing the structural relationships between the constructs, it is important to examine collinearity and to make sure that it does not bias the regression results through the Variance Inflation Factor (VIF) measure given that the relationships between the constructs are derived from estimating a series of regression equations (Hair et al., 2018). The VIF values give the percentage of the variance that is inflated for each construct. For values equal to 1, it means the variables are not correlated, values between 1 and 5 means that they are moderately correlated and for values greater than 5 the variables are highly correlated.

Table 10 - VIF Values

	Image	Expectations	Perceived Quality	Perceived Value	Satisfaction	Trust	Loyalty
Image		1.000			2.783		
Expectations			1.000	3.072	4.213		
Perceived Quality				3.072	3.667		
Perceived Value					2.069		
Satisfaction						1.000	3.599
Trust							3.599
Loyalty							

From Table 10, there are some relationships that seem not to be correlated having a VIF value of 1 such as Image with Expectations, Expectations with Perceived Quality and Satisfaction with Trust. All the other existent relationships between the constructs are moderately correlated between them having VIF values between 1 and 5, which is good.

5.3.1. Coefficient of Determination

The most common measure used to evaluate the quality of the structural model is the coefficient of determination, the R^2 value. R^2 is a measure of the model's predictive power, where higher values (in a scale from 0 to 1) indicates a greater explanatory power and predictive accuracy. The coefficient value represents the amount of variance in the endogenous variables explained by all of the exogenous variables that are associated to it (Hair et al., 2017).

Table 11 - Coefficient of Determination Values

Latent Variable	R^2	R^2 adjusted
Image	-	-
Expectations	0.581	0.580
Perceived Quality	0.674	0.674
Perceived Value	0.516	0.513
Satisfaction	0.820	0.818

Trust	0.722	0.721
Loyalty	0.803	0.802

The coefficient of determination is 0.820 for Satisfaction, which means that the 4 latent variables (Image, Expectations, Perceived Quality and Perceived Value) explain 82% of the variance in Satisfaction. For Loyalty, this value corresponds to 0.803 which means that Satisfaction and Trust explain 80.3% of the variance in Loyalty. Regarding the other variables, the values presented vary between 51.6% (in Perceived Value) to 72.2% (in Trust), meaning that they are well explained by the constructs linked to it too.

Given the relatively high coefficient of determination values (above 50%) for the latent variables, we can confirm that the structural model is well adjusted.

5.3.2. Size and Significance of Path Coefficients

The path coefficients estimates are in essence standardized regression coefficients and can be interpreted as "the change in the dependent construct measured by standard deviations, if an independent construct is increased by one standard deviation while keeping all other explanatory constructs constant" (Benitez et al., 2020).

Table 12 - Path Coefficient estimates

	Image	Expectations	Perceived Quality	Perceived Value	Satisfaction	Trust	Loyalty
Image		0.762			0.201		
Expectations			0.821	0.553	0.477		
Perceived Quality				0.191	0.183		
Perceived Value					0.135		
Satisfaction						0.850	0.571
Trust							0.359
Loyalty							

From both Figure 16 and Table 12, we can see that the path coefficient estimates for the hypothesized relationships range from 0.135 to 0.850. Apparently, from these values it is possible to confirm that the customer satisfaction has influence on loyalty. Although the mediator variable Trust seems to have

a relevant impact on that relationship since the path coefficient value between Satisfaction and Trust is 0.850 and between Trust and Loyalty is 0.359 while between Satisfaction and Loyalty is 0.571. From the values presented in the table, it is plausible to affirm that all the standardized path coefficients seem to be significant because they are all above 0.05.

A path coefficient estimate is considered as statistically significant at a 5% significance level when the p-value is lower than 0.05. In order to confirm and have surer if the path coefficient estimates are significant, the Bootstrapping technique was applied. Bootstrapping is a non-parametric procedure that allows testing the statistical significance of various PLS-SEM results, namely the path coefficients. In Table 13, there are present the bootstrapping results for Path coefficient estimates and the ones that have a T-value above 1.96 and a P-value below 0.05 are statistically significant.

Table 13 – T-statistics and P-values of Path Coefficients

	T-values	P-values	Hypothesized supported?
Image -> Expectations	24.016	0.000	Yes
Image -> Satisfaction	2.803	0.005	Yes
Expectations -> Perceived Quality	41.199	0.000	Yes
Expectations -> Perceived Value	8.232	0.000	Yes
Expectations -> Satisfaction	6.397	0.000	Yes
Perceived Quality -> Perceived Value	2.602	0.009	Yes
Perceived Quality -> Satisfaction	2.218	0.027	Yes
Perceived Value -> Satisfaction	3.297	0.001	Yes
Satisfaction -> Loyalty	11.303	0.000	Yes
Satisfaction -> Trust	49.600	0.000	Yes
Trust -> Loyalty	6.908	0.000	Yes

From Table 13, we can conclude that all the hypothesized path relationships are highly significant since the T-values are larger than 1.96 and the P-values below 0.05. Therefore, Satisfaction is a good predictor of Loyalty with a standardized path coefficient estimate of 0.571. Also, Trust is a partial mediator because the direct relation between Satisfaction and Loyalty is relevant although the relationships Satisfaction-Trust and Trust-Loyalty still relevant too.

5.3.3. f² effect sizes

In order to complement to the evaluation of R^2 values of all endogenous variables, the change in the R^2 value when omitting an exogenous construct from the model can be evaluated to understand if that omitted construct has a relevant effect on the endogenous constructs. f^2 effect size explain how the omission of a certain exogenous construct from the model affects an endogenous construct's R^2 value. According to Cohen (1988), when assessing f^2 effect size values higher than 0.02, 0.15 and 0.35 represent small, medium and large effects respectively, of the exogenous latent variable.

Table 14 - f^2 effect size values

	Image	Expectations	Perceived Quality	Perceived Value	Satisfaction	Trust	Loyalty
Image		1.387			0.081		
Expectations			2.072	0.206	0.301		
Perceived Quality				0.024	0.051		
Perceived Value					0.049		
Satisfaction						2.599	0.459
Trust							0.182
Loyalty							

From Table 14, we can conclude that Satisfaction (0.459) has a large effect on Loyalty and Satisfaction has also a large effect on Trust (2.599). Trust has a medium effect on Loyalty (0.182), which reinforces the fact that Trust is a partial mediator of the relationship Satisfaction-Loyalty. Expectations is the antecedent of Satisfaction with a bigger effect since it is above 0.15. The other antecedents are between 0.02 and 0.15 having a small effect on Satisfaction.

5.3.4. Predictive Relevance Q²

The measure Q^2 should also be examined in addition to the magnitude of the R^2 values as a criterion of predictive accuracy. Q^2 is an indicator of the model's predictive relevance and when confirmed, it accurately predicts data not used in the model estimation (Hair et al., 2017). These values should be larger than 0 for a specific endogenous construct to indicate the structural model's predictive accuracy for the construct. Hair et al. (2018) defend that small differences between the predicted and the original values translate into a higher Q2 value, thus indicative of a higher predictive accuracy. Q^2 values higher than 0, 0.25 and 0.50 describe small, medium and large predictive relevance of the structural model.

Table 15 - Construct Crossvalidated Redundancy

	SSO	SSE	Q^2 (=1-SSE/SSO)
Image	1484.000	1484.000	-
Expectations	2226.000	1205.979	0.458
Perceived Quality	1484.000	821.231	0.447
Perceived Value	1484.000	1030.595	0.306
Satisfaction	2968.000	1071.799	0.639
Trust	1113.000	417.723	0.625
Loyalty	1484.000	424.597	0.714

Table 15 presents the Construct Crossvalidated Redundancy estimates and SSO shows the sum of the squared observations, SSE the sum of the squared prediction errors and Q^2 the final value which we interpret to judge the model's predictive relevance. As can be seen, the Q^2 values for all 6 endogenous constructs are considerably above 0. More precisely, Loyalty has the highest Q^2 value (0.714), followed by Satisfaction (0.639) and Trust (0.625). These three variables show a large predictive relevance of the model while Expectations (0.458), Perceived Quality (0.447) and Perceived Value (0.306) show a medium predictive relevance. These results provide clear support for the model's predictive relevance regarding the endogenous constructs.

5.4. MODEL ADJUSTMENT

The main and final objective of this study is to understand if customer satisfaction impact linearly or not on loyalty and retention levels. The scatter plot obtained from the results in order to analyse the relationship between Customer Satisfaction and Loyalty is the following:
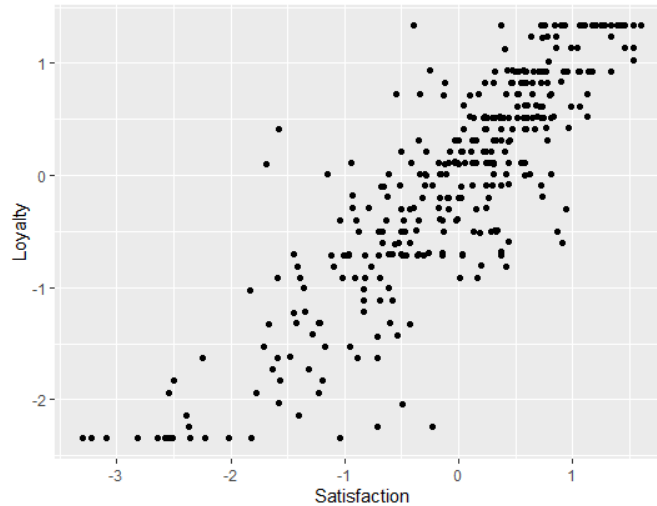
Figure 17: Scatter plot of the Satisfaction-Loyalty Relationship

From Figure 17, it is possible to observe and get a first impression of the type of shape that may suit the relationship between satisfaction and loyalty. It is clearly a positive relationship between the two variables. Regarding linearity, the scores do not appear to be completely linear since it is possible to see some scores accumulated at the top and bottom of the scatter plot. That must be the 1's and 10's values selected by the respondents. Therefore, it will be essential to try to adjust to this relationship a linear model and subsequently one or more non-linear ones in order to understand which fits best in this relationship. This is what will be done right after.

In order to see how a linear model (1) fits the impact that Customer Satisfaction has on Loyalty, it was adjusted to the relationship as the equation presented above and the results obtained from it were the following:

Table 16 - Summary of the Linear Model

Variable	Estimate	Standard Error	T-value	P-value
Trust	0.35911	0.04384	8.192	$4.27e^{-15}$
Satisfaction	0.57070	0.04384	13.018	$2e^{-16}$

Table 17 – Strength of the Linear Model

R^2 adjusted	Deviance explained
0.802	80.3%

From Table 16, both Trust and Satisfaction appears to have a significant impact on Loyalty with a very low p-value. From Table 17, the R^2 adjusted is a relatively good value with 0.802 which implies that 80.2% of the fluctuation in customer loyalty is explained by changes in both customer satisfaction and trust. With this result, Customer Satisfaction together with trust may be able to explain changes in Customer Loyalty although not 100% of them. The linear model explains 80.3% of the deviance.
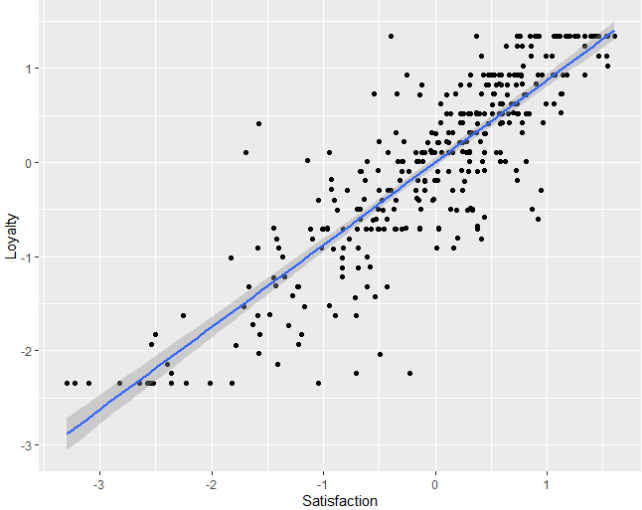

Figure 18: Scatter plot of the Linear model

However, from Figure 18 it is possible to say that it does not seem to be the best fit for this relationship. The initial scatter plot of the CS-CL relationship appears to have a slight curve both at the beginning and at the end of the plot, which is not the case of a linear model. Therefore, apparently a non-linear model or at least a model with some possible curvatures may fit better this relationship.

After the linear model, a polynomial regression (2) was adjusted and the results obtained are presented next:

Table 18 - Summary of the Polynomial Model

Variable	Estimate	Standard Error	T-value	P-value
Trust	0.359835	0.044001	8.178	$4.84e^{-15}$
Satisfaction, polynomial 1	0.645665	0.066246	9.746	$2e^{-16}$
Satisfaction, polynomial 2	0.030145	0.057720	0.522	0.602
Satisfaction, polynomial 3	-0.019960	0.030155	-0.662	0.508
Satisfaction, polynomial 4	-0.027484	0.024039	-1.143	0.254

Satisfaction, polynomial 5	-0.007454	0.006515	-1.144	0.253

Table 19 - Strength of the Polynomial Model

R^2 adjusted	Deviance explained
0.805	80.7%

From Table 18, Satisfaction appears to only be significant at a linear level 1. The other levels of the polynomial like the quadratic and cubic functions do not appear to be significant. However, a polynomial of order 5 was analysed and the R^2 adjusted value of 0.805 is slightly better than the linear one present in Table 17. The deviance explained in this model is also slightly higher which, is a better sign.
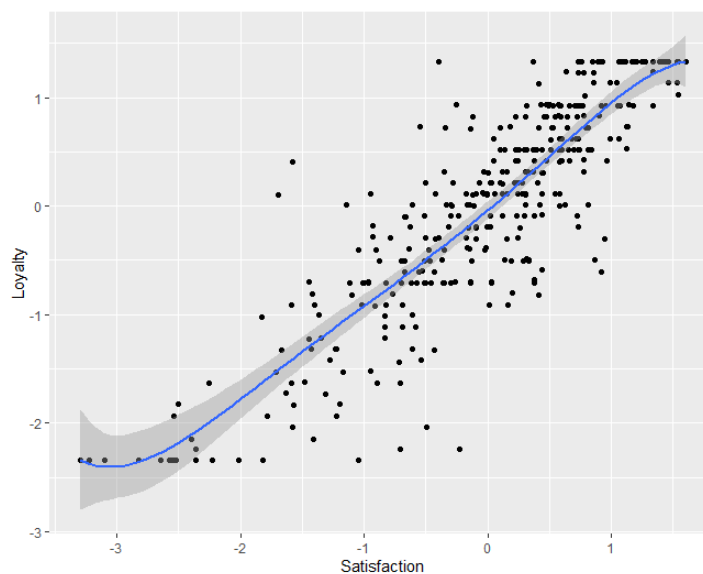
Figure 19: Scatter plot of the Polynomial Model

From Figure 19, it is also possible to affirm that this model seems to be more adjusted to the relationship than the linear one. Now there will be presented some non-linear models in order to see how they adjust to the intended relationship.

The results obtained for the Log transformation (3) were the following:

Table 20 - Summary of Logarithm Model

Variable	Estimate	Standard Error	T-value	P-value
Trust	0.84121	0.02810	29.938	$2e^{-16}$
log(Satisfaction)	0.01470	0.01754	0.838	0.403

Table 21 - Strength of the Logarithm Model

R² adjusted	Deviance explained
0.713	71.3%

In this model, log (Satisfaction) appears to not have a significant influence on loyalty. From Table 21, it can be concluded that both the R^2 adjusted and the deviance explained are lower than in the two first models. For this reason, the other two models may be better in the adjustment of the relationship in study.
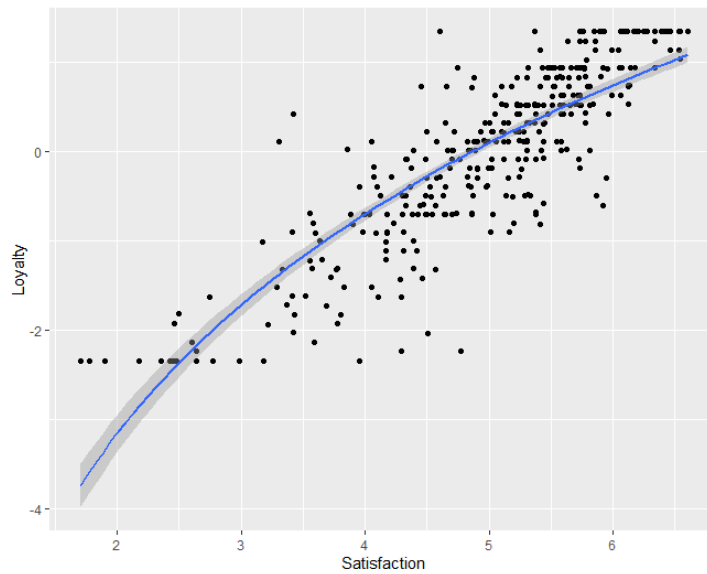

Figure 20: Scatter plot of the Logarithm Model

From Figure 20, the Logarithm model does not appear to be the best fit at least at the beginning of the scatter plot. The polynomial one seemed to have a better fit on all the values/points.

Regarding the Splines model (5), the results that were obtained were:

Table 22 - Summary of Splines model

Variable	Estimate	Standard Error	T-value	P-value
Trust	0.50657	0.04087	12.395	$2e^{-16}$
Satisfaction, bs 1	-2.45680	0.33005	-7.444	$7.36e^{-13}$
Satisfaction, bs 2	0.11614	0.22802	0.509	0.61084
Satisfaction, bs 3	-0.04022	0.09110	-0.441	0.65913
Satisfaction, bs 4	0.43464	0.18209	2.387	0.01751

Satisfaction, bs 5	-0.21054	0.22348	-0.942	0.34678
Satisfaction, bs 6	0.84382	0.26466	3.188	0.00156
Satisfaction, bs 7	0.10146	0.21631	0.469	0.63933
Satisfaction, bs 8	0.48646	0.23081	2.108	0.03576
Satisfaction, bs 9	0.21118	0.18716	1.128	0.25993
Satisfaction, bs 10	0.69763	0.33320	2.094	0.03698
Satisfaction, bs 11	0.63191	0.36140	1.749	0.08123
Satisfaction, bs 12	0.51042	0.16286	3.134	0.00187

Table 23 - Strength of the Spline model

R^2 **adjusted**	**Deviance explained**
0.782	78.9%

From Table 22, it can be observed that some of the parametric coefficients are significant while others are not. The R^2 adjusted and the deviance explained are not bad values although the linear and polynomial models have better values.
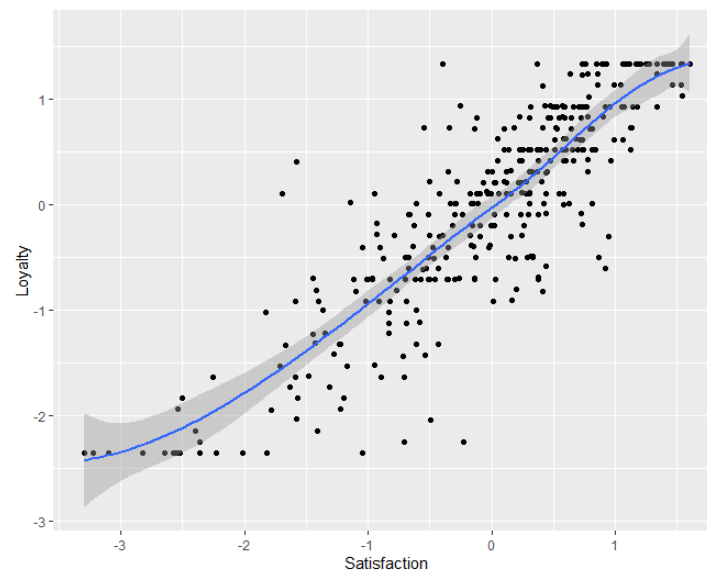
Figure 21: Scatter plot of Spline Model

From Figure 21, the Spline model appears a better fit than the Logarithm one. Apparently, the line is more adjusted to the presented scores in the plot. Therefore, it may be a good fit too.

The last model to be adjusted is the Generalized Additive Model (7) and the results are the following:

Table 24 - Summary of the GAM Model

Variable	Estimate	Standard Error	T-value	P-value
Trust	0.35742	0.04419	8.089	$8.85e^{-15}$
Satisfaction	2.695	3.338	52.06	$2e^{-16}$

Table 25 - Strength of GAM Model

R^2 adjusted	Deviance explained
0.804	80.5%

From Tables 24 and 25, it can be assumed that both Trust and Satisfaction appear to be significant in this model and the R^2 adjusted and Deviance explained values are higher and consequently better than the other regressions with the exception of the polynomial one.
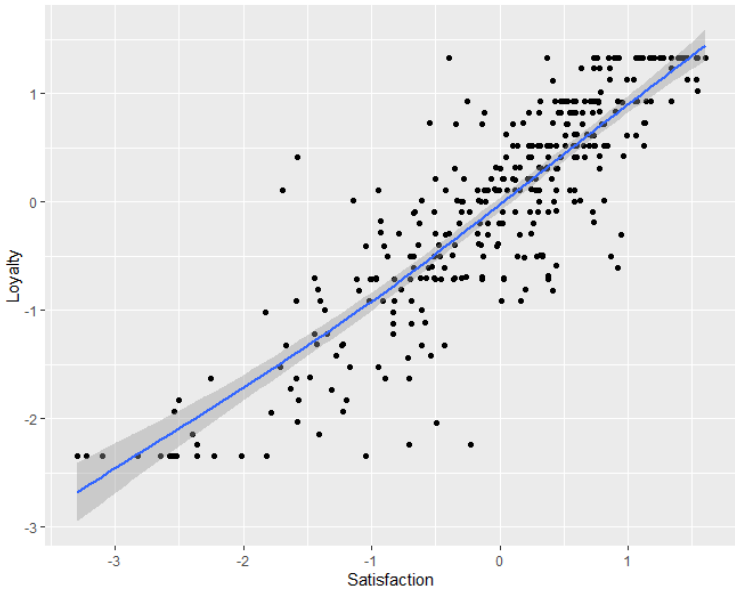
Figure 22: Scatter plot of the GAM Model

From Figure 22, the model appears to fit well the data although it causes doubt about which may be the best model through these scatter plots, as the polynomial and spline ones appear to adjust even better due to the present curvatures in those. However, the gam model also seems to adjust.

In order to get a final view on these models and try to understand which may be the one with a better fit to the relationship, the RMSE and R^2 values will be analysed for each model. As mentioned before, the lower the RMSE value the better the model. The contrary happens with the R^2 value, the higher the R^2 value the better the model.

Table 26 - Performance of the models

Model	RMSE	R^2
Linear	0.570947	0.7671526
Polynomial	0.5677038	0.7699753
Logarithm	0.9978168	0.6275443
Splines	0.6836755	0.6866889
GAM	0.5677575	0.7705646

From Table 26, it is possible to see that through these two values the model that appears to be the best one is the GAM, followed by the Polynomial one. These two models have the two highest values of R^2 and the two lowest values of RMSE.

Using the *anova* function in R software to compare the 4 models, the results are:

Table 27 - Anova Results

Model	Residual Df	Residual Deviance	Df	Deviance
Linear	369.00	73.094		
Polynomial	365.00	71.531	4.0000	1.563
Logarithm	369.00	106.461	-4.0000	-34.930
Spline	358.00	78.206	11.0000	28.255
GAM	366.66	72.196	-8.6617	6.010

Given the different nature of these models, the comparison between them will be done through the Deviance results. Deviance is a measure of how much unexplained variation there is in the model. The higher the value, the less accurate the model. In these results, it is possible to see in the Residual Deviance results that the two best models are the Polynomial and the GAM. In the Deviance results, the same happens. The best values correspond to the Polynomial and the GAM models. On the contrary, the worst model is clearly the Logarithm one with higher Residual Deviance and negative Deviance.

In order to complement these results, an AIC (Akaike Information Criterion) function was used. This is a method used to compare different possible models and see how well they fit the data and evaluate between the existent models which is the best one for the data. The results were the following:

Table 2828 - AIC Results

Model	Df	AIC
Linear	3.000000	456.1800
Polynomial	7.000000	456.1613
Logarithm	3.000000	595.6881
Spline	14.000000	503.2609
GAM	4.694941	454.9833

The lowest AIC model is the best model. The results obtained in Table 28 are similar to the results obtained in Table 27. From this, it is clear that GAM is the model that best fits the data while Polynomial is the second one that best fits.

6. CONCLUSION

Every company purpose is to maintain a long-term relationship with their customers and retain them. The most important part of every business is the customers, given that without customers there is no business. For a business to achieve success, customer satisfaction must be the first priority. A company needs to understand what their customers' needs are and how to create customer satisfaction. Therefore, the business will grow and develop, since once the customer reaches his/her satisfaction level it may influence them to consume and repurchase the product or service continuously.

Furthermore, they may share their positive experiences and recommend it to family and friends. Thus, they may become loyal customers to that business and attract new customers by their positive word of mouth, creating a positive effect on the business' profit margins, as it is less expensive to retain the current customers than to attract new ones. Customer satisfaction is proved to be the foundation for building customer loyalty. In the same way that a satisfied customer shares the experience, a dissatisfied customer will also share their unfortunate experience, and not recommend the service. Coupled with satisfaction is customer loyalty, which is also essential for any business area.

This dissertation intended mainly to analyse how customer satisfaction impacts customer loyalty and analyse which factors influence each one of them. It was applied to the Portuguese telecommunications market since it presents a considerable penetration rate in the European market and a great dynamism and innovation. The variables under study as antecedents of customer satisfaction and loyalty are also considered essential for building long-term relationships with customers and preventing them from switching to another operator, given the easiness of changing to a competitor in this market.

From the questionnaires, 58.4% of the respondents rely between 40 and 54 years and also 58.8% of the respondents are male. 49.6% of the inquiries have only Vodafone as their mobile operator and 26.1% have MEO. Overall, customers' satisfaction with their current mobile operator is good and according to the averages obtained in this research, it can be stated that respondents are satisfied with the several factors regarding their operator since all the mean values of the indicators of all variables under study, except one indicator, are well above the scale's mid point. Image indicators are where apparently respondents show higher rates of satisfaction, followed by Perceived Quality and Satisfaction. The indicator of Image affirming that the operator is a stable company and established in the market is the one with a higher mean, this indicates that it is the indicator where most of the respondents agree with. Perceived Value is the variable where the customers appear to be more in disagreement with, meaning that the customers think they are not paying a reasonable price for the services they get. The second less positive scored variable is Trust, where a lot of respondents do not agree with the main concern of the operator with the customers' interest. The majority of the respondents agree when relating to the intention to remain as a customer and to buy from their operator when wanting to purchase a new service or product.

Regarding the reliability of the scales used in the questionnaire, after a comparison of the Cronbach's alpha values and the composite reliability values, the scales are considered to be reliable. After analysing the results obtained, it is clear that customer satisfaction is the variable with the biggest impact on customer loyalty having a path coefficient value of 0.571. This can mean that if the customers are highly satisfied with the service, they will tend to be more loyal too. As Gronroos (2000)

points out, high satisfaction has positive consequences for an organisation and, consequently, increasing customer loyalty generating more profits. Therefore, it is proved the hypothesis that customer satisfaction influences customer loyalty. However, Trust proved to have a significant effect as a mediator variable between customer satisfaction and customer loyalty. The path coefficient estimate from customer satisfaction to trust is 0.850 and from trust to customer loyalty is 0.359. This result is in line with Kumar et al. (2013) and Ahrholdt et al. (2019). Customer satisfaction is not sufficient to explain loyalty while including other variables may better predict loyalty. This result also provides empirical evidence supporting previous literature (Leninkumar, 2017) that the higher the level of satisfaction and trust perceived by the customer, the higher the level of customer loyalty achieved by mobile service providers. The association between satisfaction and trust demonstrates that when consumers experience the operator's ability to satisfy their needs, their trust tends to increase as described by Garbarino and Johnson (1999). Thus, this study supports the theory of having other variables significantly impacting loyalty besides satisfaction.

All the hypotheses present in *Chapter 3* (path coefficients present in the structural model) were proved to be significant, so all the antecedents of customer satisfaction and loyalty are relevant. According to the results, the variable with a higher influence on customer satisfaction is Expectations with a path coefficient estimate of 0.477. Furthermore, after applying the Bootstrapping technique, the significance of all path coefficients was proved to be supported. Since none of the hypotheses is rejected, all of these factors are important for acquiring customer loyalty and therefore none should be overlooked as it is relevant to improve what is needed in each one. However, there is one aspect or another where consumers are clearly less satisfied, which will be mentioned later. Regarding the coefficients of determination, satisfaction's variance is well explained by the four antecedents in the model, namely image, expectations, perceived quality and perceived value with 82%, and loyalty with an explained variance of 80.3% by satisfaction and trust.

It is worth mentioning again that it was impossible to prove the moderate effect of Age, Monthly Income and Qualifications on loyalty as defended by both Homburg and Giering (2001) and Chiguvi and Guruwo (2015). As mentioned, the possible reason found for this lack of significant effect on the increase or not on loyalty may be due to the lack of a wider range of ages and salaries since the respondents are mostly between 40 and 54 years old, there should also be a greater number of responses outside this range to try to prove the effect. The same happens with the variable income, most respondents are between the intervals 1001-1500€ and More than 2000€. It would also be needed a higher number of respondents at the various levels of qualification and not mostly focused on the Bachelor and Secondary Education qualifications. Therefore, this intention to prove the significant impact of the moderators failed because most of the respondents belonged to the same categories in age, income and qualifications. It did not allow the comparison between the increasing ages, incomes and qualifications.

Regarding the adjustment of the model, as seen in the previous chapter, several models were tested on the relationship between Customer Satisfaction and Customer Loyalty in order to understand which ones better adjust. The linear relationship is supported by several authors, namely Fornell et al. (1996); Bloemer and Ruyter (1998); Bolton and Drew (1991); Garbarino and Johnson (1999), although it has been questioned. This study refutes the linear relationship between the variables in question. In fact, from the initial scatter plot of the customer satisfaction-loyalty relationship (Figure 17), it is possible to retain that the present line does not appear precisely straight. From the scatter plot of the linear

model (Figure 18), it is clear that linearity is not the best choice to the data because it does not appear to be the best fit. On the contrary, Jones and Sasser (1995), Mittal et al. (1998) and Anderson and Mittal (2000) do not support the same idea of linearity. Ahrholdt et al. (2019) defend a nonlinear effect of satisfaction on loyalty. This study agrees with that opinion, given that from the scatter plots present on Figures 19, 21 and 22, the present lines in each of them are better adjusted to the data than Figure 18.

Furthermore, from the final results obtained of the RMSE and R^2 values and from the ANOVA and AIC results, the conclusion is clearly standing out the Polynomial and GAM models. These two were the models with the best results in all the three tables (Table 26, 27 and 28). So, the models with a slight curve at the beginning and at the end appear to be a better fit to the data. Consequently, there is evidence to conclude that models with some curvature may better explain the relationship between customer satisfaction and loyalty and better fit that relationship than the linear one without any curve. From this, there is evidence to confirm that the changes made in customer satisfaction will not impact directly the changes occurred in customer loyalty.

An additional conclusion from the results of the questionnaire was that the variable where there is clearly less agreement on the part of the respondents is the Perceived Value. Respondents seem to agree that the price paid for the service given the quality is not fair, being the lowest mean value from all variables and indicators. Therefore, most respondents agree that the price they pay for the quality of the service they get is too high. Moreover, a significant percentage of respondents deny that the price they pay for the service is less than the price charged by competitors. So, this explains that there are respondents who do not agree with the price they pay although they know there are better prices in the market. One possible reason may be because they are still obliged to remain in the current operator due to a contract and cannot change operators before that contract ends. From this, it is essential to note that mobile service providers should try to understand their customers' opinion regarding this characteristic since the customers are not that pleased with the prices they pay. Operators could maybe understand if the quality their customers are receiving is decent and if the price is equivalent to that and, if not, experiment to reduce the prices or improve the quality to increase customer satisfaction level. Another possible strategy may be the creation of some discounts or promotions which will benefit their customers.

The second variable where there is less agreement in a positive opinion is in Trust. A substantial percentage of the respondents do not agree that their operator is reliable due to their main concern with the customers' interest. Therefore, mobile service providers should start caring more for their customers' interest and needs. It is important for the customers to feel that their operator is working to provide the adequate service to their needs and interests and that way the customer will be more satisfied with it and gain trust on the operator. So, mobile service providers need to think and care about their customers' interests and work towards that in order to get their trust on the operator and consequently their satisfaction and loyalty. Trying to work on the factors that customers show to be less satisfied with, will push the satisfaction level of the customers high and may lead to loyalty.

This study has highlighted that not only satisfaction but also loyalty are fundamentals of any business and understanding them helps the company to improve. The companies who accept as true the linear relationship between these concepts might be surprised if the investment made on satisfaction does not result in a proportional increase in customer retention. Customer retention will only be obtained

if the customer is greatly satisfied with the service. It should be emphasised that operators really need to think about their customers' needs to be able to provide the best service possible and make them satisfied with the service they are obtaining. Only in this way will it be possible to lead their customers to become loyal to the operator and with the willing to keep purchasing from it. As already mentioned, the most important part of a business are their customers, they make the company's success and define its growth. A business would not remain a business if there were no customers to sell their products and services to, and trying to attend a customer's interests is immensely important because it will make the customer want to buy it and maybe rebuy it later if satisfied. More important than what a company offers is what their customers need to obtain from a specific product or service that would make them want to buy it.

7. LIMITATIONS AND RECOMMENDATIONS

It may be relevant to state some of the limitations found during the realisation of this dissertation in order to indicate possible lines for future investigations. Firstly, due to the method used through an online questionnaire made available on social networks, it was only possible to reach people from mostly one or two geographic regions, the one where I am from and the one where I study, which may limit the study a little as it may not be well representing the entirety of Portugal. It would be interesting in future work to try to reach a greater geographic area in order to have a broader knowledge of the behavior of operator's service in various parts of the country and to be able to have a more comprehensive view of the behavior of mobile service customers in Portugal.

Secondly, although the sample used in this study has a sufficient number of answers, it is never too much to obtain as many as possible since the larger the sample, the more reliable the analysis made to it will be. Furthermore, the low spread in terms of age, income and qualifications of the respondents is a major limitation as it was not possible to prove their effect on customer loyalty due to this. Therefore, one recommendation for future work is to take this factor into account and make sure to have a significant portion of respondents from the various intervals to be analysed. Thus, it will be possible to have a sufficient number of respondents with the various intervals of age, with the various levels of qualifications and salary ranges and be able to analyse their impact. Having a larger sample will help in this regard, as it will likely include a wider range of respondents.

Lastly, another limitation present in this study was the focus only on the telecommunications market, more specifically on the mobile service. The behavior of the relationship between customer satisfaction and loyalty may differ by industries, countries or the market under analysis, as well as the determinants of customer loyalty. In order to generalise these findings, it could be interesting in a future study to analyse this same relationship and determinants in different areas/industries and compare the customer satisfaction's impact on loyalty in other markets.

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9. APPENDIX

Annexe I – Questionnaire

O meu nome é Inês Vasconcelos e sou estudante de mestrado da Universidade Nova de Lisboa. Este questionário pretende recolher dados para a realização de uma tese de mestrado em Estatística e Gestão de Informação.

O principal objetivo é compreender quais os fatores que influenciam a satisfação e a lealdade dos clientes na área das telecomunicações.

Caro participante, este questionário online demorará entre 8 a 12 minutos. As respostas ao questionário são anónimas pelo que não existe qualquer risco envolvido em responder a qualquer uma das questões.

Não existem respostas certas ou erradas, por isso solicito-lhe gentilmente que responda com a máxima honestidade. A sua participação é voluntária.

É utilizador regular do serviço de telefone móvel?

○ Sim
○ Não

Se não tiver serviço de telecomunicações móveis ou se não for utilizador regular, agradeço mas pode terminar o questionário aqui.

Qual a sua operadora de serviço de telefone móvel (possibilidade de resposta múltipla)?

☐ Vodafone
☐ MEO
☐ NOS
☐ NOWO
☐ [_____] Outra

Se respondeu mais do que uma operadora na questão anterior, por favor indique qual aquela que utiliza mais frequentemente?

○ Vodafone
○ MEO
○ NOS
○ NOWO
○ [_____] Outra

Nas perguntas que se seguirem, peço o favor de formular a sua resposta sobre a operadora ${q://QID3/ChoiceGroup/SelectedChoices}.

Há quanto tempo é cliente da operadora ${q://QID3/ChoiceGroup/SelectedChoices}?

○ Menos de 6 meses
○ 6 meses - 1 ano
○ 1 - 2 anos
○ 2 - 3 anos
○ Mais de 3 anos

Se tiver escolhido a opção "menos de 6 meses", agradeço mas pode terminar o questionário aqui.

De 1 a 10, considerando 1 - Nada satisfeito e 10 - Completamente satisfeito, responda às seguintes questões:

	1 - Nada satisfeito	2	3	4	5	6	7	8	9	10 - Completam satisfeit
Qual o seu grau de satisfação global com a operadora ${q://QID3/ChoiceGroup/SelectedChoices}?	O		O	O	O	O	O	O	O	O
Qual o seu grau de satisfação com o serviço que usa da operadora ${q://QID3/ChoiceGroup/SelectedChoices}?	O		O	O	O	O	O	O	O	O

De 1 a 10, considerando 1 - Discordo fortemente e 10 - Concordo fortemente, classifique cada uma das seguintes afirmações relacionadas com a imagem que tem sobre a operadora ${q://QID3/ChoiceGroup/SelectedChoices}:

	1 - Discordo fortemente	2	3	4	5	6	7	8	9	10 - Concordo fortemente	Não sei/Não respondo
A minha operadora é uma empresa de confiança no que diz e no que faz.	O	O	O	O	O	O	O	O	O	O	O
A minha operadora é uma empresa estável e implantada no mercado.	O	O	O	O	O	O	O	O	O	O	O
A minha operadora contribui positivamente para a Sociedade.	O	O	O	O	O	O	O	O	O	O	O
A minha operadora demonstra preocupação para com os seus clientes.	O	O	O	O	O	O	O	O	O	O	O
A minha operadora é uma empresa inovadora e virada para o futuro.	O	O	O	O	O	O	O	O	O	O	O
A minha operadora tem uma melhor imagem que os seus concorrentes.	O	O	O	O	O	O	O	O	O	O	O

De 1 a 10, considerando 1 - Muito baixa e 10 - Muito elevada, responda às seguintes questões relacionadas com a sua perceção da qualidade:

	1 - Muito baixa	2	3	4	5	6	7	8	9	10 - Muito elevada	N sei resp
Qual o grau de qualidade global sobre a operadora ${q://QID3/ChoiceGroup/SelectedChoices}?	O		O	O	O	O	O	O	O	O	(
Qual o grau de qualidade do seu serviço de telecomunicações móveis?	O		O	O	O	O	O	O	O	O	(

De 1 a 10, considerando 1 - Discordo fortemente e 10 - Concordo fortemente, classifique cada uma das seguintes afirmações relacionadas com a sua perceção da qualidade:

	1 - Discordo fortemente	2	3	4	5	6	7	8	9	10 - Concordo fortemente	Não sei/Não respondo
Considero o meu serviço de telefone móvel fiável.	O	O	O	O	O	O	O	O	O	O	O
A minha operadora tem uma boa diversidade de serviços à disposição.	O	O	O	O	O	O	O	O	O	O	O
A minha operadora transmite a informação com clareza e transparência.	O	O	O	O	O	O	O	O	O	O	O

A minha operadora permite a fácil subscrição ou alteração de um serviço.

○　　○ ○ ○ ○ ○ ○ ○ ○　　○　　○

Considero o atendimento ao cliente da minha operadora profissional e eficiente.

○　　○ ○ ○ ○ ○ ○ ○ ○　　○　　○

Considero a quantidade de lojas físicas disponíveis suficiente e com boa acessibilidade.

○　　○ ○ ○ ○ ○ ○ ○ ○　　○　　○

Dada a qualidade, como classifica o valor do preço pago pelo seu serviço de telefone móvel? Utilize a escala onde 1 significa "Muito baixo" e 10 significa "Muito elevado".

1- Muito baixo	2	3	4	5	6	7	8	9	10 - Muito elevado	Não sei/Não respondo
○	○	○	○	○	○	○	○	○	○	○

Dado o preço que paga, como classifica a qualidade do seu serviço de telefone móvel? Utilize a escala onde 1 significa "Muito baixa" e 10 significa "Muito elevada".

1 - Muito baixa	2	3	4	5	6	7	8	9	10 - Muito elevada	Não sei/Não respondo
○	○	○	○	○	○	○	○	○	○	○

De 1 a 10, considerando 1 - Discordo fortemente e 10 - Concordo fortemente, classifique cada uma das seguintes afirmações relacionadas com a sua perceção do valor:

	1 - Discordo fortemente	2	3	4	5	6	7	8	9	10 - Concordo fortemente	Não sei/Não respondo
O preço cobrado pela minha operadora é inferior ao preço cobrado por concorrentes face a serviços semelhantes.	○	○	○	○	○	○	○	○	○	○	○
O preço cobrado pela minha operadora pelo serviço que uso é justo.	○	○	○	○	○	○	○	○	○	○	○
O preço cobrado pela minha operadora pelo serviço que uso é um bom negócio comparado com os concorrentes no mercado.	○	○	○	○	○	○	○	○	○	○	○

De 1 a 10, considerando 1 - Muito baixas e 10 - Muito elevadas, classifique cada uma das seguintes afirmações relacionadas com as suas expetativas iniciais quando contratou o serviço:

	1 - Muito baixas	2	3	4	5	6	7	8	9	10 - Muito elevadas	s re
Expetativas globais sobre a operadora ${q://QID3/ChoiceGroup/SelectedChoices}.	○	○	○	○	○	○	○	○	○	○	
Expetativas sobre a qualidade do serviço.	○	○	○	○	○	○	○	○	○	○	
Expetativas sobre a capacidade da operadora oferecer serviços que satisfaçam as suas necessidades.	○	○	○	○	○	○	○	○	○	○	
Expetativas em relação à fiabilidade da operadora.	○	○	○	○	○	○	○	○	○	○	
Expetativas em relação ao serviço prestado pelos colaboradores da operadora ao cliente.	○	○	○	○	○	○	○	○	○	○	

Em que medida é que as suas expetativas iniciais foram satisfeitas pelo serviço que lhe é prestado pela operadora ${q://QID3/ChoiceGroup/SelectedChoices} (realização das expetativas)? Utilize a escala onde 1 significa "Nada satisfeitas" e 10 significa "Muito satisfeitas".

1 - Nada satisfeitas	2	3	4	5	6	7	8	9	10 - Muito satisfeitas	Não sei/Não respondo
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

Em que medida é que o seu serviço satisfaz as expetativas iniciais que tinha sobre a operadora ${q://QID3/ChoiceGroup/SelectedChoices}? Utilize a escala onde 1 significa "Nada satisfeitas" e 10 significa "Muito satisfeitas".

1 - Nada satisfeitas	2	3	4	5	6	7	8	9	10 - Muito satisfeitas	Não sei/Não respondo
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

De 1 a 10, considerando 1 - Discordo fortemente e 10 - Concordo fortemente, classifique cada uma das seguintes afirmações relacionadas com a sua satisfação:

	1 - Discordo fortemente	2	3	4	5	6	7	8	9	10 - Concordo fortemente
Estou muito satisfeito por ter subscrito à operadora ${q://QID3/ChoiceGroup/SelectedChoices}.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
O meu serviço é o melhor que já experienciei.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
O meu serviço corresponde às minhas necessidades.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

Peço-lhe agora que imagine a operadora ideal. Em que medida a operadora ${q://QID3/ChoiceGroup/SelectedChoices} se aproxima deste ideal? Utilize a escala onde 1 significa "Muito longe do ideal" e 10 significa "Muito perto do ideal".

1 - Muito longe do ideal	2	3	4	5	6	7	8	9	10 - Muito perto do ideal	Não sei/Não respondo
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

De 1 a 10, considerando 1 - Discordo fortemente e 10 - Concordo fortemente, classifique cada uma das seguintes afirmações relacionadas com a sua confiança na operadora ${q://QID3/ChoiceGroup/SelectedChoices}:

	1 - Discordo fortemente	2	3	4	5	6	7	8	9	10 - Concordo fortemente	Não sei/Não respondo
Tenho total confiança na minha operadora.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Acredito que a operadora trabalha com base no princípio da honestidade.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
A minha operadora é fiável pois preocupa-se principalmente com o interesse do cliente.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

De 1 a 10, considerando 1 - Discordo fortemente e 10 - Concordo fortemente, classifique cada uma das seguintes afirmações relacionadas com a sua lealdade:

	1 - Discordo fortemente	2	3	4	5	6	7	8	9	10 - Concordo fortemente
Tenho a intenção de permanecer como cliente.	O	O	O	O	O	O	O	O	O	O
A operadora ${q://QID3/ChoiceGroup/SelectedChoices} seria a primeira escolha em caso de necessidade de adquirir um novo serviço ou produto.	O	O	O	O	O	O	O	O	O	O
Falo positivamente sobre a minha operadora a amigos e colegas.	O	O	O	O	O	O	O	O	O	O
Tenho a intenção de recomendar a minha operadora a quem me peça um conselho.	O	O	O	O	O	O	O	O	O	O

Por favor, indique o valor mensal aproximado em euros que paga pelo seu serviço.

[   ]

Está, de momento, fidelizado à operadora ${q://QID3/ChoiceGroup/SelectedChoices}?

O Sim
O Não

Se respondeu que Sim, responda à seguinte questão:
Imagine que não está fidelizado à sua operadora. Qual seria a diferença de preço que o faria querer mudar imediatamente de operadora? Pode responder em euros ou em percentagem mas indique, por favor, a medida em uso.

[   ]

Se respondeu que Não, responda à seguinte questão:
Qual seria a diferença de preço que o faria mudar imediatamente de operadora? Pode responder em euros ou em percentagem mas indique, por favor, a medida em uso.

[   ]

Para finalizar o questionário, agradecia a resposta às seguintes informações.

Qual o seu género?

O Masculino
O Feminino

Qual a sua idade?

[   ]

Caso não queira responder a idade, por favor indique o intervalo onde se enquadra:

○ Menos de 25 anos
○ 25 - 29 anos
○ 30 - 34 anos
○ 35 - 39 anos
○ 40 - 44 anos
○ 45 - 49 anos
○ 50 - 54 anos
○ 55 - 59 anos
○ 60 - 64 anos
○ 65 - 70 anos
○ Mais de 70 anos

Qual o seu nível de Habilitações Literárias?

○ Ensino Primário (4º ano)
○ Ensino Básico (9º ano)
○ Ensino Secundário (12º ano)
○ Licenciatura
○ Mestrado
○ Doutoramento
○ Sem habilitações

Qual das seguintes opções melhor enquadra o valor líquido do seu rendimento mensal?

○ Menos de 500€
○ 500 - 800€
○ 801 - 1000€
○ 1001 - 1500€
○ 1501 - 2000€
○ Mais de 2000€

Frequencies and percentages of the Figures

Table 29 - Gender

	Frequency	Percentage
Female	153	41.2
Male	218	58.8
Total	371	100

Table 30 - Age

	Frequency	Percentage
Less than 25 years	36	9.7
25 – 29 years	14	3.8
30 – 34 years	9	2.4
35 – 39 years	25	6.7
40 – 44 years	55	14.8
45 – 49 years	81	21.8
50 – 54 years	81	21.8
55 – 59 years	41	11.1
60 – 64 years	21	5.7
65 – 70 years	8	2.2
Total	371	100

Table 31 - Academic Qualifications

	Frequency	Percentage
Basic education	35	9.4
Primary education	3	0.8
Secondary education	131	35.3
Bachelor	149	40.2
Master	44	11.9
PhD	8	2.2
Without qualifications	1	0.3
Total	371	100

Table 32 - Net Monthly Income

	Frequency	Percentage

Less than 500€	22	5.9
500 – 800€	47	12.7
801 – 1000€	56	15.1
1001 – 1500€	93	25.1
1501 – 2000€	60	16.2
More than 2000€	93	25.1
Total	371	100

Table 33 - Consumers Mobile Operator

	Frequency	**Percentage**
MEO	97	26.1
NOS	48	12.9
Vodafone	184	49.6
NOWO	2	0.5
Outra	4	1.1
Vodafone and MEO	24	6.5
Vodafone and NOS	9	2.4
Vodafone and Another	3	0.8
Total	371	100

Table 34 – For how long is a customer

	Frequency	**Percentage**
6 months – 1 year	9	2.4
1 – 2 years	27	7.3
2 – 3 years	20	5.4
More than 3 years	315	84.9
Total	371	100

Table 35 - Fidelization

	Frequency	**Percentage**
Yes	280	75.5
No	87	23.5

No answer	4	1.1
Total	371	100

Annexe III – Model Adjustment

```r
#install.packages("mgcv")
#install.packages("nlme")
#install.packages("tidyverse")
#install.packages("caret")
#install.packages("splines")

library(tidyverse)
library(caret)
library("readxl")
library(mgcv)
library(nlme)

relationship=as.data.frame(read_excel("C:/Users/vasco/OneDrive/Ambiente de Trabalho/Nova IMS/Tese/Tese/Análise dos resultados/relationship.xlsx"))
head(relationship)

#Scatter plot
ggplot(relationship, aes(Satisfaction, Loyalty) ) +
  geom_point() +
  stat_smooth()



#Linear regression
#Build the model
model_linear <- gam(Loyalty ~ -1 + Trust + Satisfaction, data = relationship)
summary(model_linear)
#Make predictions
new.data=data.frame(Satisfaction=relationship$Satisfaction,Trust=0)
predictions <- model_linear %>% predict(new.data)
#Model performance
data.frame(
  RMSE = RMSE(predictions, relationship$Loyalty),
  R2 = R2(predictions, relationship$Loyalty)
)
#Visualize the graphic
ggplot(relationship, aes(Satisfaction, Loyalty) ) +
  geom_point() +
  stat_smooth(method = lm, formula = y ~ x)
fit=data.frame(RMSE = RMSE(predictions, relationship$Loyalty),
               R2 = R2(predictions, relationship$Loyalty))
rownames(fit)=c("Linear")


#Polynomial regression
#Build the model
model_poly <- gam(Loyalty ~ -1 + Trust + poly(Satisfaction, 5, raw = TRUE), data = relationship)
summary(model_poly)
# Make predictions
new.data=data.frame(Satisfaction=relationship$Satisfaction,Trust=0)
predictions <- model_poly %>% predict(new.data)
# Model performance
data.frame(
  RMSE = RMSE(predictions, relationship$Loyalty),
  R2 = R2(predictions, relationship$Loyalty)
)
#Visualize
#experimentei com vários valores até ao 5 e este parece me ajustar
ggplot(relationship, aes(Satisfaction, Loyalty) ) +
  geom_point() +
  stat_smooth(method = lm, formula = y ~ poly(x, 5, raw = TRUE))
fit[2,]<-NA
fit[2,]<-c(RMSE(predictions, relationship$Loyalty),R2(predictions, relationship$Loyalty))
rownames(fit)=c("Linear", "Polynomial 5")

#Log transformation
# Build the model with log in satisfaction
relationship_log <- data.frame(Loyalty=relationship$Loyalty, Trust=relationship$Trust, Satisfaction = relationship$Satisfaction+5)
model_log <- gam(Loyalty ~ -1 + Trust + I(log(Satisfaction)), data = relationship_log)
summary(model_log)
# Make predictions
new.data=data.frame(Satisfaction=log(relationship_log$Satisfaction),Trust=0)
predictions <- model_log %>% predict(new.data)
# Model performance
data.frame(
  RMSE = RMSE(predictions, relationship_log$Loyalty),
  R2 = R2(predictions, relationship_log$Loyalty)
)
#Visualize
ggplot(relationship_log, aes(Satisfaction, Loyalty) ) +
  geom_point() +
  stat_smooth(method = lm, formula = y ~ log(x))
fit[3,]<-NA
fit[3,]<-c(RMSE(predictions, relationship_log$Loyalty),R2(predictions, relationship_log$Loyalty))
rownames(fit)=c("Linear", "Polynomial 5","Log Satisfaction")

# Build the model with log in loyalty
relationship_log <- data.frame(Loyalty=relationship$Loyalty+4, Satisfaction = relationship$Satisfaction, Trust=relationship$Trust)
model_log1 <- lm(log(Loyalty) ~ Trust + Satisfaction, data = relationship_log)
summary(model_log1)
# Make predictions
new.data=data.frame(Satisfaction=relationship$Satisfaction,Trust=0)
predictions <- model_log1 %>% predict(new.data)
# Model performance
data.frame(
  RMSE = RMSE(predictions, log(relationship_log$Loyalty)),
  R2 = R2(predictions, log(relationship_log$Loyalty))
)
# Visualize
ggplot(relationship_log, aes(Satisfaction, log(Loyalty)) ) +
  geom_point() +
  stat_smooth(method = lm, formula = y ~ x)
fit[4,]<-NA
fit[4,]<-c(RMSE(predictions, relationship_log$Loyalty),R2(predictions, relationship_log$Loyalty))
rownames(fit)=c("Linear", "Polynomial 5","Log Satisfaction","Log Loyalty")
```

```r
#Spline regression
library(splines)
# Build the model
#knots <- quantile(relationship$Satisfaction, p=c(seq(0.1,0.9,0.1)))
model_spl <- gam(Loyalty ~ -1 + Trust + bs(Satisfaction, knots = c(seq(0.1,0.9,0.1))), data = relationship)
summary(model_spl)
# Make predictions
new.data=data.frame(Satisfaction=relationship$Satisfaction,Trust=0)
predictions <- model_spl %>% predict(new.data)
# Model performance
data.frame(
  RMSE = RMSE(predictions, relationship$Loyalty),
  R2 = R2(predictions, relationship$Loyalty)
)
#visualize the cubic spline
ggplot(relationship, aes(Satisfaction, Loyalty) ) +
  geom_point() +
  stat_smooth(method = lm, formula = y ~ splines::bs(x, df = 7))
fit[5,]<-NA
fit[5,]<-c(RMSE(predictions, relationship$Loyalty),R2(predictions, relationship$Loyalty))
rownames(fit)=c("Linear", "Polynomial 5","Log Satisfaction","Log Loyalty","regression spline 7 df")


#Generalized addictive model
# Build the model
model_gam <- gam(Loyalty ~ -1 + Trust + s(Satisfaction, bs="cr"), data = relationship)
# Make predictions
new.data=data.frame(Satisfaction=relationship$Satisfaction,Trust=0)
predictions <- model_gam %>% predict(new.data)
# Model performance
data.frame(
  RMSE = RMSE(predictions, relationship$Loyalty),
  R2 = R2(predictions, relationship$Loyalty)
)
#Visualize
ggplot(relationship, aes(Satisfaction, Loyalty) ) +
  geom_point() +
  stat_smooth(method = gam, formula = y ~ s(x, k=5,bs="cr"))
fit[6,]<-NA
fit[6,]<-c(RMSE(predictions, relationship$Loyalty),R2(predictions, relationship$Loyalty))
rownames(fit)=c("Linear", "Polynomial 5","Log Satisfaction","Log Loyalty","regression spline 7 df","GAM")

fit
barplot(fit$RMSE[-4])
barplot(fit$R2[-4])

#Compare the model
anova(model_linear, model_poly, model_log,model_spl, model_gam)
```