Universidade de Aveiro
Ano 2020

MARIANA SANTOS MARTINS

ARE THE PORTUGUESE READY FOR THE FUTURE OF TOURISM? A TECHNOLOGY ACCEPTANCE MODEL APPLICATION FOR THE USE OF ROBOTS IN TOURISM

ESTÃO OS PORTUGUESES PREPARADOS PARA O FUTURO DO TURISMO? APLICAÇÃO DO MODELO DE ACEITAÇÃO TECNOLÓGICA AO USO DE ROBOTS EM TURISMO

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Dissertação apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Gestão e Planeamento em Turismo, realizada sob a orientação científica do Professor Doutor Carlos Manuel Martins da Costa, Professor Catedrático do Departamento de Economia, Gestão, Engenharia Industrial e Turismo da Universidade de Aveiro e co-orientação do Professor Doutor Stanislav Ivanov, Professor na Universidade de Gestão de Varna

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agradecimentos

A elaboração desta dissertação não seria possível sem o apoio de um conjunto de pessoas a quem gostaria de agradecer.

Aos meus pais, Isabel e António, e aos meus irmãos, Daniela e Diogo, por todo o amor, apoio e confiança e por me manterem os pés na terra.

Ao David, por todo o amor, carinho, paciência e apoio técnico e por acreditar mais em mim do que eu própria.

Aos meus colegas e amigos do gabinete, Ana, Joana, Liliana, Silvana e Vítor, por toda a ajuda e apoio incansável e por todos os momentos de descontração!

À Professora Doutora Maria João Carneiro, pela disponibilidade e apoio.

Às minhas tias, primas e amigos que ajudaram na divulgação do questionário e a todos os que participaram no estudo.

E, finalmente, ao meu orientador, Professor Doutor Carlos Costa, e coorientador, Professor Doutor Stanislav Ivanov, pela incrível orientação, apoio, disponibilidade, dedicação e inspiração.

palavras-chave

robots, turismo, modelo de aceitação tecnológica, inteligência artificial.

resumo

O setor do turismo em Portugal tem vindo a crescer exponencialmente nos últimos anos, tornando-se cada vez mais competitivo. Por outro lado, o uso de máquinas, robots e inteligência artificial nesta que é uma indústria construída por e para pessoas, tem também vindo a aumentar e a diversificar-se.

O objetivo desta investigação centra-se no estudo das variáveis que podem afetar a aceitação dos robots por parte do público português. É aplicado o Modelo de Aceitação Tecnológica para perceber a influência de um conjunto de variáveis sociodemográficas, de comportamento em viagem, de motivação e de atitude face à tecnologia em geral na facilidade de utilização percebida e utilidade percebida do uso de robots em turismo.

Os resultados obtidos permitem concluir que o caso português se assemelha ao de outros países ocidentais, tendo o género, idade, grupo de viagem, motivação e atitude face à tecnologia um impacto significativo nas variáveis dependentes.

keywords robots, tourism, technology acceptance model, artificial intelligence.

abstract

The tourism sector has been growing exponentially in Portugal over the last few years, becoming increasingly competitive. On the other hand, the use of machines, robots and artificial intelligence in this industry that is built by and for people, has also been increasing and diversifying.

The objective of this investigation focuses on the study of variables that can affect the acceptance of robots by the Portuguese public. The Technology Acceptance Model (TAM) is applied to understand the influence of a set of sociodemographic variables, travel behavior, motivation, and attitude towards technology in general in the perceived ease of use and perceived usefulness of using robots in tourism.

The results obtained demonstrate that the Portuguese case is similar to that of other Western countries, with gender, age, travel group, motivation and attitude towards technology having a significant impact on the dependent variables.

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List of abbreviations

AI	Artificial Intelligence
CPS	Cyber-physical Systems
GDP	Gross Domestic Product
HRI	Human-robot interaction
ICR	Internal Consistency reliability
IMF	International Monetary Fund
IoT	Internet of Things
IT	Information technology
OECD	Organisation for Economic Co-operation and Development
PEOU	Perceived Ease of Use
PU	Perceived Usefulness
RAISA	Robots, Artificial Intelligence and Service Automation
SDGs	Sustainable Development Goals
TAM	Technology Acceptance Model
TRA	Theory of Reasoned Action
TRI	Technology Readiness Index
UNWTO	United Nations World Tourism Organization
USD	U.S. dollar
WTTC	World Travel and Tourism Council

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Chapter 1. Introduction

1.1. Introduction

Chapter 1 is conceived to present the research project developed in this dissertation, including the importance of the topic for decision makers in the tourism industry, in section 1.2. Subsequently, the main goal and more specific objectives of the research are presented in section 1.3., along with the methodology used. Finally, the structure of the thesis is presented in section 1.4.

1.2. Framework and theme relevance

When talking about tourism over the last few years, it is impossible not to talk about Portugal. This small southern Europe country has now won 'Europe's Leading Destination' for four years in a row, and 'World's Leading Destination' in 2017, 2018 and 2019. Needless to say, the number of visitors has raised exponentially over the past few years, registering an amazing 24,6 million foreign guests in 2019 (INE, 2020d). Not only did the number of foreign visitors grew exponentially, but also Portuguese people started to travel more, both inside and outside the country, due to better economic conditions, the 'Turismo de Portugal' campaigns, and the spreading of low-cost airlines. In 2019 the residents accounted for 26.1 million overnight stays, a growth of 6% compared to 2018 (INE, 2020d). "Leisure, recreation or holidays" is the main motivation for travelling to Portugal (49.4%) (INE, 2020d).

At the same time, the explosion of the 'Fourth Industrial Revolution', or the 'Industry 4.0' has shown how technology is leaving the factories and entering everyday reality. Robots, Artificial Intelligence and Service Automation (RAISA) are rapidly developing and there already several examples on our daily lives. At this point, Amazon's Alexa, the home automation system that works as a virtual assistant, allowing people to control smart devices, is wildly known. In the tourism industry there are also several examples of service or social robots. The Hilton's concierge is Connie, a small, white and blue, 60 centimeters robot that helps visitors on what to see, what to do, where to eat, and other useful information, having the ability to point and to move his arms and legs. Another example would be Botlr, a room service delivery robot, that belongs to the Aloft Hotels. Also, in the F&B department, there is some artificial intelligence, for example, in Boston, the 'Spyce' restaurant has a 'robotic kitchen that cooks complex meals' as they say themselves. More ordinary examples of RAISA would be the self-check in machines that almost every airport owns nowadays, as well as the automated ordering machines that one can find everywhere and the cleaning robots that are also very popular.

According to Bowen and Whalen (2017), one of the trends in the tourism sector is the increasing use of Artificial Intelligence (AI) to substitute humans. Considering the tourism sector is facing new

challenges related to human-to-human interaction, it is of uttermost importance to understand what variables may affect robot acceptance and adoption so that stakeholders take the best possible advantage of these intelligent machines (Beer et al., 2011). Several models have been developed over the years to study technology acceptance, such as the Technology Acceptance Model (Davis, 1986), Unified Theory of Acceptance and Use of Technology Model (Ventakesh et al., 2003) and the Chain Model (Beer et al., 2011; Oliveira, 2015). These models can give extremely valuable information to developers, by providing information on the variables that influence user acceptance.

1.3. Objectives and applied methodology

Considering the above-mentioned framework, the main goal of this dissertation is to implement the Technology Acceptance Model, developed by Fred Davis (1986) to the use of RAISA in tourism. Based on this core target, two sets of objectives were defined, theoretical and empirical objectives.

The theoretical objectives, based on the literature review are:

- To investigate the growth of the tourism sector and the arising trends;
- To understand the evolution of automation and artificial intelligence;
- To comprehend the impact of artificial intelligence in the tourism industry;
- To identify the different types of robots;
- To analyse human-robot interaction studies.

Considering the empirical objectives, that focus on the study itself, the following were identified:

- To know if sociodemographic characteristics play a role in RAISA acceptance;
- To analyse the tourism practices of the respondents and their influence on RAISA acceptance;
- To determine if the acceptance of technology, in general, contributes to the acceptance of RAISA in tourism;
- To understand the influence of motivation toward technology in RAISA acceptance;
- To evaluate if the perceived ease of use influences the perceived usefulness of RAISA in tourism.

To fulfil these objectives, the Technology Acceptance Model was used in this research, as explained in detail in chapter 5. This model has been applied multiple times in research and even has some

extended version. A survey by questionnaire was applied to Portuguese residents, over 18 years old, to understand technology and robots' acceptance among the respondents.

The literature review served as a guide for the selection of the model, considering its application to the topic and the lack of studies applied to Portugal.

1.4. Structure of the dissertation

This dissertation is divided in two main parts. The first part, developed in chapters 1 to 4, introduces the theme, its importance and the theoretical background that supports it, while the second part, developed in chapters 5 to 7, explores the empirical analysis, explaining the methodology used and the achieved results.

Chapter 1 presents a framework of the study regarding its relevance. It then elaborates on the research main goal and the more specific objectives, followed by the methodology used throughout the thesis, finishing with the structure of the dissertation.

Chapter 2 proceeds with facts and figures of the tourism sector, highlighting its importance and growth but also the challenges the industry faces and the trends that are rising. The chapter then finishes with an overview of the impacts of the current COVID-19 pandemics on the sector.

Chapter 3 presents a literature review on Automation and Industry 4.0. First, an historical overview on automation, referring its greatest landmarks but also its downside, contextualizing the rise of Industry 4.0 and the use of Artificial Intelligence and the Internet of Things in tourism. This chapter will also focus on customer's attitude towards technology. The goal is to understand how people react to the evolution of technology and what impacts that might have in the acceptance of Artificial Intelligence.

Chapter 4 introduces robots and presents the different types of robots, as well as the laws of robotics. Moreover, this chapter focuses on the use of robots in services and the tourism industry, presenting some studies on human-robot interaction.

Chapter 5 explains the development of this research, starting with the research design and literature review, followed by an explanation of the model used and the hypothesis tested. Then, it presents the population and sample under consideration, the methods and data collection techniques used. Finally, data analysis is discussed.

Chapter 6 presents the empirical analysis and results obtained from the survey. The survey was conducted nationally, to Portuguese residents over 18-years-old, and this chapter outlines the analysis and discussion of the results. The software used for data analysis was SPSS and a

multivariate regression analysis, Spearman's correlations and *t* of Student tests were performed, along with univariate analysis for every variable.

Chapter 7 presents the main outcomes of the study and refers to its main contributions. The chapter is concluded with the discussion of the limitations of the study and the suggestion of future areas of research.

Chapter 2. Tourism Industry

2.1. Introduction

Considering the main objective of this thesis, it is fundamental to understand the importance of the tourism industry and the importance of studying it. Thus, this chapter presents the importance of the tourism industry and its contribution to the economy and many other areas. Section 2.3 focuses on the growth of the industry, globally and in Portugal, over the last few years, presenting some facts and figures.

Furthermore, section 2.4. intends to explain the challenges the industry faces, and section 2.5 elaborates on the arising trends, including the use of technology in tourism.

Contemplating the current events, section 2.6 focuses on the effects of the COVID-19 pandemics in the tourism sector.

2.2. The Tourism industry

The tourism industry is the world's largest industry (Oliveira, 2015). It is responsible for one in every ten jobs globally, accounts for over 10% of the global DGP, creates demand and induces consumption and fosters development (WTTC, 2019). For these reasons, tourism can have a great impact on a country's economy, making it a key sector for governments and investors.

Figure 2.1 - Tourism economic impact as share of total GDP
Source: World Travel and Tourism Council

From 1950 to 2015, the number of international tourists has grown from 25 million to 1.2 billion (Perdomo, 2016) showing the evolution of the industry over the last decades, that has had a

massive human impact in terms of new job opportunities, poverty alleviation and conflict resolution through mutual understanding (Perdomo, 2016). Even though travelling for leisure and by air still dominates international tourism (UNWTO, 2019a) it is fundamental to learn about the consumer and industry trends to better prepare for the future.

In 2015, the United Nations (UN) established the 17 Sustainable Development Goals (SDGs), of which all 193 members agreed to adopt, in order to create a better future for people and the planet. The World Tourism Organization (UNWTO) has identified four key areas in which tourism can help to fulfil these goals: job creation and new opportunities; economic growth and development; peace, understanding and social integration; and, finally, developing policies to protect the planet (Perdomo, 2016). Tourism has indeed the power to create jobs and new opportunities, but the brighter side is that the minorities like women, young people, rural workers/communities and migrants are the ones who can benefit the most from these (WTTC, 2015; Aynalem, Birhanu & Tesefay, 2016). Secondly, tourism has become a fundamental piece for several countries, despite of being a developing, emerging or advanced economy. The problem is, regardless of its importance, the industry is still not benefiting from suitable international funding and most of the companies linked to the industry are small or medium enterprises (Baum, et al., 2016). An adequate level of funding and investment could multiply the development impacts of tourism. The third key factor draws attention to the ability of the industry to promote the cultural knowledge that allows peace to prosper. As people travel further, so does their understanding of others and their beliefs (Tucker, 2016). Finally, tourism can be a great ally against climate exchange and other environmental issues, by promoting sustainable practices and low-carbon tourism development (Santos & Bernandes, 2019).

As this industry now represents a lot more than just people moving from one place to another, tourism is indeed a motor for the global development, that needs to be understood so that more interested parties can benefit from it. In order to understand the industry, it is necessary to look at its growth and at the current trends but also at the challenges it is or will be facing. This chapter aims to explain the importance of the sector in the world, and in particular in Portugal, focusing on the emerging trends and obstacles the destinations or the stakeholders may face.

2.3. Tourism growth

Tourism is one of the fastest growing industries in the world, contributing with USD 1.7 trillion to the international exports (UNWTO, 2019a). Since 2010, tourism exports grew faster than merchandise exports and is now the world's third largest export category (UNWTO, 2019a), which allowed many countries to balance their trade, whilst giving them the opportunity to create more and better jobs and boost other complementary industries. Out of the world service exports, 29%

were related to tourism, as well as 7% of the total of exports (UNWTO, 2019b) Besides contributing to international exports, tourism accounted for 10.4% of the global DGP in 2018, as well as 319 million jobs (WTTC, 2019). This industry can be very important for both emerging and developed economies, as it creates demand and can boost a country's wholesome economy.

In the first nine months of 2019 alone, the world received 1.1 billion international tourists (UNWTO, 2019b). Even though some events like geopolitical tensions, the global economic slowdown, climate exchange (UNWTO, 2019b) or outbreaks like the Coronavirus COVID-19 (UNWTO, 2020a) may slow tourism down, the industry is expected to continue to grow over the next decades.

Regarding tourism policies, on a UNWTO (2019a) survey, 101 member states referred to sustainability as an objective, 67% referred to resource efficiency, 64% connected sustainability and competitiveness and 55% referred to sustainability extensively, showing that stakeholders understand the link between sustainability and competitiveness and how their territories may become stronger competitors considering an efficient use of resources, the promotion of biodiversity conservation and by taking action against climate change.

Tourism is growing across the globe, allowing less developed economies to have a chance to thrive. The Asia and the Pacific region is the fastest growing, for both arrivals (+7%) and earnings (+7%), followed by Europe that still holds the first place when it comes to arrivals (51%) (UNWTO, 2019a). Regarding the receipts, Europe also leads the group with 39% of the total, closely followed by Asia and the Pacific with 30% (UNWTO, 2019a). The Old Continent had a growth of 5% of international arrivals in 2018, led essentially by the Southern and Mediterranean Europe. Figure 2.2 shows the 2018 international tourist arrivals and tourism receipts.

Figure 2.2- International tourist arrivals (million) and tourism receipts (USD billion)
Source: UNWTO, 2019

Portugal is one of the countries that has contributed to this growth, with +3.8% of arrivals in 2018, that corresponds to 24.8 million visitors (Turismo de Portugal, 2019). The United Kingdom, France and Spain were the main contributors to the 9.6% growth in earnings, that corresponds to 16.6 billion euros (Turismo de Portugal, 2019). The Portuguese economy is largely powered by tourism as the sector represented, in 2018, 51.5% of service exports and 18.6% of the total exports and contributed with 8.2% to the country's GDP (Turismo de Portugal, 2019). However, this was not always the case for the country, as the earnings were only 7.6 billion euros in 2010 (Travel BI, 2019a) and unemployment reached 16% in 2013 (IMF, 2019a). The unemployment rate on the fourth trimester of 2019 was 6.7% and the tourism industry was responsible for 328.5 thousand jobs in 2018 (Turismo de Portugal, 2019). Portugal is now the 12th most competitive destination in the world, taking the 17th place when it comes to arrivals and the 20th place on earnings (Travel BI, 2020). In 2019, at the World Travel Awards, Portugal was elected as the World's Leading Destination, for the third time in a row and 'Turismo de Portugal' was elected as the World's Leading Tourist Board, also for the third year in a row (Travel BI, 2019b).

2.4. Challenges for the tourism industry

As previously mentioned, events that cause geopolitical tensions, the global economic slowdown, climate exchange or outbreaks can have a great impact on tourism.

The tourism industry is made by people and for people, thus is it very sensitive to behavioural changes. One of the things that can change people's behaviour is fear and insecurity (Liu & Pratt, 2017) and some of the latest events of terrorism all over the world, but especially in Europe, may post a challenge for tourism (Sönmez, 1998). When safety is threatened, people tend to change their plans. Although terrorist attacks do not seem to be directed at tourists, they have a major impact in travel intentions/behaviours and on the destination's image until the incident is forgotten (Liu & Pratt, 2017; Walters, Wallin & Hartley, 2019). Thus, terrorist attacks may have economic implications, causing the governments to suffer. According to some authors, its primary target might be the destination itself (Freyer & Schroder, 2007 as cited in Walters, Wallin & Hartley, 2019). One isolated event may be quickly forgotten by tourists, but continuous tension inside the country reinforces the uncertainty thoughts of tourists (Liu & Pratt, 2017). Tiwari, Das and Dutta (2019) state that tourists prevent going to places tormented by geopolitical tensions and economic uncertainty, having long-term implications.

Another particular event that can have a great negative impact on the travel and tourism industry are the economic crisis. Papatheodorou, Rosselló and Xiao (2010) indicate that even though tourism was one of the latest sectors to feel the consequences of the 2008 global resection, it had several negative impacts, including a decrease in international tourists' arrivals and in the GDP. According to the UNWTO (2009), tourism grew only with 2% in 2008, causing it to be the first in four consecutive years to have a considerably low growth rate. The International Monetary Fund (IMF, 2019b) has stated that the global economy is once again slowing down, reaching only 3% of growth rate, the lowest value since the global crisis. This might mean that the next few years will be hard for the industry.

Jørgensen and McKercher (2019) identified that the main challenge to tourism is sustainability in general and, in particular, climate change. The authors argue that, regardless of being portrayed as a symbol for sustainability and the good intentions, the efforts have been made on the wrong activities. To stop the large amount of pollution created by the industry, namely, to reduce the carbon emissions, tourism would have to slow down. However, this is the main source of income for many developing countries and poorer areas, making it unthinkable to stop the industry. Jørgensen and McKercher (2019) state that it should be up to the policy makers, governments and other stakeholders to take this as an issue and consider it in their strategies in order to reduce its impacts.

Even though the industry was prospering in 2019, the beginning of 2020 brought a new reality. The outbreak of the Coronavirus, a pandemic that affected over 200 countries caused the industry to nearly stop. A study carried out by Ruiz Estrada, Park and Lee (2020) shows that this pandemic will have a negative impact on the tourism, trade and air transportation sectors in China, where it began. So far, a huge number of worldwide events and conferences have been cancelled or postponed due to the virus[1], several airlines have stopped[2] and are in laying off their workers, several destinations have travel bans[3,4] or quarantine their visitors from the moment they arrive, and a great part of the world population is or was at home. The WTTC (2020a) has announced that up to 75 million jobs are at risk and the Travel and Tourism GDP will potentially lose $2.1 trillion, with the Asia-Pacific region suffering the greatest impact, while the UNWTO (2020a) expects international tourists' arrival to decline by 20% or 30%, which means a loss of $300 to $450 billion in global exports. Likewise, this pandemic will certainly cause several countries to face economic crisis over the next years, which will bring more obstacles for the travel and tourism industry.

Besides these modern problems, tourism still has some of its older difficulties, such as seasonality and precariousness in most of its jobs. The Travel and Tourism sector positions consist mostly, according to WTTC (2015), in low skilled occupations, performed predominantly by young and female workers. Furthermore, a great percentage of these jobs are part-time, casual and seasonal. According to Aynalem, Birhanu and Tesefay (2016) and Terry (2018) the majority of the jobs in the travel and tourism industry are unstable, associated with low status, long working hours and low pay, making it very difficult to find suitable employees and causing high levels of staff turnover. These characteristics go against the UNWTO Sustainable Development Goals, especially goals 1, 3, 4, 5, 8, 10 and 16 (Baum, et al., 2016), showing that tourism can have a great contribution to fulfill the goals, but can also be one of the reasons for those problems.

2.5. What the future holds – trends in tourism

To prepare for the future, it is very important to forecast what will happen. The OECD (2018) developed a workshop on Analysing Megatrends to Better Shape Future of Tourism, of which participants included representatives from government, international organisations and industry,

[1] List of major events cancelled or postponed due to the coronavirus https://www.businessinsider.com/major-events-cancelled-or-postponed-due-to-the-coronavirus-2020
[2] Chart of the impact of the coronavirus on airlines and international flights https://www.weforum.org/agenda/2020/03/this-chart-shows-how-airlines-are-being-grounded-by-covid-19/
[3] List of travel restrictions by country https://www.nytimes.com/article/coronavirus-travel-restrictions.html
[4] COVID-19 Travel Restrictions https://www.unwto.org/news/covid-19-travel-restrictions?fbclid=IwAR0QZ-20mmtunQ1Y5oKVF2UWEiv9-WJ_J98DpXLoYLG6LxfGcQiVe3yFnZM

and put together a list of megatrends that are expected to change the travel and tourism industry over the next few years.

According to the OECD (2018), the rise of globalisation and technological advances were the motors of the growth in the travel and tourism industry over the last decades, especially due to the cheaper airfares. Even though that growth is expected to continue, the OECD (2018) believes that three main factors are likely to transform the industry: the shifting environmental conditions, the technological innovations and the changing demographics. The report refers to megatrends as "circumstances that will unfold across the globe in a number of countries and that can often drive the global economy and society in specific directions" (OECD, 2018, p.63) and identifies four key categories of these megatrends: people, planet, productivity and polity. Table 2.1 describes these four categories.

Table 2.1 – OECD Megatrends framework

Megatrend	Description
People	Generally refers to changing demographics, as well as trends related to health, labour and social cohesion. In the context of tourism, this trend is most closely related to evolving visitor demand, which refers to trends such as aging populations and the growth of the global middle class.
Planet	Generally refers to the state of the environment and the impacts of climate change, as well as access to resources such as food, energy and water. In the context of tourism, this trend is most related to sustainable tourism growth.
Productivity	Generally refers to sources of growth, such as technology, innovation and entrepreneurship. In the context of tourism, the rise of enabling technologies has impacted the way people around the world can travel, such as through platforms in the sharing economy. Advancements in automation are also likely to transform the sector.
Polity	Generally refers to the state of governance, trust and accountability in the public sphere. In the context of tourism, public decisions will have a role in a number of areas, particularly on travel mobility. For instance, mobility is significantly impacted by the degree to which national governments support international transport and facilitate travel.

Source: OECD, 2018

There are many indicators that assure these trends will influence the future of the travel and tourism industry, namely: people – an increase in the levels of income and education in emerging countries, the higher life expectancy and the emergency of new consumer groups; planet – the increasing awareness for resource-efficiency; productivity – the creation of new marketplaces and business models enabled by technology; polity – several indicators such as the expected growth of international visitors, the transport innovation and regulation, safety concerns, change in travel policies, among others (OECD, 2018).

One of the things the OECD (2018) believes will have the biggest impact in the travel and tourism industry is technology, as the disruption is rushing. Technologies like artificial intelligence, the Internet of Things, autonomous vehicles, big data and blockchain are continuously creating a more affordable and accessible industry. However, technology will also create some challenges, for example on the employment, as some tasks may be completely automated, causing some jobs to disappear or to change drastically. Over the next two decades, automation is thought to eliminate 69% of the existing jobs in India, 47% in the United States and 30% in the United Kingdom (Frey & Osborne, 2013 and Kim, 2016 as cited in OECD, 2018). At the same time, new

opportunities arise such as translating apps, the use of big data and predictive analytics to better understand consumer behaviour, the spread of virtual assistants and autonomous vehicles or hotels fully staffed by robots. Besides, according to the UNWTO (2018) artificial intelligence, is also allowing several destinations to measure tourism in real time, allowing the decision makers to better manage the visitor flow.

Under the same mindset, Turismo de Portugal (2016) also divides the big international trends in five categories: demographic and sociocultural, economic, environmental, transportation and technological.

The demographic and sociocultural trends include the ageing population, the decrease in household size, the increasing concern with health, food and well-being as well as with the environment, a search for unique and authentic travel experiences, among others, that are leading to more frequent short and city breaks throughout the year, minimizing seasonality, and a greater search for health and well-being tourism as well as for adventure tourism.

Economically, the greater tendencies include the emergency and development of a new market with global dimension, the expansion of the emerging economies like China and India, the globalization in production and consumption, the arise of new consumers markets that will contribute to the transitioning and the developing economies leading to a greater awareness on the quality-price ratio globally, new destinations and new issuing markets, difficulties to establish visitors loyalty and an increase in visiting friends and relatives (VFR) and international student mobility.

The global environmental concerns drive this set of trends, mainly taking into consideration the climate change. The awareness of the population, the industries and the governments of the importance to change habits and adopt sustainable practices and develop efficient systems and the increase in environmental regulation and the consequent rise in environmental certification result in increased demand for nature tourism and natural/biological products, in increased demand during low season and in changes in management and marketing strategies.

Transportation is a big part of the travel and tourism industry. The development of alternative, more cost-effective fuels, the rise of more sustainable transportation solutions, the continuous rise in low-cost airline in secondary airports and the development of new routes, the investment in high-speed trains and the construction of more and bigger cruise terminals are leading to the emergence of new destinations and new visitor markets and a shift in travel patterns.

Finally, the technological trends include the increasing importance of the internet as a communication, information and commercialization channel, the availability of more information globally, new reservation and payment systems and the increasing automation in management, production and consumption produce several outcomes such as a greater control of pricing and products by the tourists, the use of apps and digital platforms to collect information or buy

products, the access to other visitors feedback that results in expectations and the increased search for more creative and interactive offers.

2.5.1. – Technology and tourism

Technology has been linked to tourism since its beginning and it has been the focus of academics for several years now. In 2003, Buhalis stated that "information and communication technologies (ICTs) and tourism are two of the most dynamic motivators of the emerging global economy" (p. XXIV). In 2006, Buhalis and Costa developed the Tourism Futures Framework, referring to ICTs as new tools for tourism management dynamics (figure 2.3)

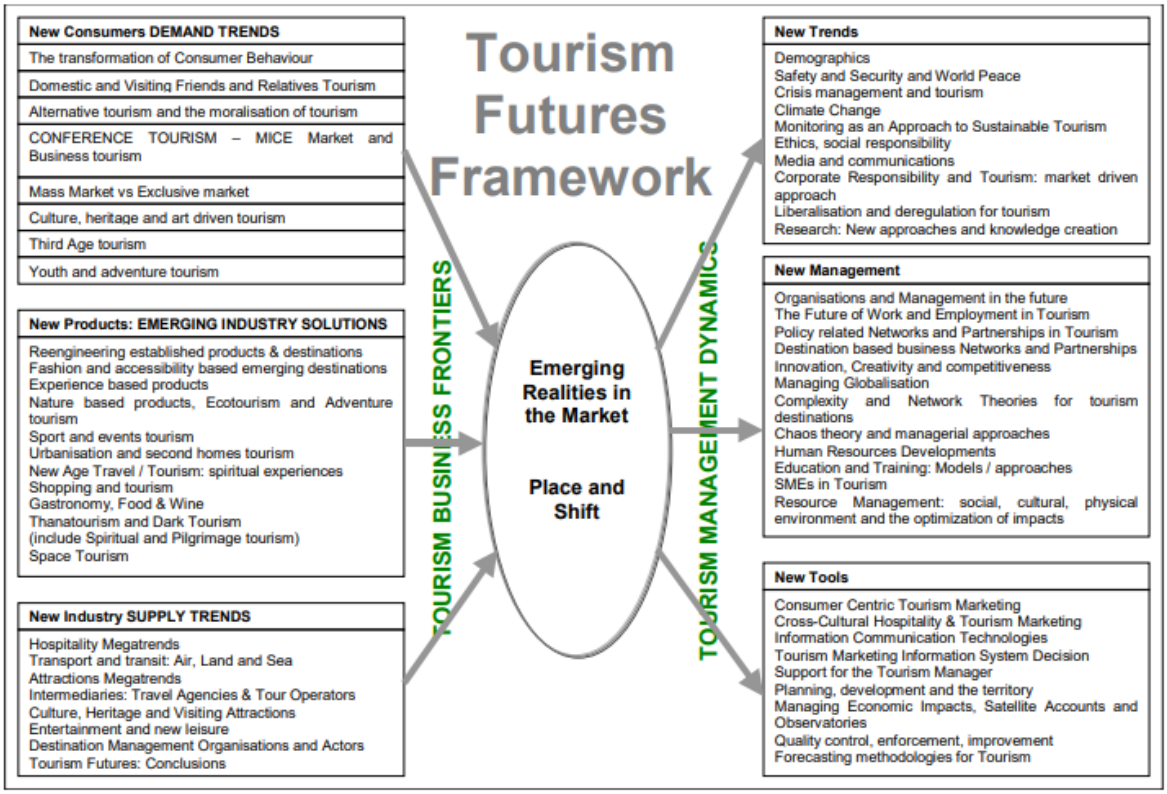

Figure 2.3 - Tourism Futures Framework
Source: Buhalis & Costa, 2006

More recently, technology has been defined as a determinant for the level of competitiveness of tourism organisations and destinations by Buhalis (2020) and the development of new technology is connected to the emergency of new types of tourism activities and experiences (Neuhofer, Buhalis & Ladkin, 2013). The eruption of the 4th industrial revolution brought a new paradigm to the tourism sector, related with digitalisation. Technology transforms the industry's structures, processes and practices, leading to service innovation (Buhalis, 2020). Chapters 3 and 4 will explain how industry 4.0 disrupted the tourism industry and how technology is being used to create new and better services.

2.6. The impacts of COVID-19

The current COVID-19 pandemics, that started in China in late 2019 and rapidly spread throughout the world in 2020, is having a major impact in society in general and particularly in the tourism industry. This outbreak has had a tremendous effect on how people live across the globe, causing millions of people to lose their jobs and the global extreme poverty rate to increase (Carranza et al., 2020).

What was thought to be a great year for tourism, quickly became a nightmare. The pandemic led to the application of confinement policies for several months and most countries established travel restrictions, including border closures (WTTC, 2020b). By September, 93 destinations (43% of the destinations worldwide) still had their borders closed for international tourists (UNWTO, 2020c). Besides, the "new normal" brought several restrictions, for example, the number of seats in restaurants had to be reduced to half[5] and one's temperature is taken almost everywhere.

Figure 2.4 - International Tourist Arrivals, World
Source: UNWTO (2020D)

The OECD believes international tourism will decrease around 80% in 2020 (OECD, 2020) and the UNWTO announced a 70% decline in international arrivals in 2020, causing a loss of USD 460 billion in export revenue in the first half of the year alone (UNWTO, 2020e). With no customers and no plan B, 513 restaurant related companies, 297 transportation companies and 117 aviation companied filed for bankruptcy, as of 22 June (WTTC, 2020b).

[5] https://www.doh.wa.gov/Portals/1/Documents/1600/coronavirus/DiningAreaClosureGuidance.pdf

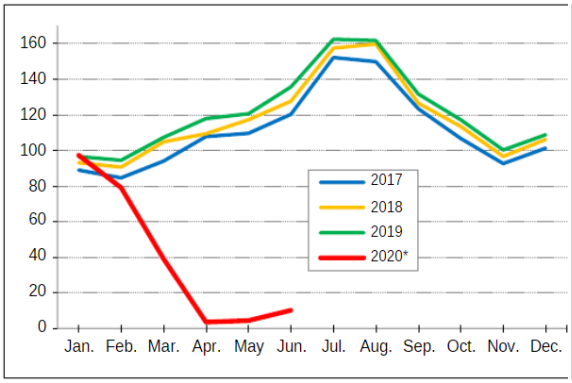

Figure 2.5 - International tourist arrivals by month (World, millions)
Source: UNWTO (2020e)

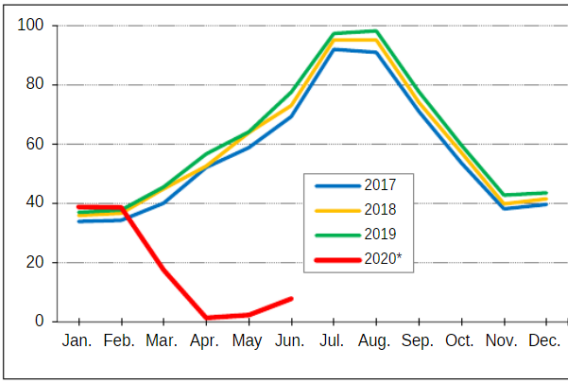

Figure 2.6 - International tourist arrival by month (Europe, millions)
Source: UNWTO (2020e)

The biggest the importance of tourism in a country's GDP, the biggest the losses in 2020. The UNCTAD (2020) deliberates that, considering a moderate scenario, the most affected countries will suffer a loss of 11% of their GDP (Jamaica), or USD 187,038 million (USA).

Figure 2.7 - Changes in GDP: 15 most affected countries, moderate scenario
Source: UNCTAD (2020)

The McKinsey Global Institute (2020) believes that, considering an optimistic scenario, the sector will only recover in 2023, depending obviously on the economic recovery. The recovery of the sector will depend on 5 key drivers: 1) attractiveness of domestic destinations, 2) materiality of air transport, 3) health and hygiene factors, 4) importance of business travel and 5) sustainability. The report also states the domestic tourism will probably recover faster, considering fewer restrictions for national trips, more transport options, lower levels of anxiety, among others

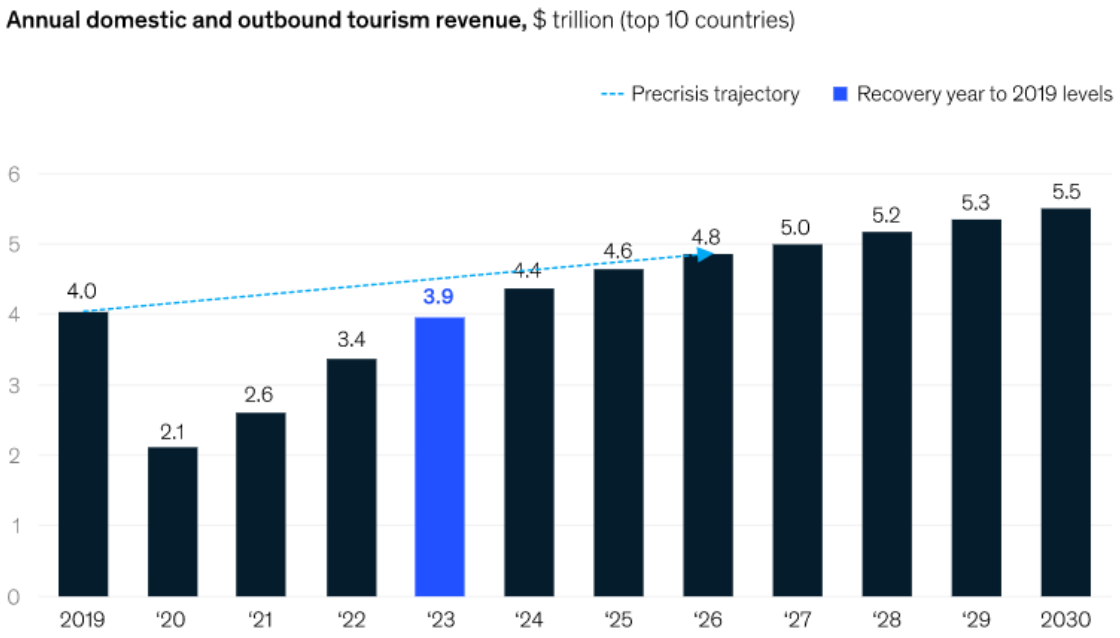

Figure 2.8 - Annual domestic and outbound tourism revenue
Source: McKinsey Global Institute (2020)

On another note, the pandemics caused people to be more open to technology and digitization, not only because of teleworking but also due to contactless technologies, creating an opportunity for the travel and tourism industry to reinvent itself (WTTC, 2020b). The permanent contact with technology during the pandemics, social distancing and the use of cashless payment methods will probably contribute to the automation of tasks and, at the same time, tourists might be more willing to interact with technology considering it cannot transmit viruses (Ivanov et al., 2020a).

2.7. Conclusions

In summary, the importance of the tourism industry in the global economy is undeniable. Tourism allows millions of families to gain an income, supporting mainly the minorities like women, young people and rural communities. Also, tourism contributes to a fairer world, by creating more jobs and helping to reduce poverty and by promoting peace and understanding between cultures and people. Tourism is a great ally in fulfilling the UN 17 Sustainable Development Goals.

However, the travel and tourism industry is immensely affected by global tragic events, whether it is an economic crisis, an epidemic or a terrorist attack. This kind of events may cause severe losses for tourism and for the economy itself, cause jobs to be lost, a decrease in the GDP, a reduction in international arrivals and many other constraints. People need to feel safe in order to travel and uncertainty causes stress and creates doubts.

The OECD has identified several trends that will impact the next decades and that everyone should be aware of. These trends were divided in four categories, regarding their key areas: people, planet, productivity and polity. The travel and tourism sector will definitely be affected by these trends and it is necessary for the industry to start preparing and planning so that the growth rate does not stop.

Out of all of the trends that are rapidly emerging in the tourism sector, technology should be policy makers main focus, as it is the one with the potential to change the industry the most, either by creating or eliminating jobs, providing completely different experiences such as virtual reality or autonomous vehicles, or simply because of its contribute to an increasing sense of globalization where comparing prices or learning about consumer behaviour is quite simple.

Finally, the COVID-19 pandemic is having a massive impact in the industry, causing companies to file for bankruptcy, unemployment to increase and poverty levels to raise. The sector is expected to recover only in 2023 or later, but the virus may have opened the way for technology in tourism.

Chapter 3. Automation and industry 4.0

3.1. Introduction

As mention in the previous chapter, one of the fastest growing trends for the next decades is technology, especially robotics and artificial intelligence. To understand the future, it is necessary to look at the past, to see how humankind grew from discovering fire to creating machines that can almost think for themselves.

Chapter 3 proposes a look through the evolution of automation, in section 3.2., with reference to its greatest landmarks but also to the downside of it.

Section 3.3. will begin with the developments that led to Industry 4.0 and then immerse into the Cyber-Physical Systems and the Internet of Things dimensions, leading to the development Society 5.0 and other approaches on how technology can improve the quality of life in many different aspects.

Understanding the two previous sections is of the uttermost importance to comprehend section 3.4., that introduces the uses of the Internet of Things and Artificial Intelligence in the travel and tourism industry. Several examples of practical uses will be presented.

Finally, section 3.5. will focus on the attitude towards technology, in order to understand how people react to the evolution of technology and what impacts that might have in the acceptance of Artificial Intelligence.

In summary, this chapter aims to explain several concepts, linked with automation and with the concept of industry 4.0, focusing on the changes they brough to society in general and, in particular, to the travel and tourism industry

3.2. Automation

Although the idea of automation comes from the Ancient Greeks and the first controlled mechanism was reported in Ancient Egypt, it was the Industrial Revolution (1760-1840, approximately) that allowed for the development of concrete machinery. The years following World War II represented a huge industrial turning point. America reinvigorated the economy by pushing the industry with rapid advances in technology, namely the invention of numeric control (Stone, 2005; Hitomi, 1994).

According to Satchell (1998), automation consists in the replacement of human activities by machine activities, and the Britannica Online Encyclopedia (Groover, 2019) adds that it can also refer to the application of machines to tasks that would be impossible for humankind to perform on its own. The word itself means 'automatic operation' and was coined in 1936 by D.S. Harder, working for the General Motors Corporation (Hitomi, 1994). However, this term cannot be applied to every situation,

as it implies the adopting of automatic production methods, hence it has been restricted to production activities.

Hitomi (1994) divided the process to automation in three different phases. The first phase is the creation and use of tools, simple objects that multiply or replace human force, like the wheel, lever, nail and screw (Satchell, 1998), followed by machines that did not require human strength, like windmills or waterwheels (Groover, 2020). The second step is the 'mechanization' phase, as it consists in the replacement of human physical labour by machines, brought by the Industrial Revolution. The final stage is the replacement of human mental labour by machines. Hitomi (1994) also states that the original definition of automation foresees the mass production of a single product, making it unfitting for producing a variety of goods. Automated machines are now able to do things humans cannot do, making human existence dependent upon them in order to keep the current lifestyle (Satchell, 1998). Table 3.1 shows the main landmarks in the rise of automation.

Table 3.1 - Main landmarks in the rise of automation

Year	Event
4 million ago	Tools/instruments appeared (Ramapithecus)
c. 1760	Industrial Revolution (UK)
1796	Watt: Modern factory (UK)
1800	Jacquard: Jacquard loom (France)
1818	Blanchard: Mechanical copying machine (USA)
1860	Principle of assembly line (USA)
c. 1873	Spencer: Automatic screw machine (USA)
1913	Ford: Conveyor-driven, flow-type car assembly (USA)
1930	Patent of numerical control (USA)
1947	Harder: Detroit (mechanical) automation (Ford Motor Co., USA)
1947	Remote manipulator (USA)
1950-60	Process automation (USA)
1952	Parsons: Three-axis NC milling machine (MIT, USA)
1954	Devol: Patent of industrial robot (USA)
1958	Automatic programming system - APT (USA)
1959	Polar-coordinate robot (Unimation Co., USA)
c.1965	Low-cost automation (Pennsylvania State University, USA)
1966	Automatic programming - EXAPT (Germany)
1991	Intelligent manufacturing system (IMS) project (JapanRISAI
2003	First controllers with embedded web server
2015	Henn-na hotel opens: One of the first hotels to have robotic staff
2018	First application of automated vehicles in the oilsands industry.

Source: Own construction, based on Hitomi (1994)

The Britannica Online Encyclopedia (Groover, 2019) shows the importance of some of these landmarks. The creation of the digital computer was a very important mark that allowed for the development of program storage technology, as well as computer programming methods, that many years latter allow humans to control machines. Sensor technology (electromechanical probes, laser beams, electrical fields, machine vision) also provided a huge contribute to mankind evolution, through its use as components in automatic feedback control systems. The World War II brought an advanced mathematical theory of control systems, that includes the negative feedback control, optimal control, adaptive control and artificial intelligence. The numerical control and teleoperators allowed for the development of robotics, namely industrial robots.

In 1958, General Motors introduced Unimate, a robot that would assist automobile production. It was first used on an assembly line in 1961 and, ever since, the use of robots in industry has bloomed (Hockstein, Gourin, Faust & Terris, 2007). Robotics have since been applied to deep sea and space exploration, military use, search and rescue missions, food packaging or machinery building.

Even though automation has already brought enormous benefits to society, some authors believe it also has its downside. Endsley (1996) highlights the role of human operators, that in some cases shifted from performing tasks to monitoring an automated system. The author presents some examples of tragedies that occurred in human-machine joint systems, due to different types of flaws. Two main types of incidents are detected: the amount of time needed to realize that there was a problem plus the time to fix it and the reliance in the systems behaviour. Three plane accidents are illustrated caused by 1) crew reliance on an automated take-off configuration, 2) accidental disarming of the auto throttle and 3) an erroneous entry made into the flight navigation system. Endsley (1996) points two main problems in this human-machine interaction: unawareness of critical features of the system and difficulties to understand the problems identified by the system.

Acemoglu and Restrepo (2018) affirm that recent studies discovered high levels of anxiety about automation, highlighting general concerns about their effects. The authors then divide researchers in two categories: the ones that are concerned about the technological advances and fear the end of work by humans and the ones who claim that past technological breakthroughs have caused the same reaction and the demand for labour did not decrease.

The main disadvantage associated with automation is worker displacement, however many authors show that automation will create new jobs and will only eliminate dull, repetitive jobs (Bessen, 2015; Mann & Püttmann, 2017; Wilson, Daugherty & Morini-Bianzino, 2017).

3.3. Industry 4.0

The Industry 4.0, presented in 2011 at the Hanover Fair, in Germany, represents a structure of innovation based on the extreme digital connectivity, meaning that every digital system is connected through an external network. The main aim of this industry is the development of smart factories and the dissemination of extreme automation in science and in the society in general (Özdemir, 2018; Xu, Xu & Li, 2018).

The name "Industry 4.0" arises from accounting for previous industrial revolutions, namely:

- Industry 1.0 (late XVIII century to early XIX century): steam energy appears, coal is used as an energy source, some mechanization in manufacture, boom in the textile and iron industries and the locomotive emerges (Xu, Xu & Li, 2018; Li, 2018);

- Industry 2.0 (late XIX century, early XX century): electrical energy arises, it is the beginning of the mass production era (Fordism), inventions like the lamp and the telephone crop out, and steel and oil industries start to grow (Xu, Xu & Li, 2018; Li, 2018);

- Industry 3.0 (second half of the XX century): this is a technical-scientific revolution, motivated by the advances in computer science, robotics, telecommunication, transportation, biotechnology and nanotechnology. There is a big change in production mode from "Fordism" to "Toyotism", that is, from mass production to flexible, demand-driven production. One of the most important aspects of this revolution in the industrial decentralization (the migration of the industries to places that offer more advantages), made possible by the internet and the dissemination of personal computers (Xu, Xu & Li, 2018; Li, 2018);

- Industry 4.0 (early XXI century): motivated by a series of new technologies such as the *Internet of Things,* sensors and artificial intelligence, this new industry points to extreme digital connectivity and cyberphysical systems, which allow the creation of digital replicas of every physical thing that exists on the planet, animated or not (Özdemir, 2018).

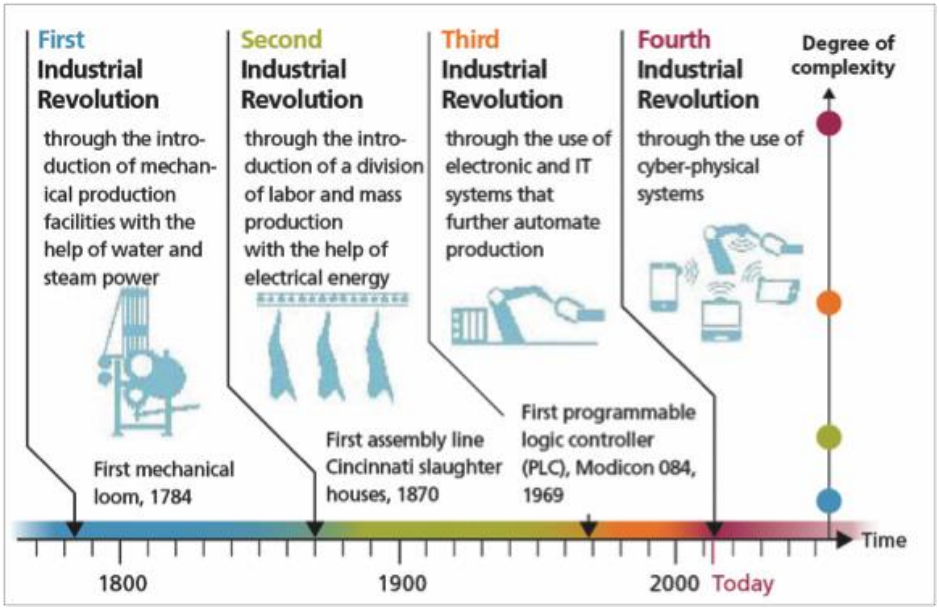

Figure 3.1 - From industry 1.0 to industry 4.0
Source: DFKI - German Research Center for Artificial Intelligence (2011)

Smit el al. (2016) defines the Industry 4.0 as the organization of production processes, based on technology and in devices that communicate autonomously between themselves, through the value chain: a model of smart factories where systems monitored by a computer control physical processes, create a virtual copy of the physical world and make decentralized decisions based on self-organization mechanisms. This concept takes into consideration the growth of digitalization of the manufacture industries, where physical objects are perfectly integrated in the information network, allowing decentralized production and real-time adaptation in the future.

The main pillar of this fourth industrial revolution are the cyber-physical systems (CPS). A cyber-physical system consists in a system that integrates computation, communication, distributed interactions and physical processes, or in other words, it is a system where computation interacts with the physical world (Schätz, et al., 2015; FCT, 2017). Some practical examples of CPSs could be autonomous cars, robotic surgery, intelligent buildings, smart manufacturing and smart electric grid. Figure 3.2 represents the functioning of cyber-physical systems, including the two main domains: the cyber space and the real space. Information is firstly collected from the real space with, for example, sensors or any device connected to the network, and then stored on the cyber space, that sends back actuation information (actions) to the real space. A simple example to understand this interaction could be someone, who is at work, using a smartphone to turn on the heater of his house before getting home.

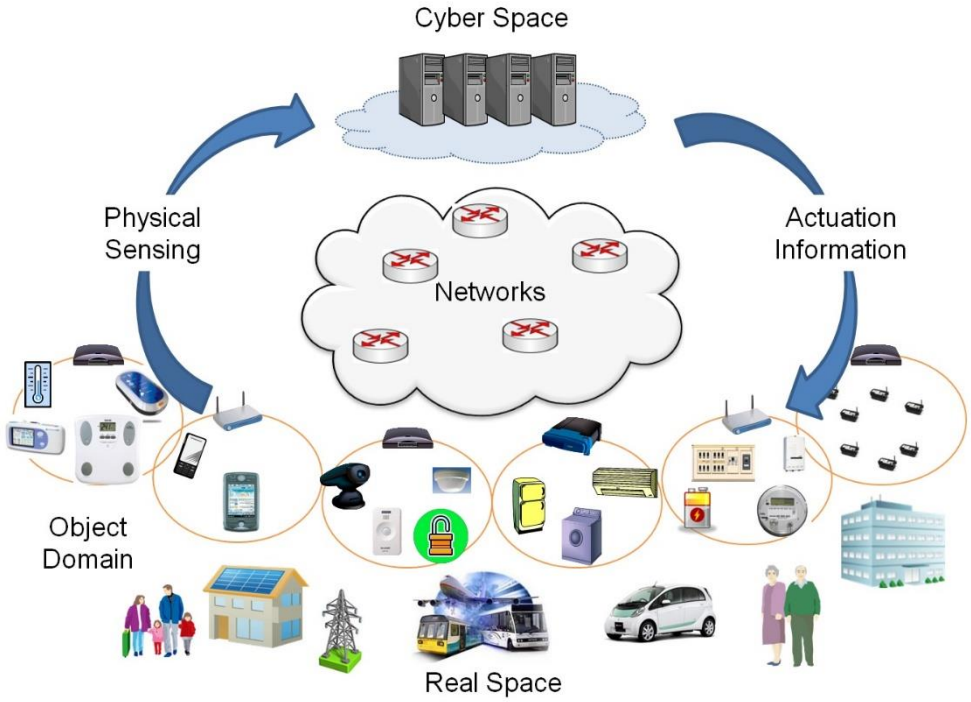

Figure 3.2 – Cyber-physical system
Source: devide-smart.com (n.d.)

This connectivity of the real world with the physical would not be possible without the *Internet of Things* (IoT). It is considered one of the most important technologies of the 21st century (Akkaş & Sokullu, 2017) due to its ability to connect several systems, allowing people to communicate with each other and with 'things' at any given time. Another benefit of the Internet of Things are the competitive advantages it gives its users, as the guarantee of high-quality data and secured processing, the minimization of human efforts and the fact that it makes analytics decisions faster and more accurate. It is applied to the context of Industry 4.0 to allow the connection, communication and collection of data between the sensors linked to the elements of the network (animate or inanimate). Internet is the base of the network, as it the functionality that allows two or more devices to be connected, and this paradigm is rapidly growing in the context of wireless telecommunication (Misra et al., 2016). The basic idea of this concept is that everything around us (sensors, smartphones, actuators, radio frequency identifiers, etc.) can interact and cooperate among them to accomplish a common goal (Giusto et al., 2010). Attached to the IoT concept, arises the idea of Smart Cities. A Smart City is a city developed with smart/intelligent solutions and technologies, that suppose the adoption of five or more of the following parameters:

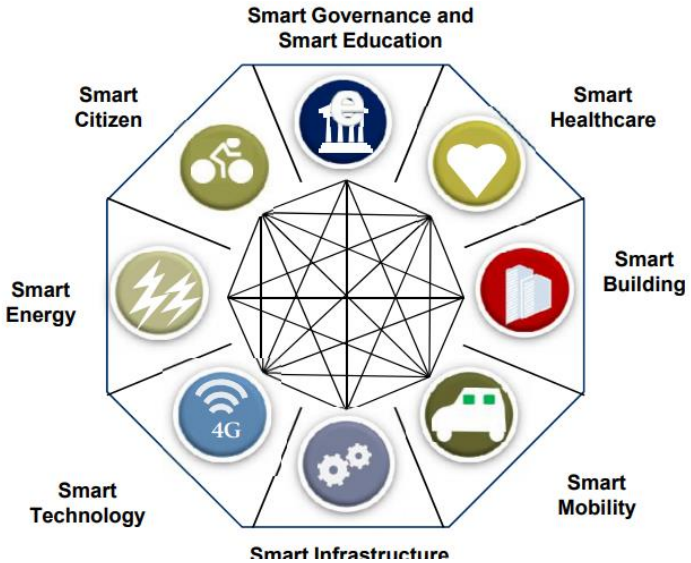

Figure 3.3 - Smart cities concepts
Source: Frost & Sullivan (2013)

According to the United Nations (2019), by 2050 around 68% of the world population will live in urban areas. Urbanization is one of four demographic trends – urbanization, growth of global population, population ageing and international migrations – and is strongly related to sustainable development. Therefore, it is extremely important to plan and manage urban expansion, as cities have a leading role from an economic, social and political point of view, that will only continue to grow (Cunha et al., 2016). Smart Cities are the answer to these contemporary challenges the cities are facing, using technology to provide efficient urban services, improve quality of life and to transform the relationships between the citizens and the local bodies and enterprises. Arasteh et al. (2016) presents six main applications of the Internet of Things for Smart Cities – smart homes, smart parking lots, weather and water systems, vehicular traffic, environmental pollution and surveillance systems – giving practical examples for each of them:

- Smart homes: monitoring pollution, making it possible to warn consumers if it exceeds its marginal limit;
- Smart parking lots: tracking vehicles arrival and departure for various parks scattered around the city;
- Weather and water systems: sensors may collect suitable information such as temperature, rain, wind speed and pressure;
- Vehicular traffic: collecting and sharing real-time data with drivers allows for a better knowledge of the traffic flow, benefiting both the citizens and the government;
- Environmental pollution: monitor pollution data, sharing it with the citizens, especially to those with health care conditions;

- Surveillance systems: the whole city should be constantly monitored, assuring everyone's safety.

Even though these examples might seem unfamiliar, other instruments that are used daily, such as, home automation systems that allow users to control the lights, fans, among other electrical devices, autonomous vacuum cleaners, smart security systems or voice assistants are only possible thanks to the IoT (Singh et al., 2019).

Together with the Internet of Things, Artificial Intelligence (AI) is another motor of the Industry 4.0. There is not an agreement when it comes to the definition of AI, but, according to Nilsson (1998), AI is the observation of smart behaviours in objects, including in "smart behaviour" reasoning, perception, learning, communication and acting in complex environments, characteristics that are normally associated with humans. The goal of AI is to create machines that can develop this kind of behaviour just as good or even better than humans. There are essentially three forms of AI: Narrow AI (for example, Google Translate and chatbots), General AI (equivalent to general human intelligence) and Super-Intelligent AI (exceeds human intelligence). So far, several forms of Artificial Intelligence have been presented, such as chatbots, machine learnings and self-check-in kiosks (Lu, 2019). Artificial intelligence is expected to have two main impacts in the industry: the automatization of tasks and the improvement and enabling effect (Geisler, 2018). The automatization of tasks grants AI the ability to perform tasks that were previously made by humans. The 'Amazon Go' store[6], an example of an AI supermarket, as well as the face-recognition system, being tested by JetBlue, that checks guests automatically at hotels and airports, show the power of AI. Besides, the 'improvement and enabling' feature shows that AI has the capacity to improve decisions and enable previously impracticable tasks, for example through recommender systems. Lu (2019) affirms that one third of European companies use AI systems in customer services and 72% claim to benefit from it, for example, through reduction of agents' time, effectiveness dealing with sigh-volume tasks and offering non-stop customer care.

Artificial intelligence is not as consensual as IoT, as it gives machines some human like capacities, making some people believe machines will replace humans. However, both IoT and AI have proven their importance for the future, especially in fields like medicine, agriculture and traffic safety. When data supplied by Artificial Intelligence is associated with the Internet of Things, creates the so-called state of universal extreme connectivity or The Quantified Planet (Özdemir, 2018).

[6] https://www.amazon.com/b?ie=UTF8&node=16008589011

3.3.1. Society 5.0

Considering the impacts that the IoT, AI and robots will have on society, in January 2016, the Japanese Cabinet present the concept of 'Society 5.0' in their Science and Technology Basic Plan (Fukuyama, 2018). The economic history of Japan, that includes a long recession period in the 1900s and 2000s, drove the government to set IoT, big data, robotics and AI as the motor for its economic recovery (Fukuda, 2020). But Japan looks at these technologies from the base of their societal problems. Japan is the second country with the highest life expectancy rate, around 84 years, very close to Hong Kong, that occupies the first position with a rate of 85 years (Worldbank, 2018a). Besides, the Japanese birth rate is of only 7, per 1,000 people (Worldbank, 2018b). These two variables combined represent a decreasing volume of labour force and a major pressure in social security costs (Fukuyama, 2018). The main goal of the Japanese government, according to their 'Society 5.0' strategy is to solve these challenges by incorporating the available technology into every industry and social life (Fukuyama, 2018).

As it happens in 'Industry 4.0', Society 5.0 also identifies the fifth division in society's history. Figure 3.4 explains the differences between the five eras.

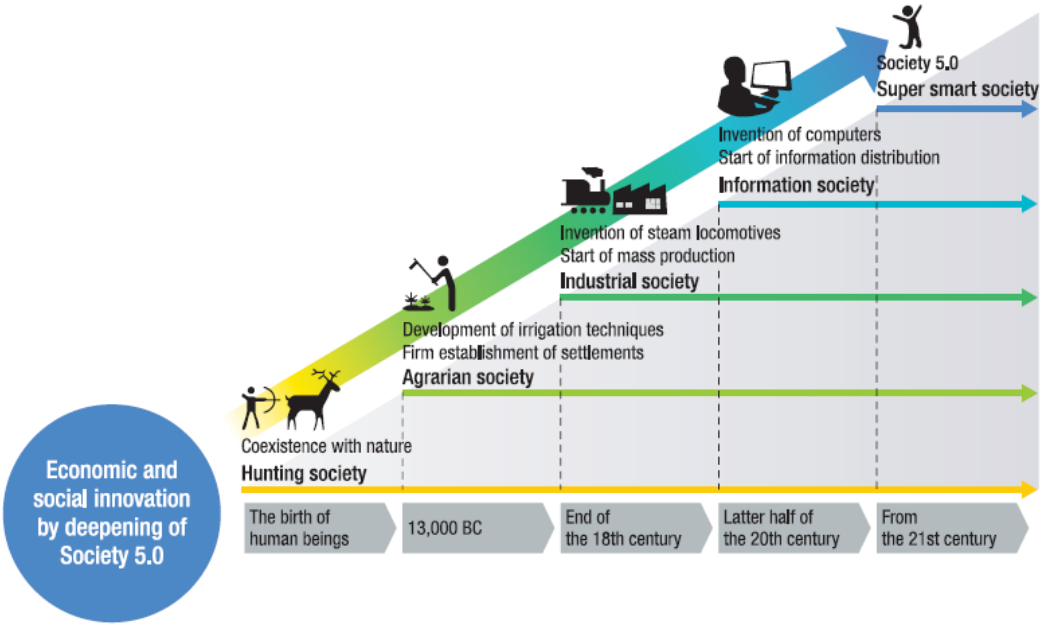

Figure 3.4 - From society 1.0 to society 5.0
Source: Fukuyama, 2018

Society 5.0 aims for a human-centred society, in which everyone can have a high quality of life, fully active and comfortable. This Super Smart Society is expected to be a sustainable society connected by technology that listens to everyone's needs, providing goods or services to who required them, when they are required and in the required amount (Shiroishi, Uchiyama & Suzuki, 2020). The key to achieve this goal are the cyber-physical systems, that will allow the connection between cyber

space and real world (Fukuyama, 2018). The Japanese government has already started a series of initiatives to fulfil these goals, for example, the 'Robot Industry', the 'Connected Industries' and the 'Conference towards AI Network Society' (Shiroishi, Uchiyama & Suzuki, 2020).

Keidanren (2018), the Japanese Business Foundation, states that Society 5.0 may help to fulfil the SDG's and to push humanity forward, using these inevitable changes to create a better and fairer society. Society 5.0 aims to create sustainable, decentralized communities in suburbs and rural areas, while preserving large cities' competitiveness. Thus, high standards medical (telemedicine, AI-based medical services) and education services should be guaranteed everywhere, and mobility should also be a priority, with autonomous vehicles serving the elder and more isolated population. Contribution to population's wellness, mobility and education will also promote tourism as people will have more time and energy to travel.

The Japanese government is the first to adopt this concept, but it certainly will not be the only one, as in most developed economies these variables have the same behaviour: increasing life expectancy and decreasing birth rate. Besides, as the Keidanren (2018) affirms, it is the current society that will guide the future society, making it crucial to plan it, considering every need and challenge that may arise and every possible solution. This is the fundamental reason why experts call it the 'Imagination Society' because imagination and creativity will be essential to seek ways of achieving a perfect synergy between humans, nature and technology, to enable sustainable development.

3.3.2. Other proposals

Japan is not the only country integrating new technology in its development plans. Around the world, governments are starting to realise the importance that technology will have in the future, especially the Internet of things and Artificial Intelligence, and how it can be beneficial for them.

In 2015, the Chinese State Council announced the 'Made in China 2025', a 10 years plan for the Chinese industrial development (Li, 2018). This is the first stage of a three-phase plan that intents to transform the Chinese industry, from labour intensive production to knowledge intensive manufacturing. China intends to improve the quality of all products produced in the county, creating its own brand, with dense manufacturing skills with advanced technology, using new material and producing main components of key products. The State Council has given priority to ten industries, among which are the information technologies, automation, aerospace and aviation, biomedicine and agriculture.

Estonia was the first country to extensively use the electronic identification cards, in 2002 (Goede, 2019). The e-Estonia program started in 1997, with the e-Governance and up until now several other

projects have been part of this journey for making Estonia a key place to create and test smart e-solutions. For this program to succeed, it was necessary to have a very secure internet database, working as an information system available for both public and private sectors. These measures are beneficial for the government but especially for the population that is now allowed to access multiple public services online, for example, digital identification, internet voting, electronic tax filing, online medical services and digital signature. The use of electronic identification cards was to key to success in Estonia, together with the population's willingness to work with government to create a more transparent public system.

The government of Singapore has also created, in 2014, an initiative, called 'Smart Nation', that focuses on improving the population's live and creating more opportunities through technology (Hoe, 2016). This strategy focuses on three main areas, elderly, transportation and data, all supported by cybersecurity, that the government believes are fundamental for enhancing que quality of life of the population. Some of the measure of 'Smart Nation' include sharing government data with the public and a credit of S$500 for every Singaporean who is 25 years or older to use in a selected range of courses.

3.4. IoT and AI in the travel and tourism industry

Technology has also changed tourism, revolutionising companies, products and experiences, business ecosystems and destinations, but also the roles of producers and consumers, with the rise of digital platforms (Dredge et al., 2018). The Internet of Things and Artificial Intelligence represent a great opportunity for the hospitality industry, particularly to generate data for analytics and optimization purposes. Car et al. (2019) state that the IoT is an extremely important element for the tourism and hotel industry, and that the travel industry is leading the way when considering IoT investment.

Nadkarni et al. (2019) presents some examples of IoT applications in hospitality. The Disney MagicBand, an RFID-enabled wristband, allows Disney World's guests to shop, enter their hotel room or use the FastPass, without needing anything else. By communicating to the sensors throughout the park, these bracelets are an example on how to enhance guests' experiences using IoT, and at the same time, allow a better understanding of guest's behaviour. IoT may also help to meet guests' preferences, for example using thermostats that can control room temperature, humidity and air quality, that can even be voice controlled, using voice assistants like Amazon Alexa. The Starwood Hotel is now using a smart door lock system, that allows member to enter the property without any keys, using only their smartphone. Another feature that can be very useful for the industry is the use of proximity sensors that can be useful for both front-of-house and back-of-house. For the front-

of-house sensors can be used to provide micro-location inside the hotel, for example to find children or to notify guests of near-by opportunities. For the back-of-house, can help staff by allocating the nearest available member to a determined service, enhancing productivity. Controlling safes and minibars use remotely may also improve productivity by saving time to the staff members. A great concern for the industry is the energy expenditures. The IoT can help reducing these expenditures by reducing the in-room power consumption, through light and climate control, as devices are able to interact and make intelligent choices.

Car et al. (2019) present other examples of the IoT in the tourism industry, for example, geo-location technology, that may enhance travellers' sense of safety and communicate with others with the same interests. Medical tourism can also be improved, allowing patients to have a vacation phase of post treatment, using teleconsultation and being continuously monitored. Ecotourism and cultural tourism can increase their attractiveness by offering different experiences such as personalised e-tours. Virtual concierges may be useful for travellers taking long vacations and several destinations, offering services such as repacking and collecting suitcases and delivering them at the next location. Several airports are already using IoT to process passengers' flow at the airport, enabling multiple entries or exits from a country at the same time, free from human errors. In this way, safety can be enhanced as well as the speed of the verification process, preventing missed flights caused by long waiting lines. Table 3.2 illustrates IoT examples for the hospitality industry.

Table 3.2 - Several solutions of IoT in the hospitality industry

Solution	Application/Example
Personalised hotel rooms	Hilton and Marriott have experimented with the 'connected room' concept, where users are able to control many of the room's features from their mobile phone, or from a provided tablet. In addition, IoT platforms could over time memorize a guest's specific comfort preferences, such as temperature, lights, TV channels & shades, and automatically set up the room for their next stay. Hotels can automatically send electronic key cards to guests' smartphones, allowing them to check-in without anyone's assistance.
voice-based interaction	Amazon Alexa enables the guest to use voice-control on different smart home devices. It's basically a guest's personal butler who never gets tired of fulfilling their needs. Alexa can be configured by hospitality providers to allow guests to control and adjust in-room devices such as lights, thermostats, blinds and TVs.
integration with mobile	Fast check-in: Starwood and Hilton, for example, already offer an option of checking in via a mobile gadget instead of spending time at the front desk. Control device: all the functions performed by quite a few remote controls, key cards and switches are now available at the click of a button on a mobile device.
body area sensors	Wireless medical sensor technology further expands the scope of data collection by providing detailed data about organs and systems within the body. For example, service providers can filter out high carbohydrate and sugary meal options for diabetic guests, high cholesterol meal options for patients with heart disease, etc.
inventory management	IoT will change the way hotels manage their inventories. IoT implemented systems will keep record of the inventory and manage the changes in them automatically.
location-based information	For example, sending SMS messages about menu items at the restaurant when guests are close by or advertising gym services when they are near the gym. It may also mean sending up-to-date information about local transport links, or nearby attractions.

Flic – a wireless button	For example, when someone calls reception to ask for more towels or coffee. With Flic, guests could notify housekeepers about it with a press of a button. Ordering services and sending automated messages has never been this easy.
building automation and monitoring	For example, in-room monitoring systems can be used to detect whether a room is occupied or unoccupied so as to schedule housekeeping services.
Valpas – autonomous bed bug prevention	"Valpas has developed an autonomous bed bug prevention system that allows guests to stay carefree from bed bug anxiety at exciting hotels around the world. By replacing their existing bed legs with Valpas' smart legs, hotels can monitor the rooms in real-time and receive notifications of eliminated bed bugs caught inside the legs."
automation	IoT automates the business functions of travel and hotel businesses. For example, hotels can track supply chains more efficiently through sensors in shipments, enabling them to get ready for any future contingency and avoid service disruptions to guests.
augmented reality and beacon technology	For example, this technology can be used to provide guests with services such as digitally guided tours, previews of in-room environment (e.g., decor, facilities and amenities, etc.), immediate translation services for signs and other written materials, interactive restaurant menus with dish previews, critic reviews, food allergy information, etc.
maintenance	By installing sensors, hotels can track the condition of all electronic devices and schedule the work of personnel according to whether the guest is in or out of the room. In addition, predictive maintenance will take hoteliers one-step further; it will use sensors to recognize the problems and alert before the issue becomes hazardous.
energy saving	While IoT can enable personalisation, it can also offer businesses financial benefits through automated or smart energy saving.

Source: Car et al. (2019)

The implementation of IoT also poses some challenges that need to be considered, such as, security, high investment costs, technology infrastructure, communication infrastructure and IoT standards. Zeinab and Elmustafa (2017) point out that most of these issues will be overcome but two of these challenges are more concerning: the coexistence of different networks and the needed size for big data. The first problem has to do with interoperability. As different companies or stakeholders create different solutions that work for them, the potential of using for example guests' preferences on a broader scope is limited as different platforms may have difficulties communicating. This can also be an issue for the guests, as they must learn how to work with different platforms in different places (Kansakar, Munir & Shabani, 2019). The second problem regards Big Data[7]. Everyday, around 2.5 quintillion bytes of data are created and, in order to benefit from all these data, it needs to be stored and analysed (Zeinab & Elmustafa, 2017). In order to do so, large computational systems are needed as well as homogeneous, readable and interpretable data.

Until 2017, Artificial Intelligence was only used in the tourism industry to develop demand forecast models and recommender systems. At that point, research on costs and benefits of artificial intelligence systems for travel companies (Ivanov & Webster, 2017) and defining how service robots will be utilized in the hospitality sector (Murphy, Gretzel & Hofacker, 2017) appeared and the paradigm shifted. Geisler (2018) identified four patterns for the AI use in the travel and tourism

[7] "Big data is a term that describes the large volume of data – both structured and unstructured – that inundates a business on a day-to-day basis." (https://www.sas.com/en_us/insights/big-data/what-is-big-data.html)

industry. The first pattern is that AI is mostly used in customer centric applications, as opposed to operational processes, because intermediaries focus on costumer experiences rather than operational excellence. Second, digital artificial systems are mostly used in the pre-travel phase and robots are used in the on-travel phase, as research is mostly done online and physical interaction is more valuable during the experience phase. Thirdly, the author identified three models that dominate the industry: chatbots, travel assistants and service robots. Finally, it is suggested that most of the AI services are implemented by technology companies in partnership with the employing company, as most of the travel and tourism industry does not consider technology as a key expertise and lacks the ability to self-develop these systems.

Ivanov et al. (2017) compiled in Table 3.3 the main examples of service automation and robot adoption in travel, tourism and hospitality companies.

Table 3.3- Main examples of service automation and robot adoption in travel, tourism and hospitality companies

		Current use	**Potential use**
Hotels	*Service automation*	✓ Self-service check-in kiosks ✓ Self-service mobile check-in ✓ Mobile service requests	✓ Full-service automation
	Robots	✓ Front desk robots ✓ Concierge robots ✓ Delivery robots ✓ Vacuum cleaning robots ✓ Porter robots ✓ Room assistant robots	✓ Housekeeping robots, e.g., cleaning, doing laundry, etc.
Restaurants	*Service automation*	✓ Table-side ordering, entertainment, and payment ✓ Conveyor restaurants ✓ Roller-coaster restaurants ✓ 3D food printing	✓ Full-service automation
	Robots	✓ Robot chefs ✓ Robot servers ✓ Robot bartenders ✓ Robot baristas	✓ Dishwashing robot ✓ Ordering companion
Meetings and events	*Service automation*	✓ Mobile telepresence ✓ Self-service check-in kiosks ✓ Self-service mobile check-in ✓ Mobile service requests	✓ Fully mobile telepresence
	Robots	✓ Booth attendants ✓ Concierge robots ✓ Robot bartenders ✓ Robot baristas ✓ Robot servers ✓ Entertainment ✓ Delivery robots	✓ Interactive booth attendants
Theme and amusement parks	*Service automation*	✓ Information kiosks and displays	✓ Self-service kiosks for information and purchases
	Robots	✓ Concierge robots ✓ Robot bartenders ✓ Robot baristas ✓ Robot servers ✓ Entertainment ✓ Delivery robots	✓ Mobile robot guide ✓ Robot cleaners

Car rental	*Service automation*	✓ (Un)locking the car with a card or app	✓ Self-service kiosks for information, booking and payment
	Robots	✓ None	✓ Robot sales agent ✓ Self-driving cars
Airports	*Service automation*	✓ Self-service check-in kiosks ✓ Self-service mobile check-in ✓ Bag check ✓ Conveyor belts ✓ Self-boarding gates	✓ Full-service automation
	Robots	✓ Airport robot-guide ✓ Bag drop robots ✓ Customer service robotic agents ✓ Entertainment robots ✓ Cleaning robot ✓ Delivery robots	✓ Robotic luggage carts ✓ Self-driving cars to transport passengers between the gates
Travel agencies and Tourist information centres	*Service automation*	✓ Information kiosks and displays ✓ Audio guides	✓ Self-service kiosks for information, booking and payment
	Robots	✓ None	✓ Robot sales agent ✓ Robot guides ✓ Home digital assistant robot linked to the website of a travel agency
Museums and art galleries	*Service automation*	✓ Information kiosks and displays ✓ Audio guides ✓ Mobile apps and QR codes	✓ Self-service kiosks for information, booking and payment
	Robots	✓ Robot guides	✓ Robot cleaners

Source: Ivanov, Webster & Berezina (2017)

It is notorious that a great part of the Artificial Intelligence applied to the travel and tourism industry is in the form of robots. Robots are a very useful and convenient form of AI that will be explored in Chapter 4.

3.5. Attitude toward technology

Considering the increasing use of technology globally and its growth in the travel and tourism industry, it is important to understand what the consumer's attitude towards it is.

The use of technology has a positive social impact for the organizations, by helping team coordination or allowing better access to price information (Cruz-Cárdenas et al., 2019). 50% of new capital investment is being assigned to IT research and implementation projects, however several projects are being reported as failures, being underused or not used at all (Abbasi et al., 2015; Parasuraman, 2000). One of the main reasons companies invest in technology is to improve customer service, by improving service encounters (Bitner, Brown & Meuter, 2000 cited in Parasuraman, 2000). Thus, it would be extremely valuable for companies to understand how the costumers feel about technology before implementing it.

Cruz-Cárdenas et al. (2019) have identified several factors that are considered predictors of the acceptance/use of technology. Demographic variables are one of the most cited, with age, gender, educational level and income being the mostly used, however there is no consensus on their role as predictors. Cultural values and behaviour are also cited. The authors state that when technology acceptance models are applied in western countries, perceived usefulness is a key predictor, whereas when they are applied to non-western cultures the perceived ease of use has a greater influence. Ivanov et al. (2018b) add that the area of residence (urban or rural) may also have an impact in predicting technology acceptance.

The Technology Readiness Index (TRI) (Parasuraman, 2000) is the most widely used scale to measure user attitude toward technology. The author describes technology-readiness as *"people's propensity to embrace and use new technologies for accomplishing goals in home life and at work"* (p. 308), and states that it can be measured in an array from strongly positive to strongly negative. Where someone stands on this scale depends on the positive or negative feelings he/she gets when using technology. The author has established four categories for technology readiness:

1. Optimism: a positive opinion of technology, supported by the principle that it gives people increased control, flexibility and efficiency in their lives.
2. Innovativeness: a predisposition to be a leader and pioneer in technology use.
3. Discomfort: an apparent lack of control over technology together with a feeling of being overwhelmed by it.
4. Insecurity: mistrust in technology and doubt about its abilities.

A negative attitude toward technology, coined with the term technophobia, causes users to resist to or avoid new technology (Tussyadiah & Park, 2017; Tussyadiah et al., 2020). It can be defined as: "(a) anxiety about current or future interactions with computers or computer-related technology; (b) negative global attitudes about computers, their operation or their societal impact; and/or (c) specific negative cognitions or self-critical internal dialogues during actual computer interaction or when contemplating future computer interaction." (Rosen & Weil, 1990, p. 276, cited in Tussyadiah et al., 2020).

Davis (1986) developed the Technology Acceptance Model, stating that the perceived ease of use and the perceived usefulness will dictate the consumer's adoption of technology. This model has been used in countless studies, for different sectors and environments (Khasawneh, 2018) and it is the model used in this dissertation and thus will be explained in detail in section 5.4.

Other models for technology acceptance were developed and are presented in figure 3.5.

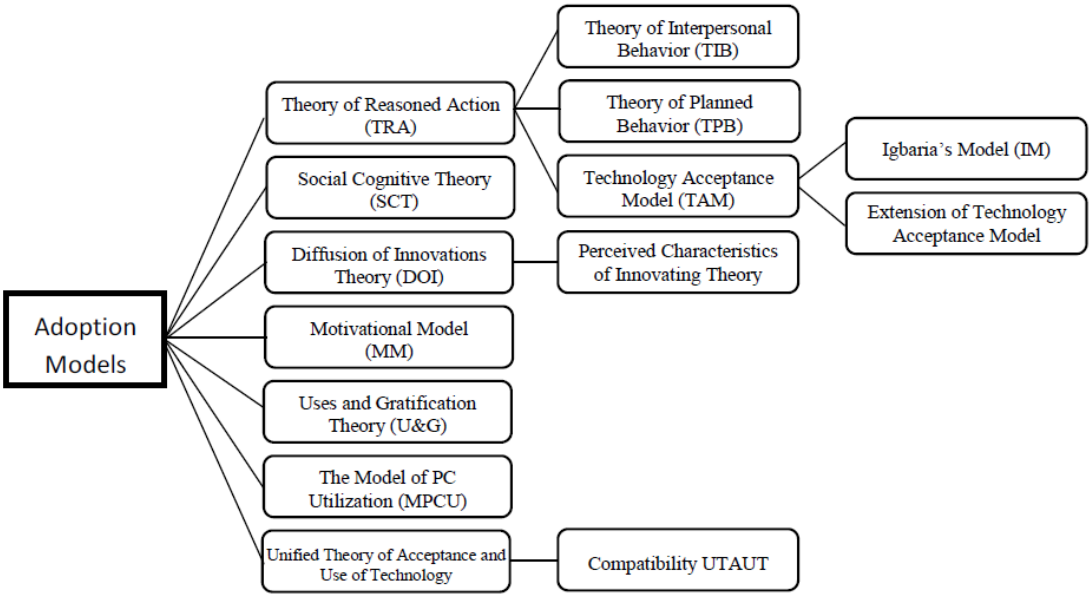

Figure 3.5 - An overview of Adoption/Acceptance Models
Source: Taherdoost, 2017

3.6. Conclusion

Automation has been a part of society since the creation of small mechanisms in Ancient Egypt. The industrial revolutions and wars, particularly, World War II, brough rapid advances, allowing for an exponential development of mechanisms and technology in a few years. These discoveries were applied in several fields, showing their importance in making human life easier at work and in daily activities. Some of the main advantages of automation include higher production rates, increased productivity, more efficient use of materials, improved worker safety and better-quality products.

The Industry 4.0 represents a new way of producing and living. Benefiting from the on-going advances in technology, cyber-physical systems allow interactions between the cyber world and the real world, creating a never before seen stage of connectivity and interaction. The technological advances brought by the Internet of Things and Artificial Intelligence enable this extreme connectivity status and are closely connected to the arise of Smart Cities and Smart Factories that will improve production processes.

Several countries have begun to use the available technologies at their service either to improve their industries or their societies. The Japanese proposal is one of the most interesting approaches, materialized in a 'Super-smart Society' that intends to use the available technologies to foster new knowledge and new values, continuously generated to boost the economic growth and social wellbeing. Although the country has already some initiatives and programs in progress, it is clear for them that this society cannot be achieved by one company or one country on its own.

The Internet of Thing and Artificial Intelligence are being used in the travel and tourism industry, even though its still in early stages. Technology is mainly used in tourism to improve customer experiences rather than to simplify or enhance processes. However, the abilities of IoT and AI should be closely monitored by hotels and other travel and tourism agents, so that the sector may remain competitive, as it can also help to save money on energy costs and maintenance.

However, user's attitude toward technology is not always favourable. Demographic and cultural variable are the most cited as predictors for technology acceptance, even though their role is not consensual. Several models were developed to try and understand technology adoption, so that the companies' investment in technology is not in vain.

Chapter 4. Robots

4.1 Introduction

After realizing the increasing importance of automation and technology in the industry and thus in society's daily life, Chapter 4 will explore a very specific part of AI: robots.

This chapter seeks to explain the evolution of robots, both theoretically and mechanically, providing knowledge about how robots appeared, what is the definition of robot, what types of robots are there, in section 4.2.

Section 4.3. will focus on the robotics laws, an important set of laws created by the father of robotics to ensure that no robot harms a human being and that the humanity' wellbeing is the number one priority of every robot.

On the following section, 4.4. Robots in services, the current use of robots in services will be explored, and some insights on how robots can be helpful in services will be provided. This section will also focus on the differences between having human and robots employees, namely the benefits and downsides of using robots, what tasks are considered appropriate and inappropriate for robots to perform and what are that chances of robots replacing human employees.

Section 4.5 focuses on robots in tourism, providing examples of robots currently used in the tourism industry and future applications. This sections also provides knowledge on the usage of robots throughout the guest cycle.

Finally, section 4.6. intends to explore the interaction between humans and robots, by understanding the concept of social robot and what characteristics it must have. Some case studies are presented as a mean to understand what human features impact the human-robot interaction.

4.2. Robots

Early in the history of human civilizations, animated mechanisms are presented, ranging from weight systems and pneumatic pumps in ancient Greece, to Leonardo DaVinci's contributions in the area of human anatomy, which allowed the development of sufficient knowledge for the emergence of mechanical joints (Groover, 2020) More recently, although there have been some significant advances in this field, such as the appearance of mechanical looms, the creation of the first robot was only possible after the creation of the first computer in 1940. This robot, created in the 1950s, was called Unimate. It was an industrial robot and was developed by George Devol and Joseph Engleberger, known as the father of robotics (Engelberger, 1980).

The concept of robot, introduced by Karel Čapek in 1920, comes from two notions: humanoid and automaton. A humanoid is a nonhuman being that resembles a human and an automaton is defined as a machine that moves/operates automatically (Clarke, 1993). The term "robot" derives from the Czech word *robota*, which means forced labour or compulsory service. In 1950, technologists defined the term robot as machines controlled by code, that can be reprogrammed, "designed to manipulate and/or transport material through programmable movements for the performance of various tasks" (Scott, 1984, quoted by Clarke, 1993, p.55).

Isaac Asimov, born in Russia, an American citizen since he was 8 years old, a renowned biochemistry teacher and author to countless works of science fiction, has defined robotics as "the science or art that involves artificial intelligence and mechanical engineering" (cited by Clarke, 1993).

The Robot Institute of America has defined a robot as "A reprogrammable, multifunctional manipulator designed to move material, parts, tools, or specialized devices through various programmed motions for the performance of a variety of tasks" (Bartneck & Forlizzi, 2004, p. 592). According to the International Organization for Standardization (2012), a robot as an "actuated mechanism programmable in two or more axes with a degree of autonomy, moving within its environment, to perform intended tasks". Murphy et al., 2017) define robot as a relatively autonomous physical device, capable of moving and performing a service. The term is still defined by Clarke (1993) who states that robots have three key features: programmability (a robot is a computer); mechanical ability (a robot is a machine); and flexibility (a robot can use several codes and handle/transport materials in several ways). So, according to this author a robot can be defined as a computer enhanced machine or a computer with sophisticated input/output devices.

4.2.1. Types of robots

According to Ivanov et al. (2019), robots can be divided in three groups: robots that operate autonomously, robots that interact with other robots and robots that interact with humans. Contemplating the goal of this study, only the third group of robots will be considered.

Robots can have several shapes, from an industrial aspect to an almost human conception. One of the premises studied in the literature is the influence of robots' appearance in consumers perceptions. Clarke (1993) states that in fiction, just as in real life, it seems that a robot only needs to have a few human features to be treated as a human. A studied carried by Tung and Au (2018) affirms the more a robot looks like a human, the more it is expected to act like one. Thus, these authors indicate that the appearance of robots does affect the consumers perception of the service, so its form must be clearly thought according to the tasks it will perform. Wirtz *et al.* (2018) advocate that the more realistic the robot face looks, the more people hope for it to behave humanly, indicating

that the more the robot mimics the emotional expressions of humans, the more likely it is to be considered pleasant. However, an approach too close to humans is admonished, as the robot may become frightening and unnatural, leading humans not wanting to interact with it - Uncanny Valley's Theory or Strange Valley (Wirtz et al., 2018).

Figure 4.1- Starwood's robotic butler
Source: thepointsguy.com

Figure 4.2 - Sony Aibo (robot dog)
Source: dezeen.com

Figure 4.3 - Connie, Hilton's robot concierge
Source: digitaltrends.com

Figure 4.4 - Sophia, the humanoid social robot
Source: tecmundo.com.br

A study carried out by Yu and Ngan (2018) looked at consumers' perception of non-verbal communication by humanoid robots (gross human features). The characteristics explored in the study were the smile and the head tilting and the author concluded that these characteristics improved the customers' perception regarding the safety and reliability of the robot. Tung and Au (2018) also state that the feeling of trust in robots can be developed after several successful interactions with them.

On the other hand, Tung and Au (2018) also state that, although robots are designed to improve the consumer experience, when failures in the use of robots are experienced, consumers feel frustrated and disappointed, particularly if the same error occurs more than once. Wirtz *et al.* (2018) also argue that people forgive human errors, but quickly lose confidence in artificial intelligence.

4.3. Robotic laws

Isaac Asimov wrote the robotic laws, with the purpose to establish a set of rules that would allow some control over semiautonomous machines (Clarke, 1993).

Asimov has dominated the robotic field, an engineering branch, between 1940 and 1990. His laws, widely known, have emerged, according to himself, from examples such as Frankenstein and Rossum, robots that destroyed their creators. Taking the possibility of robots hurting humans into consideration, in 1942 and together with John Campbell, Asimov wrote the first three laws of robotics:

> "1st law: A robot may not injure a human being or, through inaction, allow a human being to come to harm.
>
> 2nd law: A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
>
> 3rd law: A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws" (Clarke, 1993)

These laws intend to ensure the human domination over robots and to avoid a perverse use of the robots, even though they are merely philosophical laws.

With the development of robotics and other contiguous areas, Clarke raised some four key questions in its 1993 publication. In order to accomplish the previously mentioned laws, a robot must be perfectly able to distinguish a human being from a robot, must distinguish between a request and an order and should understand the concept of its own existence. Likewise, a robot should be able to acknowledge the differences between death, mortal danger, injury or non-life-threatening damage, besides discerning between physical and psychological damage. Another fundamental question is the interpretation of the term 'human', that becomes more complicated as notions like cyborg arise. A cyborg is a 'bionic human' (Merriam-Webster, 2020), meaning it is an organism whose abilities have been enhanced by electronic and/or electromechanical components. So, when a human being uses a prosthetics or as robots look extremely similar to humans, the differences between these two concepts may be blurred. Another question raised by Clarke's interpretation of Asimov's laws has to do with ethical and legal issues. A robot should be able to identify senseless or illegal requests/orders, so that it can deny or, at least, question them. Clarke (1993) points out a very current example: terrorism. The first law does not consider that a human being may be endangering countless human lives, and the robot is not able to distinguish a bad person from a good person. The third question is related with the impasse, or the dead ends, such as, for example, when two human being face equal danger, but the robot can only save one of them. According to the first law,

the robot cannot protect one and sacrifice the other. In this case, robots must be programmed to make arbitrary decisions. The last question regards the 'sleep mode' of robots. Asimov does not specify if these laws apply to robots when they are in sleep mode. In case they do not, any robot may fail its functions simply because it is in stand-by, jeopardizing human safety and life, as well as its own existence. Besides these four questions, Clarke advocates that the laws are clearly incomplete as they do not have in consideration any non-human form, such as plants, animals, or other undiscovered intelligent life forms.

Aware of some of these issues, in 1985, Asimov wrote the Zeroth law, that puts the interests of humanity above all other individual interests, always safeguarding human life.

> Zeroth law: A robot may not harm humanity, or, by inaction, allow humanity to come to harm.

Although more complete, the laws are not yet perfect, as they allow, for example, robots to manipulate the human mind (Clarke, 1994). Robots must be programmed so that their behaviour is fully controlled through the laws of robotics. Furthermore, robots do not identify any human class as superior to another, taking humanity as an egalitarian whole, both for the purposes of protection and obedience.

4.4. Robots in services

To understand the perception of consumers about the use of robots in services, it is important to first know what type of service robots already exist and are used in services in general and specifically in tourism.

According to Wirtz *et al.* (2018) service robots are autonomous and adaptable interfaces, based on a system, that interacts, communicates, and provides services to an organization's customers. The authors consider the main design attributes of service robots to be representation, anthropomorphism, and task orientation. In their study, Wirtz *et al.* (2018) also clarify that service robots can be physical or virtual but note that tangible tasks must be performed by tangible robots, while intangible tasks can be performed by four types of robots: text-based virtual robots (chatbots), voice-based robots (such as Siri and Alexa), video-based robots and three-dimensional virtual robots (holograms).

Medical and service robots are a key part of the robotics field. Economically, medical robots represent the most important subclass of service robots, including rehabilitation, surgery among others (Husty & Hofbaur, 2017). There are numerous examples of artificial intelligence used in the medical field, whether it is used for residents to practice and make less mistakes on actual surgeries (Crişan,

Andraş & Coman, 2017), medical tele-examination (Stollnberger et al., 2014) caring for elders (Rantanen et al., 2018) or fighting viruses (Yang et al., 2020). The 2015 Ebola crisis allowed for a glimpse at the potential of robots in fighting viruses, contributing mainly with disinfecting, delivering medication and food, measuring vitals and assisting border controls. Thus, three key areas of actuation for robots were established: clinical care (e.g. telemedicine and decontamination), logistics (e.g. delivery and handling of contaminated waste), and reconnaissance (e.g. monitoring compliance with voluntary quarantines). The recent COVID-19 pandemic added a new area: continuity of work and maintenance of socioeconomic functions (remotely operating), possible thanks to the technological advances (Yang et al., 2020).

Ivanov and Webster (2017) identified the different types of robots that exist in services, dividing them in terms of mobility and ownership.

		Type of robot	
		Stationary	*Mobile* (wheeled, legged, flying, underwater)
Ownership	*Company*	Front desk robots Robot chef/Cooking robots Robot baristas Robot bartenders Shoe shine machines ATMs Concierge service robots Security robots Massage robots	Security robots Robot guides Robot waiters Companion/sex robots Pet robots Robotic luggage carts Room service deliver robots Robotic vacuum cleaners Robotic lawnmowers Robotic pool cleaners Delivery drones Entertainment robots General service robots
	Customer	(Customers are unlikely to bring stationary robots to hospitality industries, in most situations, apart from extended stay facilities)	Companion/sex robots Pet robots Concierge service robots General service robots

Figure 4.5 - Types of service robots
Source: Ivanov & Webster (2017)

Analysing Figure 4.5, it is possible to see that robots are already used in services related to the tourism industry, namely in reception, catering, *concierge* services, security, and personal care services, such as massages or companion robots.

An extremely debated topic in the literature is the difference between humans and robots in practical terms, that is, what tasks will robots be able to perform and what is the cost-benefit associated with the decision to replace humans with robots, namely in the tourism sector.

Ivanov (2017) explains that, among researchers, there are essentially two streams, one more positive regarding the liberation of human beings from heavy and manual work, giving them the

possibility to develop other creative projects, and another that reveals the fear of making humans obsolete compared to machines. In the sense of the first current, Webster and Ivanov (2019) expect humans to be freed from the production of goods and services, preserving their ability to create, interpret and work in a team, which robots will never have. In addition, the authors argue that physical dexterity is another skill that will only be characteristic of humans (in the short/medium term), being able to quickly and effectively perform tasks that for a human are simple, but for a robot are still difficult, such as opening doors or walking/running.

Regarding the susceptibility of jobs to computerization, Frey and Osborne (2017) state that several jobs have already been replaced by computers, such as bookkeepers, cashiers or telephone operators. Also, the general access to computing leads to job polarization, meaning, an increasing number of jobs in problem-solving areas that require a higher cognitive activity and, thus, high-income, and an increase in the number of low-skilled jobs, while the middle-skill share of jobs decreases (Frey & Osborne, 2017; Borland & Coelli, 2017).

This is not the first time in history that a revolution eliminates some jobs and creates others. The creative destruction process, that follows technological inventions creates both wealth and disturbances. Frey and Osborne (2017) present an interesting example, showing how, in 1589, the inventor of the knitting machine wanted to relieve workers of hand-knitting but saw his patent being denied by Queen Elizabeth I, who was more concerned about the jobs that would be lost. In a study carried out in Australia, Borland and Coelli (2017) found that the introduction of computer-based technologies has not caused the job availability to decrease and that job turnover and the rhythm of labour market structural change have not augmented because of these technologies. The authors state that the tasks that are most likely to be substituted by robots are the one that are easy to codify, or in other words, easy for a programmer to 'fully understand the sequence of steps required to perform that task' (Borland & Coelli, p. 380, 2017).

However, besides considering that robots will not take humans jobs, Borland and Coelli (2017) believe that new technology has the ability to create jobs. According to the authors, even though new technology reduces the total amount of labour time needed to produce products and services, the higher income and non-satiation cause the demand for both existing and new products (some of them created by new technology) to increase. Secondly, technology is usually complementary to several types of labour, and therefore may boost the demand for other types of labour. The authors found that the increased use of IT and computers in the United States, Europe and Australia coincided with the phenomenon of job polarization, which means a change in the composition of employment, translated in an increased proportion of high-skill jobs, a decrease in middle-skill jobs and an increase in low-skill jobs.

Wilson, Daugherty and Morini-Bianzino (2017) also look at things from this perspective and consider the jobs that Artificial Intelligence will create. The authors divided the new businesses and jobs in three categories: *trainers*, *explainers* and *sustainers*. *Trainers* will be humans who teach robots how to behave as much as a human as possible. *Explainers* will be the links between technologists and business leaders, explaining complex algorithms with nontechnical terms. Finally, the *sustainers* will deal with automation ethics, economy and manage machine relations.

To clarify this discussion, Wirtz *et al.* (2018) present several advantages of robots compared to humans, namely: there is no heterogeneity in the provision of the service, neither over time nor between robots, ensuring that all customers are served in the same way; robots do not make mistakes or feel fatigue, thus are able to work 24 hours a day; and they are not biased or prejudiced. Ivanov and Webster (2018) also list a number of advantages of robots over humans, namely: they can work 24 hours a day, which reduces the company's labour costs; some types of robots, such as chatbots, can serve countless customers at the same time; they can perform the same task over and over without complaining and without forgetting the procedures; they can improve the quality of the service due to the degree of innovation they bring to the interaction with the customer; they can communicate in different languages, creating value for the customer; and, given the seasonality of tourism, they can avoid several problems with hiring employees for short periods.

In their analysis, Ivanov and Webster (2018) also present the financial costs associated with the adoption of robots, particularly the costs of acquisition, installation and maintenance, software update, adaptation of space to the mobility of the robot (elimination of barriers/obstacles), staff training so that they can work with the robots and, eventually, hiring specialists to operate the robots. However, the authors argue that these costs can be mitigated by renting the robots instead of buying them. Other costs identified are resistance by employees and customers, which can generate derogatory advertising.

Ivanov (2017) has summarized the pros and cons of hiring robots in Table 4.1:

Table 4.1 – Pros and cons of hiring robots

Why robots?	Why not robots?
✓ Robots could work 24/7 ✓ Robots could implement various tasks and expand their scope with software and hardware upgrades ✓ Robots could provide constant or improving quality of their work ✓ Robots could fulfil their work correctly and in a timely manner ✓ Robots could do routine work repeatedly ✓ Robots do not complain, get ill, go on strikes, spread rumours, discriminate, quit their job without notice, show negative emotions, shirk from work	✓ Robots lack creativity ✓ Robots will not be any time soon completely independent of human supervision ✓ Robots lack personal approach ✓ Robots can orientate in structured situations (at least for the moment) ✓ Robots may (will) be perceived as threat by human employees (e.g. Neo-Luddism movement)

Source: Ivanov (2017)

Another idea explained in the literature, by Ivanov, Webster and Berezina (2017) is that with time, the costs of acquisition and maintenance of robots will fall, which will make them a more viable option, but according to Wirtz *et al.* (2018) in the long run, robots will not represent a factor of competitive advantage for companies, giving as an example the case of ATM machines, which have replaced human tellers, and today are a banality.

In conclusion, Ivanov and Webster (2018) state that there will be no massive replacement of humans by robots, but that artificial intelligence will be used to improve the productivity of companies in the various social sectors, serving a greater number of customers with an equal or slightly lower number of employees.

4.5. Robots in tourism

The tourism sector, particularly the hospitality industry, is an extremely labour-intensive field. Waiters, receptionists, housekeepers, chefs, bellboys or baristas the industry would work very differently if it were not for the people (Tuomi, Tussyadiah & Stienmetz, 2020).

Slowly but surely automation has been making its way into hospitality from self-service kiosks, concierge robots and electronic butlers to fully robotic hotels (Ivanov, Webster & Berezina., 2020). These technologies have been used to enhance guest's experiences and to improve hotels' operations (Saravanakumar & Badri Narayanan, 2018). Technology helps to create a unified experience, as the guest can make a room reservation, ask for room service and pay using just a

smartphone. This level of automation allows for disconnected processes to be integrated and centralized, creating a better workflow.

Robots are a technological asset that can be very helpful in hospitality, when used correctly. Technology, namely Robots, Artificial Intelligence and Service Automation (RAISA) created great opportunities for the travel and tourism (TT) industry to improve operations, increase productivity and ensure consistent levels of quality (Lukanova & Ilieva, 2019). In 2015, the Henn-na Hotel opened in Japan, the first hotel fully staffed by robots (Tung & Au, 2018; Saravanakumar & Badri Narayanan, 2018; Lukanova & Ilieva, 2019; Ivanov & Webster, 2019; Ivanov, Seyitoğlu & Markova, 2020). This was a breakthrough for robots in hospitality, as it allowed for the introduction of robots as concierges[8] and front desk agents, rooms equipped with voice-controlled digital assistants like Alexa and Siri, robotic butlers like the Starwood's Aloft Hotel Boltr, robotic arms that act like bartenders at the Royal Caribbean's Quantum of the Sea and Singapore's virtual agent SARA, that provides information and assistance for tourists (Tung & Law, 2017; Saravanakumar & Badri Narayanan, 2018; Ivanov et al., 2020b; Webster & Ivanov, 2020). Other examples of robots that are used in the industry or are expected to be implemented are:

- Applications that help users with travel planning, such as "TripBuddy" (Sumardi et al., 2017);
- Robotic interpreter guides, as shown in Al-Wazzan et al.'s (2016) study;
- Robots with specific functions, such as the dealer robot, designed to serve players in casinos (Wang et al., 2010);
- Autonomous cars can pick guests at the airport, check them in before getting to the hotel and activate their smartphone as room key (Bowen & Morosan, 2018).

According to Bowen and Morosan (2018), the main reason for the increasing use of robotics in the hospitality industry is the shortage of labour. Due to tighter immigration policies, the aging population and low birth rate in many countries, European and North America's countries face labour shortages. Besides, the growing number of travellers from the Asia and Pacific region causes language and cultural barriers. Ivanov and Webster (2019) add that the use of service robots in hospitality increases cost-effectiveness, improves resource usage, creates more accurate demand prediction, improves quality control and process management and eliminates human errors.

The tourist experience will be influenced by where and how he/she interacts with a robot, hence the importance of understanding customer's needs and preferences and keep them in mind while designing a robot (Murphy et al., 2019). For instance, because of the current COVID-19 pandemics, people are advised to avoid human contact and robots may bring a solution. Robots can be used for room service, food and goods delivery, cleaning, autonomously transport people, among other uses,

[8] Hilton's first robot concierge https://newsroom.hilton.com/corporate/news/hilton-and-ibm-pilot-connie-the-worlds-first-watsonenabled-hotel-concierge

avoiding human interaction but also in disinfecting, delivering food and medicines or providing information to people (Seyitoğlu & Ivanov, 2020).

4.5.1. RAISA throughout the Guest Cycle

Lukanova and Ilieva (2019) state that one of the greater advantages of RAISA in hotels is the improved guest experience. Even though the notion of guest experience varies among authors, in every researcher's view technology can have a very significant impact, either positively or negatively. Considering that the customers' experience is a complex process that summarizes every direct or indirect interaction between the guest and the hotel organization, these authors use the Guest Cycle model to identify the different ways technology can be used throughout the experience. Figure 4.6 shows the main examples of RAISA adoption in hotel companies in each phase of the Guest Cycle model.

	Robots	**Artificial intelligence**	**Service automation**
Pre-arrival		AI search platform Chatbots	Virtual reality Mobile check-in
Arrival	Porter robots		Digital kiosks Smartphone Room Keys/Non-stop check-in
Stay	Front desk robots Concierge robots Delivery robots Vacuum cleaning robots Room assistant robots	Interactive Social Hubs Chatbots	In-room smart technologies
Departure	Porter robots	Travel assistant	Express Checkout Digital kiosks
Assessment		AI platform	

Figure 4.6 - Main examples of RAISA adoption in hotel companies
Source: Lukanova & Ilieva, 2019

Starting with the pre-arrival stage, which is when customers mainly gather information and book services, it is of uttermost important for the organisation to be visible for potential customers. Mobile technologies, virtual reality and chatbots and virtual assistants are great examples of technological tools used to boost costumer experience at this level. Some examples of mobile technologies would be mobile apps, such as Hilton HHonors App or MoodMatch[9]. Virtual reality is being used, for example, by the Best Western chain, through a YouTube channel where potential guests can explore several parts of the hotel as if they were there before booking (Lukanova & Ilieva, 2019). Alongside

[9] MoodMatch is an AI platform based on moods and experiences of tourists, that is considered as a Hotel DNA content platform (Lukanova & Ilieva, 2019)

with apps, Chatbots are one of most well-known applications of artificial intelligence in TT. From airlines to bank agencies, it is very common to talk with chatbots nowadays, and their usefulness is undeniable (Shawar & Atwell, 2007; Io & Lee, 2017).

During the trip itself, guests have the chance to interacts with RAISA in a different way. There are several examples of robots used in hotels, as previously explained. The digital kiosks, mobile check-in and smartphone room keys are used to reduce waiting time for guests, as they can register themselves, avoiding queues (Lukanova & Ilieva, 2019). Several hotels also have in-room tablets or voice-controlled technology, concierge robots, room service delivery robots and other to improve guests' experience (Tung & Law, 2017; Saravanakumar & Badri Narayanan, 2018; Lukanova & Ilieva, 2019).

At the post-trip stage, artificial intelligence is greatly used for data analysis, for example by tracking guests' reviews, giving the hotel companies a chance to improve guest experience (Lukanova & Ilieva, 2019).

4.6. Human-robot interaction

Considering its functions, a service robot must be a social robot. Bartneck and Forlizzi define a social robot as "an autonomous or semi-autonomous robot that interacts and communicates with humans by following the behavioural norms expected by the people with whom the robot is intended to interact" (2004, p. 592). Authors van den Berghe et al. (2019) describe a social robot as a robot specifically designed to interact with people, following typical human interaction behavioural norms. Unlike industrial robots, social robots always have a physical body of some sort and must be able to communicate/interact with humans (Bartneck & Forlizzi, 2004; van den Berghe et al., 2019).

As previously mentioned, the robot appearance influences the way humans perceive and interacts with it. Bartneck and Forlizzi (2004) identify some critical aspects to consider when designing a social robot:

- The form should match its abilities - social robots should not create false expectations, so their shape, size and material qualities should correspond to the task it is designed for.
- Human-human dialogue should be mirrored and communication failures must be managed – the human-robot dialogue should sound as close to human-human conversation as possible, including verbal and non-verbal cues, but the robot should never fake an emotion as it can be perceived by the human.

- Human social norms should be mimicked, and a consistent set of behaviours should be provided – the robot should know how to socially behave around humans and, if possible, be aware of its own social role.

The success of a service or social robot depends on how effective the Human-Robot Interaction (HRI) is and the level of autonomy of the robot (Tung & Law, 2017). This means the robots must have the previously mention skills, but the human must also have an appropriate level of training and skills to interact with it. This interaction is what distinguishes robots from other forms of technology, leading some people to consider robots may even develop a personality and are considered individuals (Choi et al., 2019). Personality traits such as introversion or extroversion can be perceived in robots and nonverbal behaviour also influences the users' attitude towards HRI (Choi et al., 2019). Bartneck, Kulić, Croft and Zoghbi (2008) suggest five key attributes that human sense regarding robots. These attributes are explained in Figure 4.7.

However, regardless of how the robots looks, most people have a preconception about the use of robots. These opinions will influence the customers' reactions to the robot and their expectations and perceptions (Kazandzhieva & Filipova, 2019). Consumer's attitude is also influenced by positive or negative assessments. If a robot offers a convenient, quick, and comfortable service, guests will accept them and consider the advantages of using robots (Kazandzhieva & Filipova, 2019).

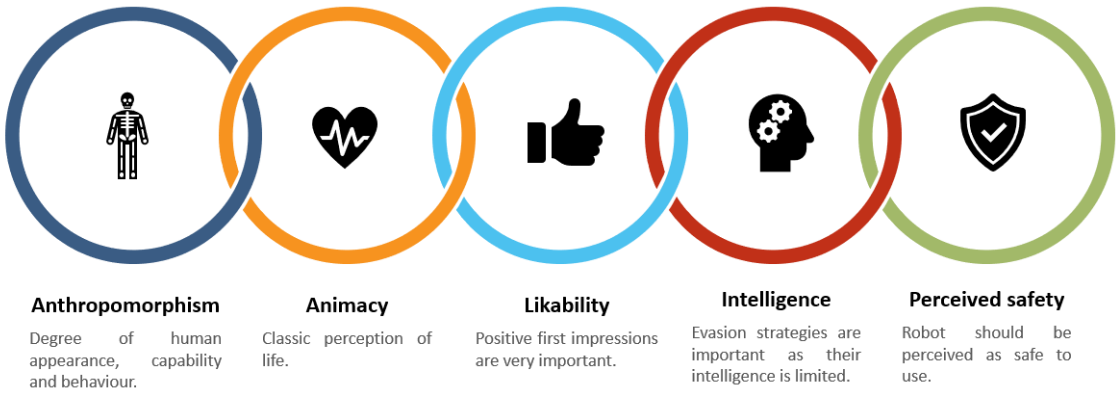

Figure 4.7 - Key attributes of social robots
Source: Own elaboration based on Bartneck, Kulić, Croft & Zoghbi (2008)

Some examples of effective social robots used in hotels already exists, such as Savioke's Relay, used in several hotels to deliver goods to customers (Choi et al., 2019). This robots' cameras and sensors allow it to reach its destination, by identifying the room number, travelling through the corridors, and going on the elevator, without colliding. As soon as it reaches the intended location, Relay autonomously opens its lid and guests can then rate Relay's performance on a screen, to what Relay

reacts with a dance. For the HRI to be effective, Relay should be able to read the users facial expressions, gestures and thus emotions to respond accordingly. In a perfect scenario, the robots should act similarly to the human, showing facial expressions, gestures, and emotions naturally.

4.6.1. Human-robot interaction studies

The impact of users' sociodemographic characteristics like culture, age, gender, and education on human-robot interaction has been studied by several authors in different fields. In their study, Li et al. (2010, cited by Tung & Law, 2017) affirm that there are cultural differences in users' attitudes and engagement with robot between the Chinese and Korean participants and the German group, as the first group perceived the robots as more trustworthy and pleasant to use. Haring et al. (2015, cited by Tung & Law, 2017) analysed the perception of morphology of the robot and suggest that Japanese users provided higher ratings for humanoid robots on anthropomorphism, intelligence, and safety, when compared to Australians. Heerink (2011, cited by Tung & Law, 2017) found that older respondents were less willing to use the robot and individuals with higher education levels recognized higher levels of social presence from the robot.

Although it is a fairly unexplored subject in the hospitality and tourism literature, there are two studies that analyse the perceptions of two distinct groups of people regarding the use of robots in tourism.

The first study, entitled "*Young Russian adults' attitudes towards the potential use of robots in hotels*", by Ivanov, Webster and Garenko (2018), studied the perception of Russian young adults regarding the use of robots in tourism, focusing on understanding what tasks should be done by robots. Data was collected from November 2016 to January 2017, through an online questionnaire, to young Russians between the ages of 18 and 30. The authors state that the group that was most receptive towards the use of robots were men, from the Moscow region and that already show a certain sympathy regarding the use of robots in general. The results also show that there are differences between the tasks that respondents of different genders consider suitable for robots, with men considering it appropriate for robots to welcome guests, check them in, provide information about the hotel and the destination, carry luggage and produce and distribute catering products. Some limitations of this study are the fact that the sample is not very significant and has a predominance of female subjects (72.7%).

The second study, entitled "*Consumers' attitudes towards the introduction of robots in accommodation establishments*", by Ivanov, Webster and Seyyedi (2018) intended to analyze the perception of Iranian consumers about the use of robots in accommodation units, also falling on the activities that respondents consider suitable for robots. Data were collected between January and

May 2017, through direct contact with the guests of the 5-star hotels in Tehran. The sample was divided into two groups with respect to age, one between 18 and 30 years old and the other over 30. Results show that, in general, respondents are receptive to the introduction of robots in the hotel sector, also agreeing that robots will be able to provide information in more foreign languages than human employees, will be more effective at making calculations and will provide more accurate information. However, respondents also indicate that robots may misinterpret an issue or stop working during service, concluding that for this segment it is preferable to have human employees in hotels. Opposing to the previous study, the results indicate that women have a more positive attitude towards the use of robots in general and in hotels than men. Also contrary to expectations, younger consumers showed a less positive attitude towards the use of robots and are more skeptical about the memorability, pleasure, and excitement of the experience than the others. The study also indicates that respondents with less educational qualifications indicated that they have higher expectations regarding the friendliness of the robots and are more optimistic about the possibility of the robots working outside their programmed environment. Finally, the study indicates that respondents with less tourist experience had higher expectations for memorability, pleasure and excitement than the rest and that, in general, respondents who adopted a more positive attitude regarding the use of robots in general are also those who support the adoption of robots in the tourism industry the most and those who are more tolerant with possible failures.

Analyzing both studies, it is possible to see that sociodemographic variables have a great influence on consumers' perceptions, essentially gender, age, educational qualifications, and place of residence. As for gender, there is no clear evidence of how it affects this perception, since in the first case men are more open towards the use of robots and in the second case it is women. In addition, other authors who have studied human-robot interaction in other sectors claim that these variables influence the perception of humans, such as Hudson, Orviska and Hunady (2017) and Nomura et al. (2006).

Choi et al. (2019) evaluated the service quality perceptions of HRI and state that humans assess robots' performance using preestablished concepts for human beings. On their study, authors found that human staff performed better in terms of interaction quality, providing better sympathetic care and pleasant and friendly services that the robot staff or the combined service of humans and robots. Respondents also believed that human staff had better communication skills and knowledge to respond to their questions. The study also showed that hotel managers see great value in the human touch, in providing careful, warm, and welcoming services and in their power to solve sudden issues. Authors believe guests expect to meet humans working at hotels rather than service robots, as hotel are a symbol of hospitality, however no significant difference was found in outcome quality. Service robots are perceived as trendier and can provide unique and interesting experiences and can provide a service as efficient as human service. However, hotels must be sure the robots meet or exceed the

required level of outcome quality prior to implementing it and the use of robots should meet the hotels' strategies based on type or level. For example, upscale hotel guests expect high human interaction and care.

Other studies tried to explore customer experiences with service robots in hotels. Authors Chang and Tung (2019, cited by Choi et al., 2019) have studied the effect of service robots on customers' hotel brand experience. Lu et al. (2019, cited by Choi et al., 2019) created the Service Robot Integration Willingness Scale. Tung and Au (2018, cited by Choi et al., 2019) applied the User Experience and Societal Impact framework to online reviews of hotels that fully or partially use service robots. Tussydiah and Park (2018, cited by Choi, et al., 2019) studied the consumer evaluation of robots considering five key dimensions. And Ziemke and Thill (2014, cited by Choi et al., 2019) focused on how the robot form influences HRI. Results can be found in Table 4.2

Table 4.2 - Results of customer experience with service robots in hotels studies

Chang & Tung (2019)	HRI has distinctive psychological effects on several dimensions of customer experience (sensory, affective, behavioral, and intellectual) varying according to the hotel type (budget, midscale, and luxury).
Lu et al. (2019	Five factors that influence customers' willingness to use service robots: performance efficacy, intrinsic motivation, anthropomorphism, facilitating conditions, and emotions.
Tung & Au (2018)	Five themes were identified in reviews: embodiment, emotion, human-oriented perception, feeling of security, and co-experience. If robots are too similar to humans, they may lead to disappointment if they cannot perform as one.
Tussyadiah & Park (2018)	Focused on consumer evaluation of service robots in terms of anthropomorphism, animacy, likability, perceived intelligence, and perceived safety. Findings show that anthropomorphism, perceived intelligence, and perceived safety influenced adoption intention.
Ziemke & Thill (2014)	Study suggests anthropomorphic (human-shaped) robots offer more meaningful interaction in HRI than other forms of robots.

Source: Own elaboration based on Choi et al., 2019

4.7. Conclusion

This chapter illustrated the definition of robots and the exponential growth in their use in industry, services, and everyday life is the past few years. A robot is a machine, programmable by a computer, that can carry out actions autonomously or semi-autonomously. There are three main types of robots - robots that operate autonomously, robots that interact with other robots and robots that interact with humans – and these may have several forms. Studies show that the more a robot looks like a human the more humans expect it to act like one, leading to disappointment when it does not

correspond. On the other hand, human feature like smiling and head tilting may improve the customers perception regarding safety and reliability.

Considering the concerns of some people on the effect robots might have over humans, Asimov wrote the robotic laws, that aim to ensure the wellbeing of humanity over any other command the robot may receive. Several authors believe these laws are not enough and do not foresee situations like terrorist attacks, the need to make arbitrary decisions when two human lives are at risk and its only possible to save one, or how should robots act in standby mode. It is however important to notice that these laws are merely philosophic and that each sector has or should have specific legislation regarding the use of robots.

Service robots are robots that interact, communicate, and provide services to a customer. Their use has been growing particularly in field like medicine, caring for elders, and fighting viruses. However, their use is not consensual among researchers, that can be roughly divided in two groups: one that believes robots may free men from dull and heavy work and another that fears humanity may became obsolete. The main advantages of robots over humans are their ability to work 24/7, the fact that they do not feel fatigue, do not get bored and do not complain about doing the same chores over and over. The disadvantages have to do with their lack of creativity and empathy (so far).

Robots are also taking over the tourism industry, with many practical examples from robotic concierges to fully staffed robotic hotels. Labour shortages, language and cultural barriers and cost-effectiveness are the main reasons why the hospitality industry is choosing robots over people. The interaction with RAISA influences the tourist experience, thus the correct linkage between the phase of the guest cycle the tourist is in and the robot used is fundamental for a successful experience.

Considering this interaction and the increasing regularity with which it happens, human-robot interaction studies are growing, and authors found some key attributes social robots should have. Besides, sociodemographic characteristics, past experiences and the type of robot and the way it looks may also influence customer’s willingness to use service robots.

Chapter 5. Methodology

5.1. Introduction

While the previous chapters elaborated on literature review, underpinning the relevant concepts for this study, chapter 5 focuses on how the study was carried out, explaining the methodology used in this research. Section 5.2. refers to the how the research design is structured, as an overview of the study.

This research began with a literature review, explained in section 5.3., from which the Technology Acceptance Model arose (section 5.4.), together with the hypothesis, explained in section 5.5. With the hypothesis established, it is then necessary to analyse the epistemology and methodology, in section 5.6. The subsequent section, section 5.7., seeks to explain the population and sample used in the study, followed by section 5.8 which presents the research methods.

Section 5.9. addresses the data collection procedure, including the questionnaire used on the survey. Finally, section 5.10 explains the data analysis procedure.

5.2. Research design and goals

> "Research design should be a reflexive process operating through every stage of a project"
> (Hammersley & Atkinson, 1995, p. 4, as cited in Maxwell, 2013).

The research design represents a framework of the research methods and techniques used in a study. It allows the researcher to refine the methods that better suit the study.

Due to the variety of approaches in research, the different phases and the structure of the design differs from one author to the other, but a research design should always be sequential (Oliveira, 2015). Regarding this dissertation, the research design is illustrated in Figure 5.1.

The motivation for this research topic arises from the combination of a popular issue, the use of robots in services, combined with the willingness to know more about the role of robots in tourism. One of the objectives of this study is to explore the current use of robots in services and in tourism. Subsequently, the authors aim to explore how consumers react to these examples and, finally, to identify the predictors that lead to those reactions. Thus, the questions this study aims to solve is if TAM is a suitable model for measuring the acceptance of robots in tourism and to what extent can the defined external variables influence the perceived usefulness and perceived ease of use of robots in tourism.

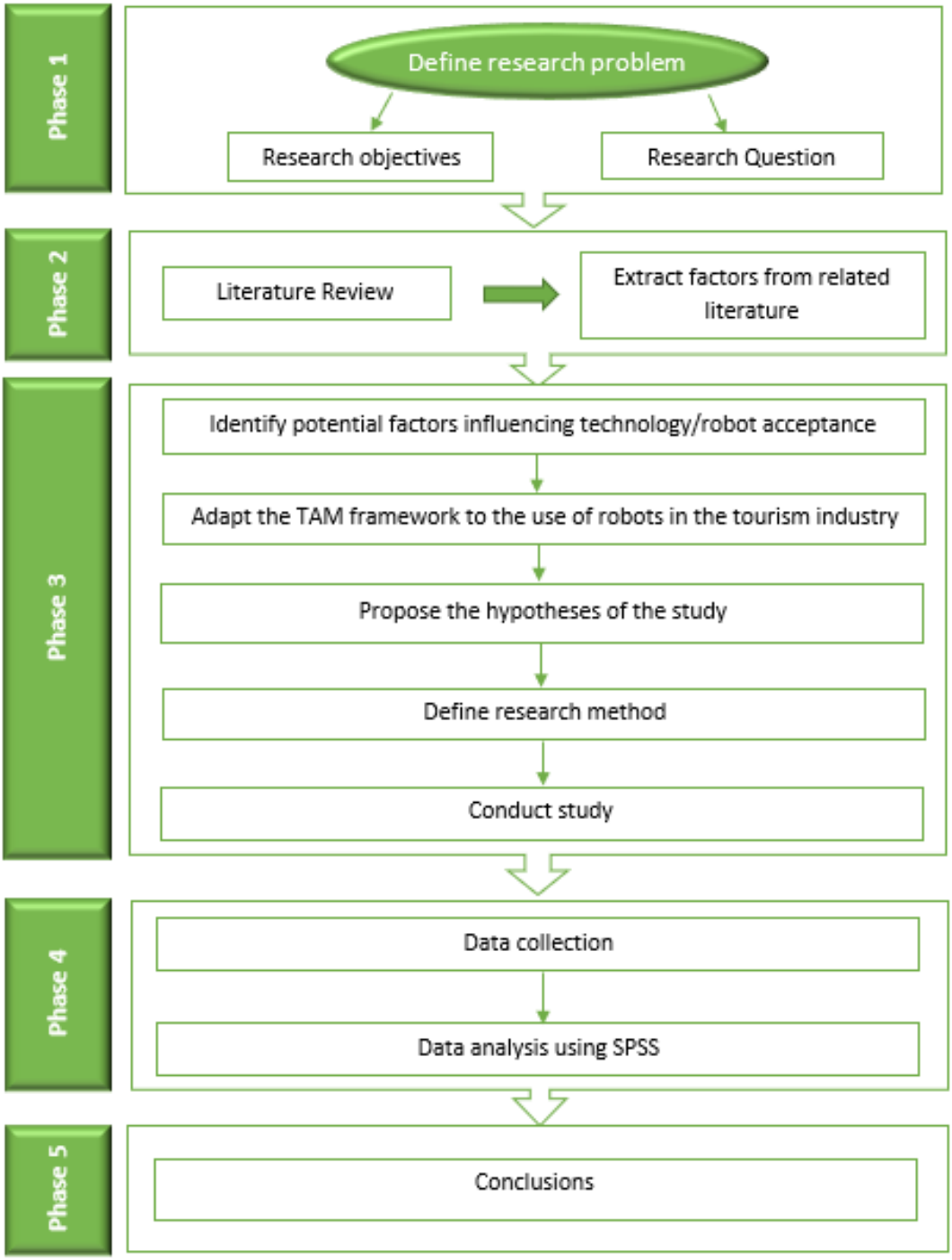

Figure 5.1 - Research design
Source: Own elaboration

5.3. Literature review

Literature review is a very important step in every research. It supports the identification of the research topic, question and hypothesis, it contextualizes the research and identifies the literature to which it will contribute, it endorses the understanding of theoretical concepts and terminology and it is fundamental for analysing and interpreting the results (Rowley & Slack, 2004). It is proven fundamental for the research design, as it helps to understand what has and has not been done in terms of research in a specific area and how it has been done (Oliveira, 2015).

The comparison of the results of this study with the literature review will allow for the confirmation of theories or add new traits to it. Thus, the following paragraphs explain how the review was carried and how it supports this research.

The literature review for this dissertation was based on 4 key areas:

Figure 5.2 - Literature Review subject areas
Source: Own elaboration

Regarding the research on the tourism industry, data were collected through the main international and national organizations, namely, the World Travel and Tourism Council, World Tourism Organization, International Monetary Fund, OECD, *Turismo de Portugal* and *Instituto Nacional de Estatística* (National Institute of Statistics).

For the second phase of literature review, to better understand concepts in the field of automation, industry 4.0, technology and the path that lead to the creation of robots, a thorough research was made in technology related journals and databases. "Automation", "Internet of Things", "Industry 4.0", "Society 5.0", "Artificial Intelligence", "Service automation" and "Technology acceptance" were the main terms used to search for information.

Relevant information on robotics in hospitality and tourism was researched in large databases, including SCOPUS and Google Scholar. The selection of these databases was based on the provision of current research on the topic and their relevance in the research field. In terms of keyword, the terms "service robot", "robotics", "human-robot interaction", "tourism", "hospitality" were used in the search for relevant publications.

Table 5.1 shows a literature review summary, with the number of publications analysed, the main ideas and main references of each topic.

Table 5.1 - Literature review summary

Topic	Publications analysed	Main ideas	Main references
Tourism Industry	38 publications: ○ 25 Reports ○ 13 Articles	○ Tourism Growth ○ Economic importance of tourism ○ Megatrends for the tourism industry ○ COVID-19's impact in tourism	UNWTO (2019; 2020a; 2020b; 2020c; 2020d; 2020e) WTTC (2020b) Turismo de Portugal (2019) Travel BI (2019a; 2020) OECD (2018)
Automation and Industry 4.0	37 publications: ○ 30 Articles ○ 4 Books ○ 3 Reports	○ Definitions: automation, industry 4.0, IoT, artificial intelligence ○ IoT and AI uses in services and tourism ○ Challenges ○ Technology readiness: predictors and models	Car et al. (2019) Cruz-Cárdenas et al. (2019) Özdemir (2018) Parasuraman (2000) Tussyadiah et al. (2020) Zeinab and Elmustafa (2017)
Robots	48 publications: ○ 46 Articles ○ 2 Books	○ Definitions: robot, service robot ○ Types of robots ○ Robots used in services and tourism ○ Pros and cons of robots ○ Human-robot interaction studies and predictors	Clarke (1993) Ivanov et al. (2019) Ivanov and Webster (2018) Kazandzhieva and Filipova (2019) Lukanova and Ilieva (2019)

Source: Own elaboration

5.4. The Technology Acceptance Model

The knowledge of whether the public will accept or reject a new information system poses a great challenge in the study of new technology, as it can be the crucial factor determining the success or failure of a project (Laumer & Eckhardt, 2011; Park, Lee & Cheong, 2007; Davis, 1993; Davis, Bagozzi & Warshaw, 1989). The Technology Acceptance Model (TAM), developed by Fred Davis in 1986, is a theoretical model that aims to explain how users come to accept technology and how they use that technology (Davis, 1986).

The TAM is based on the Theory of Reasoned Action (TRA), developed by Martin Fishbein e Icek Ajzen in 1967, specifically designed for the acceptance of information systems (Davis, 1986; Davis, Bagozzi & Warshaw, 1989). The TRA is based on the person's attitude concerning the behaviour and the subjective norm about the same behaviour (Park, Lee & Cheong, 2007).

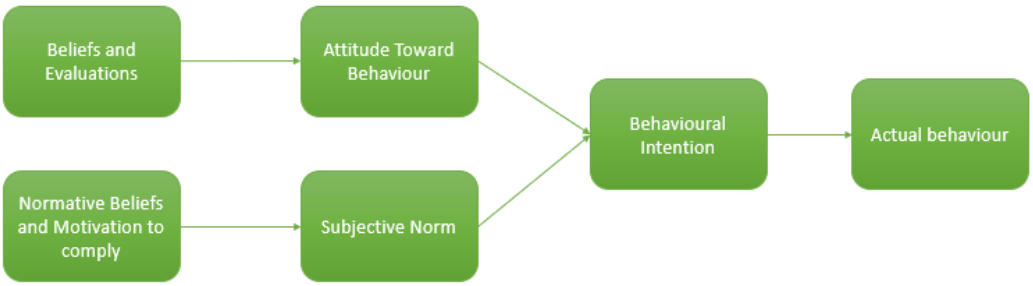

Figure 5.3 - Theory of Reasoned Action
Source: Davis, Bagozzi & Warshaw, 1989

Following this logic, the TAM aims to explain the factors that affect behavioural intention to use technology, implying a causal linkage between the perceived usefulness and the perceived ease of use – the two main constructs of this model – and their influence on the attitude toward using and its effect on the actual system use (Rodriguez, 2012; Park, Lee & Cheong, 2007). The model is based on the assumptions that "(a) when end users perceive the target system as one that is easy to use and nearly free of mental effort, they may have a favorable attitude toward using the system, (b) when end users perceive the system as one that is helpful to their job, then they may have a positive attitude toward the system used and (c) when users have a favorable attitude toward the target system, they may use the system frequently and intensely, which means that the system developed is successful" (Rodriguez, 2012, pp 3-4).

Figure 5.4 shows the original Technology Acceptance Model, developed by Davis (1986).

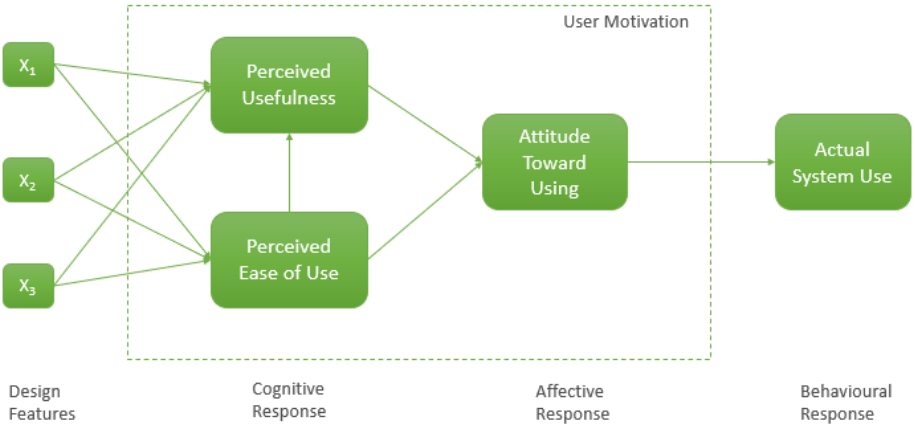

Figure 5.4 - Technology Acceptance Model
Source: Davis, 1986

The model factors can be characterized as:

- Perceived Ease of Use: The extent to which a person believes that using the system will not require any physical or mental effort (Davis, 1986);
- Perceived Usefulness: The extent to which a person believes that using the system will enhances his/her performance and productivity (Davis, 1986);
- Attitude toward Using: the extent to which a person would assess and relate the use of the system to job performance (Davis, 1993);
- Actual System Use: external psycho-motor response measured by a person's real course of action (Davis, 1986).

The original publication of the model, by Fred Davis in 1989, has over 55500 citations in Google Scholar, making it a highly cited paper among researchers. Since its publication, the model has been used in several areas, such as personal computer usage, word processing programs, spreadsheet software, Windows operating system, email and, most recently, to e-commerce, telemedicine and digital library systems (Park, et al., 2007). It has been the leading model for about three decades (Bagozzi, 2007).

The model's parsimony is both a strength and a weakness, as some authors believe it is unreasonable to assume a model as simple as TAM can explain decisions and behaviours across a large range of technologies and situations (Bagozzi, 2007).

5.5. Hypotheses

According to Mourougan and Sethuraman, "a research hypothesis is the statement created by researchers when they speculate upon the outcome of a research or experiment" (2017, p. 34). The purpose of defining hypothesis is to provide direction to the research, as they can be deduced from theory and tested to show whether they are supported.

Sociodemographic variables have been established as predictors of new technology/robots' acceptance (Tung & Law, 2017; Ivanov, Webster & Garenko, 2018; Ivanov, Webster & Seyyedi, 2018). Hence, hypotheses H1 were established to understand their effect on the perceived ease of use (H1a) and perceived usefulness (H1b) of robots in tourism.

Travel characteristics, such as travel frequency, companionship, motivation and type of accommodation were also established as possible predictors of robots' acceptance in tourism. Thus,

hypotheses H3 were defined to comprehend if the type of traveller influences the perceived ease of use (H3a) and perceived usefulness (H3b) of robots in tourism.

Park et al. (2007) state motivation to use technology is one of the most relevant variables in its success. Also, instrumental use of technology with greater motivation produces stronger attitudinal and behavioural effects. Hence, motivation toward technology was used as a design feature and it is proposed that H3a) user's motivation toward technology will have a positive effect on the perceived ease of use of robots in tourism and H3b) user's motivation toward technology will have a positive effect on the perceived usefulness of robots in tourism.

The attitude toward technology in general is the fourth design feature. Blut et al. (2016) believe that consumers highly technology ready are more likely to try technology and are thought to have less problems exploring it and less difficulties using it. Therefore, it may be connected to perceived ease of use (H4a) and perceived usefulness (H4b) as a predictor.

The last hypothesis (H5), states that the perceived ease of use of robots in tourism will have a positive impact on the perceived usefulness of robots in tourism.

Table 5.2 shows the hypotheses developed for this research.

Table 5.2 - Research hypotheses

H1 – Sociodemographic variables	**H1a** - Sociodemographic variables influence the perceived ease of use of robots in tourism	**H1.1a –** Gender influences the PEOU of robots in tourism
		H1.2a – Age is a significant predictor of PEOU of robots in tourism
		H1.3a – Higher education has a positive effect on the PEOU of robots in tourism
		H1.4a – Income is a significant predictor of PEOU of robots in tourism
		H1.5a – Living in a developed area contributes to the PEOU of robots in tourism
	H1b - Sociodemographic variables influence the perceived usefulness of robots in tourism	**H1.1b –** Gender influences the PU of robots in tourism
		H1.2b – Age is a significant predictor of PU of robots in tourism
		H1.3b – Higher education has a positive effect on the PU of robots in tourism
		H1.4b – Income is a significant predictor of PU of robots in tourism
		H1.5b - Living in a developed area contributes to the of PU of robots in tourism
H2 – Type of traveller	**H2a** - Type of traveller influences the perceived ease of use of robots in tourism	**H2.1a –** Leisure travellers have a more positive PEOU of robots in tourism
		H2.2a – Independent travellers have a more positive PEOU of robots in tourism
		H2.3a – Travelling with family and friends contributes to a more positive PEOU of robots in tourism
		H2.4a – Tourists who stay at hotels have a more positive PEOU of robots in tourism
	H2b - Type of traveller influences the perceived usefulness of robots in tourism	**H2.1a –** Leisure travellers have a more positive PU of robots in tourism
		H2.2a – Independent travellers have a more positive PU robots in tourism
		H2.3a – Travelling with family and friends contributes to a more positive PU of robots in tourism
		H2.4a – Tourists who stay at hotels have a more positive PU of robots in tourism
H3 – Motivation toward technology	**H3a** - User's motivation toward technology will have a positive effect on the PEOU of robots in tourism	
	H3b - User's motivation toward technology will have a positive effect on the PU of robots in tourism	
H4 – Attitude toward technology	**H4a** - User's attitude toward technology will have a positive effect on the PEOU of robots in tourism	
	H4b - User's attitude toward technology will have a positive effect on the PU of robots in tourism	
H5 - PEOU	Perceived ease of use will have a positive effect on the PU	

Source: Own elaboration

Having defined the hypotheses, Figure 5.5 illustrates the proposed research model.

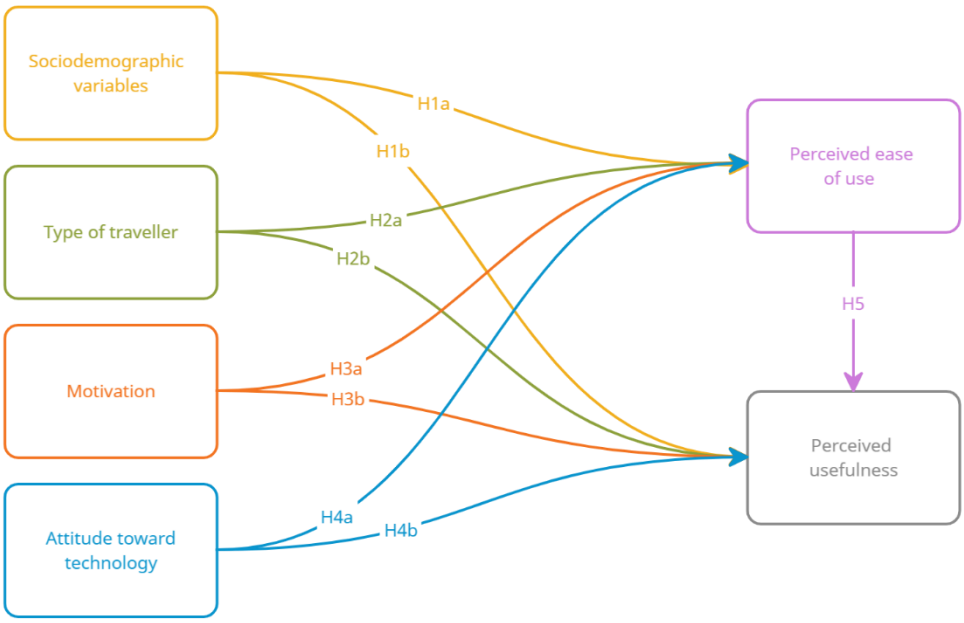

Figure 5.5 - Hypothesis diagram
Source: Own elaboration

5.6. Data Collection

This research started with a literature review that supported the analysis model, validated by the epistemology and methodological options. This section will now focus on the empirical part of the study.

The data collection technique used in the research relies on the literature review. The growing use of robots in tourism and the increasing importance of Portugal as a destination and as an issuing country, explored in chapters 2 to 4, created the opportunity for the study. Besides, as far as the authors knowledge goes, TAM has only been applied to the Portuguese context once and the study regarded User Generated Content. Hence, due to the lack of information regarding the factors that influence the acceptance of robots by Portuguese residents, this is an exploratory study.

To collect quantitative primary data, a survey by questionnaire was developed and applied, based on the original TAM, and other variables that might influence technology/robot's acceptance were added. Data was collected between November and December 2020, and given the target population of the questionnaire, the final version was developed in Portuguese using the Google Forms tool (see Appendix 1 – Survey (original version)). Due to the current pandemic situation and in order to have a better spatial distribution of the respondents through Portugal, the link to the questionnaire was disclosed online, in several social media pages and groups, such as LinkedIn and Facebook.

The original Technology Acceptance Model integrates four key categories: perceived ease of use, perceived usefulness, attitude toward using and actual use. As the number of people who have interacted with robots is diminished, the "attitude toward using" and the "actual use" features were not considered in this research, hence the study only contemplates the design features and cognitive response phases (see Figure 5.4). Table 5.3- Perceived Usefulness Item Pools and

Table 5.4 show the Perceived Usefulness and Perceived Ease of Use item pools. Both variables were measured using a 5-point Likert-type scale: 1- strongly disagree, 2- disagree, 3- neither agree nor disagree, 4- strongly agree and 5- strongly agree.

Table 5.3- Perceived Usefulness Item Pools

Item	Item Wording
1	My job would be difficult to perform without electronic mail.
2	Using electronic mail gives me greater control over my work
3	Using electronic mail improves my job performance.
4	The electronic mail system addresses my job-related needs
5	Using electronic mail saves me time.
6	Electronic mail enables me to accomplish tasks more quickly.
7	Electronic mail supports critical aspects of my job.
8	Using electronic mail allows me to accomplish more work than would otherwise be possible
9	Using electronic mail reduces the time I spend on unproductive activities.
10	Using electronic mail enhances my effectiveness on the job.
11	Using electronic mail improves the quality of the work I do.
12	Using electronic mail increases my productivity.
13	Using electronic mail makes it easier to do my job.
14	Overall, I find the electronic mail system useful in my job.

Source: Davis, 1986

Table 5.4- Perceived Ease of Use Item Pools

Item	Item Wording
1	I often become confused when I use the electronic mail system.
2	I make errors frequently when using electronic mail
3	Interacting with the electronic mail system is often frustrating.
4	I need to consult the user manual often when using electronic mail
5	Interacting with the electronic mail system requires a lot of my mental effort.
6	I find it easy to recover from errors encountered while using electronic mail.
7	The electronic mail system is rigid and inflexible to interact with.
8	I find it easy to get the electronic mail system to do what I want it to do.
9	The electronic mail system often behaves in unexpected ways.
10	I find it cumbersome to use the electronic mail system.
11	My interaction with the electronic mail system is easy for me to understand,

12	It is easy for me to remember how to perform tasks using the electronic mail system.
13	The electronic mail system provides helpful guidance in performing tasks.
14	Overall, I find the electronic mail system easy to use.

Source: Davis, 1986

Four design features were established: sociodemographic variables, type of traveller, motivation toward technology and attitude toward technology.

In the analysed studies that regard robot acceptance, sociodemographic variables have been pointed out as relevant, but researchers have not yet fully understood how these variables affect the process, as there are contradicting results (see chapter 4). Hence, sociodemographic variables were collected to understand which are predictors of robots' acceptance in tourism.

Likewise, the travel characteristics of the respondents were also considered. Xu, Li and Lu (2019) demonstrated that each type of traveller considers specific satisfaction/dissatisfaction determinants. Hence, the respondents were asked to state their usual travel motivation, travel group, type of accommodation, duration of the trip and type of trip organization (independent or organized). Furthermore, respondents were asked if they had ever been hosted in an accommodation that used robots, to consider the possibility that actual contact with robots influences the perceived ease of use and perceived usefulness of robots in tourism.

Motivation toward technology was the third studied feature, based on Park et al. (2007). To measure motivation toward technology, the scale used by the authors was adapted to this research and four item pools were applied. A four-point Liker-type scale was used: 1- Not important, 2- Somewhat important, 3- important and 4- very important.

Table 5.5- Motivation toward technology item pools

Item	Wording
1	Keep up with technical change
2	Save time
3	Learn more about technology
4	Help others learn about technology

Source: Park et al., 2008

Considering the attitude toward technology feature, the Technology Readiness Index 2.0 scale was used. Table 5.6 presents the item pools used for the attitude toward technology in general, used by Cruz-Cárdenas et al. (2019) that were adapted by the original TRI 2.0 scale developed by Parasuraman and Colby (2014).

Table 5.6- Adaptation of the Technology Readiness Index 2.0 scale

TR dimension	Item
Optimism (OP1)	opt1: New technologies contribute to a better quality of life.
	opt2: Technology gives me more freedom of mobility.
	opt3: Technology gives people more control over their daily lives.
	opt4: Technology makes me more productive in my personal life.
Innovativeness (INN)	inn1: Other people come to me for advice on new technologies.
	inn2: In general, I am among the first in my circle of friends to acquire new technology when it appears
	inn3: I can usually figure out new high-tech products and services without help from others.
	inn4: I keep up with the latest technological developments in my areas of interest.
Discomfort (DIS)	dis1 When I receive technical support from a provider of a high-tech product or service, I sometimes feel as if I am being taken advantage of by someone who knows more than I do.
	dis2: Technical support lines are not helpful because they don't explain things in terms I understand.
	dis3: Sometimes I think that technology systems are not designed for use by ordinary people.
	dis4: There is no such thing as a manual for a high-tech product or service that is written in plain language
Insecurity (INS)	ins1: People are too dependent on technology to do things for them.
	ins2: Too much technology distracts people to a point that is harmful.
	ins3: Technology lowers the quality of relationships by reducing personal interactions.
	ins4: I do not feel confident doing business with a place that can only be reached online.

Source: Cruz-Cárdenas et al., 2018

Table 5.7 - Questionnaire outline

Question		**Type of question**	**Objective**	**Sources**
Group 1	Number of trips last 3 years	Closed questions/ multiple choice	To characterize the respondents in terms of travel characteristics and behaviour	Joseph & Anandkumar (2016)
	Duration of trip			
	Travel Group			
	Travel Motivation			
	Independent or organized trip			
	Preferred type of accommodation			
	Previous experience with robots in accommodation			
Group 2	Motivation toward technology	Likert-type 4 points scale	To characterize the respondents in terms of motivation and attitude toward technology in general	Park, Lee & Cheong (2007) Konca, Ozel & Zelyurt (2016)
	Attitude toward technology	Likert-type 5 points scale		
Group 3	Perceived Ease of Use	Likert-type 5 points scale	To collect data on the dependent variables	Davis (1986)
	Perceived Usefulness	Likert-type 5 points scale		

Group 4	Age	Closed questions/multiple choice Open question	To characterize the respondents in sociodemographic terms	Tung & Law (2017) Ivanov, Webster & Garenko (2018) Ivanov, Webster & Seyyedi (2018)
	Gender			
	Residency district			
	Level of education			
	Monthly income			

Source: Own elaborations

5.6.1. Population and sample

Considering the focus of this study, it was defined as target population every resident in Portugal not younger than 18 years old. As the final version of the questionnaire was in Portuguese, the lack of knowledge of the language was an excluding factor. Also, the questionnaire considered the respondent had travelled at least one time over the last three years. This time frame is considered adequate as robots in hospitality are a fairly new subject, however, due to the COVID-19 pandemics, in 2020 people did not travel as much, hence the 3-year interval. The age limit has to do with the fact that people 18 years old is the legal age in Portugal and the belief that people younger than 18 are not financially independent.

According to INE (2020a), a total of 10.295.909 people lived in Portugal in 2019. Out of these, 1.396.985 were under 15 years old and 545.322 were between 15 and 19 years old. Therefore, the population not younger than 18 years is around 8.353.603 people.

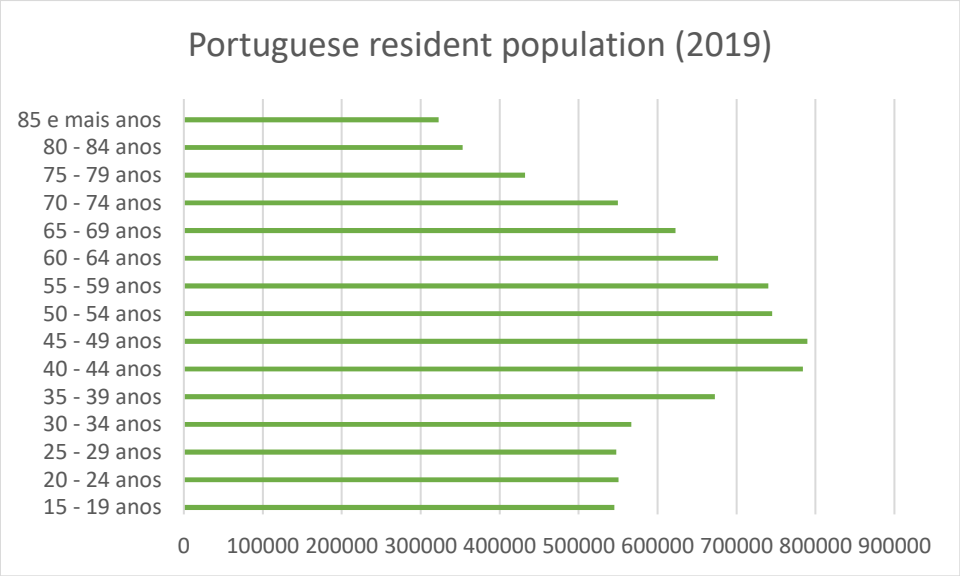

Figure 5.6 - Portuguese resident population 2019
Source: INE, 2020a

Having defined the population under study, it is necessary to choose the sampling method. Given the characteristics of the population and the impossibility of knowing and contacting every Portuguese resident, not younger than 18 years old that understand the Portuguese language

and has travelled at least once over the last 3 years, the authors chose a non-probabilistic sampling method. A non-probabilistic method is a deviation from probabilistic methods and using it means not every individual from the population has the same probability of being chosen (Vehovar et al., 2016). The chosen method was the convenience sampling method, and this method proposes that "members of the target population that meet certain practical criteria, such as easy accessibility, geographical proximity, availability at a given time, or the willingness to participate are included for the purpose of the study" (Etikan, 2016, p.2).

There was a total of 404 answers to the questionnaire. However, 14 respondents did not meet the criteria to be included in the target population, as 13 of them did not live in Portugal and one was 17 years old, so 390 responses were considered in the data analysis.

5.7. Data Analysis

After collecting all the necessary data, the SPSS statistics data analysis software was used to find reliable answers to support the validity of the research problem.

Univariate analyses were conducted for every variable, including mean and standard deviation, first for the sociodemographic and the travel characteristics variables and then for the model constructs.

Then, to approximate the constructs of the model, it was necessary to assure the internal consistency reliability, using Cronbach's Alpha. Cronbach's Alpha is based on the average correlation among the studied items and its value varies from 0 to 1. If the value is above 0.7 it shows that the item used to measure that construct represents it correctly (Oliveira, 2015; Bhatnagar et al., 2014).

Table 5.8 - Cronbach's alpha interpretation

Cronbach's alpha (α)	Internal Consistency Reliability
α > 0.9	Excellent
0.7< α <0.9	Good
0.6< α <0.7	Acceptable
0.5< α <0.6	Poor
α <0.5	Unacceptable

Source: Bhatnagar et al., 2014

Following the reliability analysis, inferential statistics were conducted to begin the hypotheses validation.

Bivariate tests were performed first to test the assumptions or to see if the items of the model are statistically different from zero.

A multivariate regression analysis was performed for each dependent variable (PEOU and PU). The linear regression presupposes there is no multicollinearity, analysed through Tolerance and VIF. Tolerance levels should be over 0.1 and VIF levels should be below 10 for multicollinearity to be excluded. Also, the Durbin-Watson test was conducted to show if the residuals are correlated. The linear regression was used to test the significance of the independent variables as predictors of the dependent variable.

As variables need to be either interval or binary to perform the regression, district, education, usual travel group, motivation, and accommodation were recoded as following:

Table 5.9 - Variables recodification

Variable	Original coding	Binary coding
District	1 – Aveiro 2 – Beja 3 – Braga 4 – Bragança 5 – Castelo Branco 6 – Coimbra 7 – Évora 8 – Faro 9 – Guarda 10 – Leiria 11 – Lisboa 12 – Portalegre 13 – Porto 14 – Santarém 15 – Setúbal 16 – Viana do Castelo 17 – Vila Real 18 – Viseu 19 – R.A. Açores 20 – R.A. Madeira	0 – Beja, Braga, Bragança, Castelo Branco, Évora, Faro, Guarda, Setúbal, Portalegre, Santarém, Viana do Castelo, Vila Real, Viseu, R.A. Açores, R.A. Madeira 1 – Lisboa, Aveiro, Leiria, Coimbra, Porto
Education level	1 – Basic education 2 – High education 3 – Superior education 4 – Other	0 – Basic education, high education, other 1 – Superior education
Usual travel group	1 – Partner 2 – Family 3 – Alone 4 – Friends 5 – Colleagues 6 – Others	0 – Alone, colleague, others 1 – Partner, family, friends
Motivation	1 – Leisure 2 – Visiting friends and family 3 – Business 4 – Health and well-being 5 – Other	0 – Visiting friends and family, business, health and well-being, other 1 - Leisure
Accommodation	1 – Hotel 2 – House of family and friends 3 – Hostel 4 – Airbnb	0 – House of family and friends, Airbnb, touristic apartments, rural tourism, camping, holiday village, other

	5 – Touristic apartments 6 – Rural tourism 7 – Camping 8 – Resort 9 – Holiday village 10 – Other	1 – Hotel, Resort, Hostel

Source: Own elaboration

Hence, to test the difference between groups for gender, district, education, usual travel group, motivation, accommodation and organization, the *t* of Student test was used and for age, income, motivation toward technology, attitude toward technology and perceived ease of use, Spearman's correlations were used.

5.8. Conclusion

This chapter aimed at explaining the framework and methodological process adopted in this research. The different stages of the study were explained, including the population and sample used, the methods, and the data collection techniques and analyses.

The lack of scientific information regarding the acceptance of robots by Portuguese citizens, led to the collection of primary quantitative data, via a survey by questionnaire disseminated online. The questionnaire was build based on the original Technology Acceptance Model and four possible predictors: demographic variables, travel characteristics, motivation towards technology and attitude toward technology. Given the focus of the study the questionnaire was applied to Portuguese citizens, not younger than 17 years old and who understand the Portuguese language.

Finally, SPSS software was used to analyse data, as it allows for the development of univariate, bivariate and multivariate analysis, needed to fulfil the investigation goals.

Chapter 6. Data Analysis

6.1. Introduction

As stated in the previous chapter, data analysis was conducted based on a quantitative approach, with univariate, bivariate and multivariate analysis. Data analysis was developed using SPSS software.

Section 6.2. presents the characteristics of respondents. Section 6.3 focuses on testing the internal reliability of the model, while section 6.4 addresses the results obtained for the items used in estimating TAM and their analysis and discussion. Finally, section 6.5 presents some limitations and section 6.6 the conclusion.

6.2. Characteristics of respondents

The analysed sample of the survey by questionnaire comprises 390 respondents, whose sociodemographic profile and travelling behaviour will now be analysed.

6.2.1. Sociodemographic characteristics

The sociodemographic profile of the participants is characterized based on gender, age, district of residence, education level and monthly income. Table 6.1 shows the respondent's profile.

Table 6.1 - Respondent's profile

		Frequency	**Percentage**	**Cumulative percentage**
Gender	Female	264	67.3	67.7
	Male	126	32.3	100
Education	Basic education	10	2.6	2.6
	High school education	85	21.7	24.3
	Superior education	295	75.4	99.7
	Others	1	.3	100
Income	< 635€	43	11.0	11.0
	635€-999€	116	29.7	40.7
	1000€-1499€	107	27.4	68.1
	1500€-1999	43	11.0	79.1
	≥ 2000€	38	9.7	88.7
	No income	44	11.3	100

Analysing the table, it is possible to see that 67.7% of the respondents are female and 32.3% are male. Although the difference is quite expressive, the percentage of female residents in Portugal is also higher than of male residents (INE, 2020a). Regarding education level, the number of

respondents with superior education in very high, representing 75.4% of the total sample, and even though this is not an exact mirror of the Portuguese reality (INE, 2020b), it can be explained considering the age of most of the respondents and the fact that the questionnaire was highly shared among academics and superior education students. In terms of income, 57.1% of the respondents are in the groups 635€-999€ and 1000€-1499€ per month, which is in accordance with the monthly average income of 2018, 1166,9€ (INE, 2020c).

In terms of geographical distribution, respondents were asked to select their district of residence. The district with the highest number of respondents was the district of Aveiro, with 102 people, followed by the district of Castelo Branco with 82 people, Lisbon with 64 and Porto with 46 respondents. There was only one district from which there were no respondents, the district of Bragança. Figure 6.1 illustrates the geographic distribution of respondents.

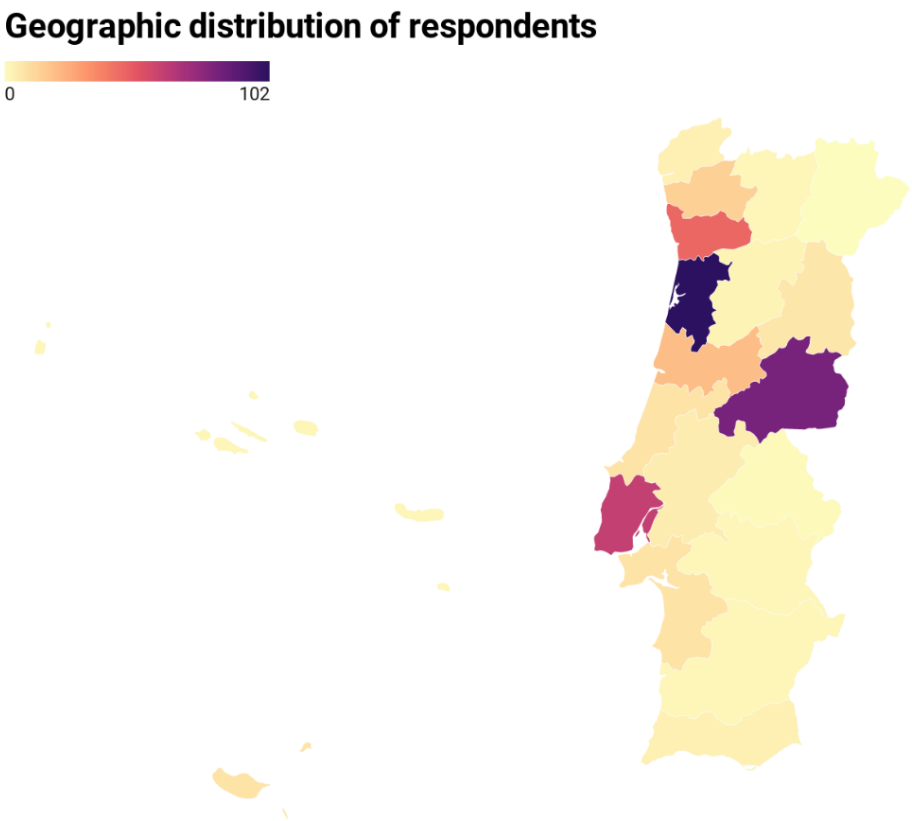

Figure 6.1 - Geographic distribution of respondents
Source: Own construction

Considering age, participants were asked to state their age and were then divided in age groups. Looking at the Portuguese resident population distribution according to age groups, the groups with higher frequency are 45-49, 40-44, 50-54 and 55-59 (INE, 2020a). As shown in Figure 6.1, the

sample has a good distribution among the age groups, but groups 25-29 (17.7%) and 45-49 (14.4%) stand out as the ones with higher percentages. The youngest respondent was 18 years old and the oldest 81 years old.

Table 6.2 - Age groups of the respondents

Age group	Frequency	Percentage
18-24	62	15.9
25-29	69	17.7
30-34	29	7.4
35-39	35	9.0
40-44	41	10.5
45-49	56	14.4
50-54	50	12.8
55-59	28	7.2
60-64	12	3.1
+65 years old	8	2.1

6.2.2. Travel behaviour

Regarding travel behaviour, respondents were asked to state their usual or most frequent travel motivation, group, type of accommodation, trip duration and trip organization. Also, respondents were asked how many trips they have done over the last three years.

Considering the number of trips over the last three years, respondents were scattered among the five categories, with 1 to 4 being the one with the highest percentage (35.9%), closely followed by 5 to 8 (32.6%). It is important to remember that 2020 was a very atypical year for travelling and travellers, as travelling was discouraged and travel bans were applied.

Table 6.3 - Number of trips over the last three years

		Frequency	Percentage	Cumulative percentage
Number trips last 3 years	1 to 4	140	35.9	35.9
	5 to 8	127	32.6	68.5
	9 to 12	61	15.6	84.1
	13 to 16	19	4.9	89.0
	Over 19	43	11.0	100

Table 6.4 demonstrates the respondents' most frequent travel group, motivation and trip organization. Most of the respondents travel with their family (43.8%) or partner (29.5%) and the most referred travel motivation was leisure (73.1%) followed by visiting family and friends (13.3%).

In what concerns travel organization, the majority of respondents stated they are independent travellers, meaning 88.7% of the respondents organize their trips themselves.

Table 6.4 - Travel group, motivation and trip organization

		Frequency	Percentage	Cumulative percentage
Travel group	Friends	51	13.1	13.1
	Partner	115	29.5	42.6
	Family	171	43.8	86.4
	Alone	31	7.9	94.3
	Business partners	20	5.1	99.4
	Other	2	0.6	100
Motivation	Leisure	285	73.1	73.1
	Business	37	9.5	82.6
	Health and well being	15	3.8	86.4
	Visiting family and friends	52	13.3	99.7
	Other	1	0.3	100
Organization	Independent	346	88.7	88.7
	Organized	44	11.3	100

When asked about the duration of their trip, almost half of the respondents indicated that their travels usually last 3 to 5 days (46.9%), followed by those who answered 1 week (30.8). Table 6.5 shows trip duration in detail. The table includes 386 answers as there were 4 missing values.

Table 6.5 - Trip duration

		Frequency	Percentage	Cumulative percentage
Duration	1 to 2 days	56	14.4	14.4
	3 to 5 days	183	46.9	61.3
	1 week	120	30.8	92.1
	2 weeks	18	4.6	96.7
	More than 2 weeks	9	2.3	99.0

Table 6.6 demonstrates the most frequent type of accommodation used by the respondents. The categories were established based on the Portuguese terminology and law. Almost half of the respondents affirm the use mostly hotels (46.2%), followed by family or friend's house (19%).

Table 6.6 - Accommodation type

		Frequency	Percentage	Cumulative percentage
Accommodation	Airbnb	33	8.5	8.5
	Holiday village	4	1.0	9.5
	Hostel	49	12.6	22.1
	Tourist apartments	27	6.9	28.9
	House of family/friends	74	19.0	47.9
	Resort	4	1.0	48.9
	Hotel	180	46.2	95.1
	Camping	5	1.3	96.4
	Rural tourism	10	2.6	99.0
	Others	4	1.0	100

Given the increasing use of robots in tourism and to teste if previous interaction with robots in this context could influence the respondents perceived ease of use and perceived usefulness of robots in tourism, respondents were asked to state whether they have been hosted in as accommodation that uses robots. The response was quite expressive, as 351 participants (90%) have never had contact with robots in accommodation, and only 39 (10%) did.

The respondents who have had contact with robots were asked to state what kind of robots they had been in contact with. The most mentioned types of robots were self-check-in robots (25 respondents) and concierge robots (7 respondents).

6.3. Analysis of the items used in estimating TAM

With the sample fully characterized the results obtained from the questionnaire for estimating the Technology Acceptance Model are now presented.

As mention in the previous chapter, four constructs were used to estimate the model: i) Motivation toward technology, ii) Attitude toward technology, iii) Perceived ease of use and iv) Perceived usefulness. The model presupposes several independent variables (Motivation toward technology, attitude toward technology) to estimate its dependent variables (Perceived ease of use and Perceived usefulness). A detailed analysis of the results of each item is here presented.

Motivation towards technology was measured using a 1 to 4 Likert-type scale, with 1 meaning "Not important" and 5 meaning "Extremely important". Table 6.7 shows the frequency of each option, and the mean and standard deviation for each item.

Table 6.7 - Motivation toward technology

	N	1	2	3	4	Mean	Std. Deviation
Keep up with technology	390	1	46	210	133	3.22	.650
Save time using technology	390	7	21	208	154	3.31	.655
Learn more about technology	390	4	35	227	124	3.21	.638
Help others to use technology	390	5	50	213	122	3.16	.684

When looking at the table, it is possible to identify that the mean of every item is slightly above 3, with the item "Save time using technology" scoring the highest value (3.31) and the item "Help other to use technology" scoring the lowest value (3.16).

Considering attitude toward technology, 13 items were used to measure respondents' attitude, with a Likert-type scale from 1- Strongly disagree to 5 – Strongly agree. Table 6.8 presents the results.

Table 6.8 - Attitude toward technology

	N	1	2	3	4	5	Mean	Std. Dev.
New technology contributes to a better quality of life	390	6	14	42	222	106	4.05	.813
Technology gives people more control over their daily lives	390	14	55	116	152	53	3.45	1.010
Technology makes me more productive in my personal life	390	9	32	74	200	75	3.77	.931
Other people come to me for advice on new technologies	390	48	60	135	109	38	3.07	1.146
In general, I am among the first in my circle of friends to acquire new technology when it appears	390	77	119	106	61	27	2.59	1.169
I can usually figure out new high-tech products and services without help from others.	390	40	93	107	105	45	3.06	1.175
I keep up with the latest technological developments in my areas of interest	390	25	68	91	142	64	3.39	1.141
Technical support lines are not helpful because they explain things in terms I don't understand	390	41	97	156	72	24	2.85	1.039
Sometimes I think that technology systems are not designed for use by ordinary people	390	78	102	105	83	22	2.66	1.179
People are too dependent on technology to do things for them	390	6	22	65	163	134	4.02	.936
Too much technology distracts people to a point that is harmful	390	16	28	82	160	104	3.79	1.045
Technology lowers the quality of relationships by reducing personal interactions	390	20	34	76	130	130	3.81	1.143

I do not feel confident doing business with a place that can only be reached online	390	68	105	106	78	33	2.75	1.203

Most respondents believe technology improves their quality of life (M=4.05), makes personal life more productive (M=3.77) and provides more control over it (M=3.45). A large number of respondents also believe people are too dependent on technology (M=4.02) and that too much technology distracts people (M=3.79) and lowers the quality of relationships (M=3.81). In general, participants keep up with the technological developments of their interest areas (M=3.39) and can figure out new technological products and services without help (M=3.06) but are not the first to acquire new technology when it appears (M=2.59). Most participants do not have difficulties with support lines (M=2.85) and they also do not believe technology is not designed for ordinary people (M=2.66). Besides, most respondents are comfortable doing business online (M=2.75).

Focusing on the perceived ease of use dimension, respondents were asked to score each of the items on a scale from 1 – Strongly disagree to 5 – Strongly agree. Table 6.9 shows the mean and stand deviation of each item and the frequency of each category of response.

Table 6.9 - Perceived Ease of Use

	N	**1**	**2**	**3**	**4**	**5**	**Mean**	**Std. Dev.**
A lot of times I get confused with automatic machines	390	39	127	119	92	13	2.78	1.024
I make frequent mistakes when using automatic machines	390	50	163	108	59	10	2.53	.982
My interaction with automatic machines is usually frustrating	390	62	184	94	40	10	2.36	.954
Interacting with automatic machines requires a lot of my mental effort	390	66	179	89	47	9	2.37	.976
I find it easy to get machine to do what I want	390	22	66	126	154	22	3.23	.983
The automatic machines I use tend to behave unexpectedly	390	48	166	135	35	6	2.45	.876
I find it complicated to use automatic machines	390	64	155	107	55	9	2.46	1.000
I find it easy to remember how to execute tasks on an automatic machine	390	14	51	100	173	52	3.51	.998
Generally, I think automatic machines are easy to use	390	14	33	147	159	37	3.44	.907

In general, respondents perceive the use of automatic machines as easy to use (M=3.44) and consider it easy to remember how to execute task on these machines (M=3.51). Accordingly, most of the respondents are not confused by automatic machines (M=2.78), do not make frequent

mistakes while using them (M=2.53), do not consider the interaction as frustrating (M=2.36) or as requiring of great mental effort (M=2.37), do not think machines behave unexpectedly (M=2.45), do not find them complicated to use (M=2.46) and find it easy to get a machine to do what they want (M=3.23).

Subsequent to the assessment of the perceived ease of use and following the Technology Acceptance Model, participants were asked to evaluate the following items on the perceived usefulness of robots in tourism, using a scale from 1- Never to 5 Always. Table 6.10 shows the results.

Table 6.10 - Perceived Usefulness

	N	1	2	3	4	5	Mean	Std. Dev.
Travelling would be hard without technology	390	26	85	63	147	69	3.38	1.195
Technology gives me more control over my trips	390	16	35	51	206	82	3.78	1.011
Automatic machines improve my performance in trips	390	22	50	138	138	42	3.33	1.017
Technology meets my travel-related needs	390	15	30	106	191	48	3.58	.936
Using automatic machines save me time	390	15	36	87	186	66	3.65	.992
Using automatic machines allow me to do tasks quicker	390	14	28	81	194	73	3.73	.966
Automatic machines support critical aspects of my trips	390	21	46	160	126	37	3.29	.978
Using automatic machines improves the quality of my trips	390	22	50	128	155	35	3.34	1.000
Automatic machines make my trips easier	390	16	45	115	172	42	3.46	.971
Overall, automatic machines are useful in my trips	390	17	32	109	184	48	3.55	.960

The results were all positive, with the lowest scored item being "Automatic machines support critical aspects of my trips" (M=3.29), and the highest "Technology gives me more control over my trips" (M=3.78), closely followed by "Using automatic machines improves the quality of my trips" (M=3.73). Respondents believe automatic machines are useful in their trips (M=3.55), stating they make it easier (M=3.46), improve the quality of the trips (M=3.34), save time (M=3.65) and improve the travellers performance on the trip (M=3.33), believing that travel without technology would be hard (3.38).

6.4. Internal consistency of the model

To test the Internal Consistency reliability (ICR) of the model, Cronbach's alpha was calculated. The survey items were all validated by the respective authors, nevertheless it is important to confirm their reliability for this specific context.

Cronbach's alpha is based on the average correlation among the items studied and varies from 0 to 1 (Bhatnagar et al., 2014). Values over 0.7 mean the items used to measure that construct represents it correctly and generate similar scores.

Table 6.11 shows the values of Cronbach's Alpha for each construct.

Table 6.11 - Cronbach's alpha

	Number	**Cronbach's Alpha**
Motivation toward technology	4	0.840
Attitude toward technology	13	0.743
Perceived Ease of Use	9	0.685
Perceived usefulness	10	0.940

The obtained results were higher than 0.7 in every construct except for "Perceived Ease of Use". Considering the Cronbach's alpha interpretation table (Table 5.6), the ICR of "Motivation toward technology" and "Attitude toward technology" is classified as Good, of the "Perceived Usefulness" is classified as Excellent and of "Perceived Ease of Use" is classified as Acceptable.

After validating the constructs, the inferential statistics to test the hypotheses were performed. To continue with the analyses, it was necessary to create a new combined variable based on the averages of each of the four constructs. Hence, a new variable was created for: "Motivation toward technology", "Attitude toward technology", "Perceived ease of use" and "Perceived usefulness".

6.5. Hypotheses validation

The hypotheses validation had two different moments: i) bivariate analysis to compare differences between groups and ii) a multivariate regression to test cause-and-effect relationships between the independent and dependent variables.

Sociodemographic variables were tested first. Gender, district, and education level were recategorized as binary variables (see subchapter 5.7) and to test their relationship with the PEOU, the *t* of student test was used. As every group has over 30 cases, the test can be carried out. Table 6.12 shows the results for the three variables.

Table 6.12 - t of Student Test for H1a

		N	Mean	Levene's test (sig.)	t-Test (Sig. 2-tailed)
Gender	Female	264	2.832	.200	.024
	Male	126	2.706		
District	Undeveloped	150	2.808	.009	.637
	Developed	240	2.781		
Education	No higher education	95	2.849	.003	.301
	Higher education	295	2.772		

Analysing the table, it is possible to see that equal variances are only assumed for gender and, looking at the test result, this is also the only group were the test result is lower than α, which means there are statistically significant differences between the groups. Hence, we fail to reject the null hypothesis and infer that females have a better perceived ease of use of robots in tourism.

H1.1a – Gender influences the PEOU of robots in tourism

For district and education level, the test result is greater than α ($p \geq 0.05$), so we fail to reject the null hypotheses, meaning having a higher education degree or coming from a more developed area does not contribute to a more positive PEOU.

H1.3a – Higher education has a positive effect on the PEOU of robots in tourism

H1.5a – Living in a developed area contributes to the PEOU of robots in tourism

Age and income were categorised as ordinal variables, hence their relationship with the PEOU was tested with correlations. When comparing an ordinal variable with an internal variable, Pearson's correlation should be used. Table 6.13 presents the obtained results.

Table 6.13 - Age and income

		PEOU
Age	Sig (2-tailed)	.146
	Correlation Coefficient	.074
Income	Sig (2-tailed)	.167
	Correlation Coefficient	-.070

Test results show there is no relation between age and PEOU, and income and PEOU, as in both case the results is higher than the α ($p \geq 0.05$). Therefore, we fail to reject the null hypotheses and conclude that these two variables do not have a direct impact on the PEOU of robots in tourism.

H1.4a – Income is a significant predictor of PEOU of robots in tourism

H1.2b – Age is a significant predictor of PEOU of robots in tourism

Considering the sociodemographic profile, travel group, motivation to travel, trip organization and accommodation were recoded in binary variables (see subchapter 5.7) and the *t* of student test was used to compare the groups regarding the PEOU. Table 6.14 shows the test results.

Table 6.14 - t of Student Test for H2a

		N	Mean	Levene's test	Sig. (2-tailed)
Group	Others	52	2.776	.992 assumed	.813
	Family and friends	338	2.793		
Motivation	Other	105	2.858	.011	.168
	Leisure	285	2.767		
Organization	Independent	346	2.797	.414	.572
	Organized	44	2.750		
Accommodation	Other	157	2.844	.363	.101
	Hotel/Hostel	233	2.756		

Considering the outcome, equal variances can be assumed for travel group, trip organization and accommodation. In all four variables the test result is greater than α, meaning we fail to reject the null hypotheses and deduce travelling with family and friends, travelling in leisure, travelling independently and preferring hotels does not influence the PEOU.

H2.1a – Leisure travellers have a more positive PEOU of robots in tourism

H2.2a – Independent travellers have a more positive PEOU of robots in tourism

H2.3a – Travelling with f&f contributes to a more positive PEOU of robots in tourism

H2.4a – Tourists who stay at hotels have a more positive PEOU of robots in tourism

Motivation toward technology in general and attitude toward technology are both interval variables, hence the relation between these independent variables and the PEOU was tested using correlations. As none of the variables has a normal distribution, Spearman Correlations were used and are presented in Table 6.15

Table 6.15 – Spearman's correlations for H3a and H4a

		PEOU
Motivation toward technology	Sig (2-tailed)	.012
	Correlation Coefficient	-.127
Attitude toward technology	Sig (2-tailed)	.063
	Correlation Coefficient	.094

Analysing the correlation coefficient, it is possible to determine that motivation toward technology in general influences the PEOU (.012 ≤ 0.05). The correlation is positive but not very significant (-.127).

H3a - User's motivation toward technology will have a positive effect on the PEOU of robots in tourism

Considering the attitude toward technology, the p-value is greater than 0.05, meaning there is no correlation, thus we fail to reject the null hypothesis.

H4a - User's attitude toward technology will have a positive effect on the PEOU of robots in tourism

To further test the hypotheses, a multivariate regression analysis was conducted for the PEOU. This will determine the linear regression equation that reasonably describes the relationship between various explanatory variables and a dependent variable. In this case, the independent variables are gender, age, place of residence, education, income, usual travel group, motivation, organization and accommodation, motivation toward technology and attitude toward technology. The regression used the Enter method and is presented in Table 6.16.

Table 6.16 - Multivariate regression model (PEOU)

Independent variables	**Unstandardized Coefficients**		**Standardized coefficients**	**t**	**p-value**
	B	Std. Error	Beta		
Constant	2.599	.229		11.351	.000
Age	.008	.011	.039	.730	.466
Gender	-.150	.057	-.136	-2.650	.008
District	.001	.055	.001	.027	.978
Education	-.017	.067	-.014	-.256	.798
Income	-.021	.018	-.060	-1.167	.244
Travel group	.021	.088	.014	.232	.816
Travel motivation	-.098	.053	-.103	-1.849	.065
Accommodation	-.071	.057	-.068	-1.247	.213
Trip organization	-.058	.085	-.036	-.683	.495
Motivation toward technology	-.038	.069	-.033	-.548	.584
Attitude toward technology	.198	.055	.204	3.621	.000
Model summary					

R	.255
R Square	.065
Adjusted R Square	.038
Std. Error of the estimate	.50589
F-statistic	.007
Multicollinearity	
Tolerance	>0.69
VIF	<1.4

The results show the correlation coefficient R^2 = 0.065 and the adjusted R^2=0.038, meaning around 4% of the dependent variable variation is explained by the independent variables. Also, the Durbin-Watson test result (1.789) shows that the residuals are not correlated. The multicollinearity tests show there is no significant correlation between the independent variables, hence, no multicollinearity. With every assumption of the multivariate regression verified, the t-test result may be analysed.

The regression analysis shows a statistically significant model, demonstrating that gender (B = -.136; t = -2.650; p<0.05) and attitude toward technology (B = .204; t = 3.621; p<0.05) are predictors of the PEOU. The linear equation should be as follows:

$$PEOU = 2.599 - .150(Gender) + .198(Attitude\ toward\ technology) + \varepsilon$$

$\varepsilon = \text{error}$

After testing the hypotheses for the first dependent variable (PEOU), inferential statistic for the second dependent variable, Perceived Usefulness, were performed.

Likewise, sociodemographic variables were analysed first and Table 6.17 presents the results

Table 6.17 - t of Student test for H1b

		N	Mean	Levene's test	Sig. (2-tailed)
Gender	Female	264	3.527	.005	.525
	Male	126	3.467		
District	Undeveloped	150	3.313	.130	.000
	Developed	240	3.629		
Education	No higher education	95	3.428	.919	.276
	Higher education	295	3.533		

Analysing the outcome, it is possible to conclude that equal variance can be assumed for district and education level. Considering the test results, statistically significant differences between the groups

are found in the district variable ($p \leq 0.05$), meaning we reject the null hypothesis and believe that living in a more developed area contributes to the PU of robots in tourism.

H1.5b – Living in a developed area contributes to the PU of robots in tourism

For gender and education, we fail to reject the null hypotheses, meaning they do not influence the perceived usefulness of robots in tourism.

H1.1b – Gender influences the PU of robots in tourism

H1.3b – Higher education has a positive effect on the PU of robots in tourism

Age and income were again analysed using Spearman's correlations and Table 6.18 shows the results.

Table 6.18 – Spearman's Correlations for H1b

		PU
Age	Sig (2-tailed)	.033
	Correlation Coefficient	-.108
Income	Sig (2-tailed)	.401
	Correlation Coefficient	.043

Results show no relation between income and PU, as $p \geq 0.05$, consequently we fail to reject the null hypotheses and conclude income does not influence PU.

H1.4b – Income is a significant predictor of PU of robots in tourism

Considering age, the p-value shows that there is an association between the independent variable and the PU. The correlation is negative and very weak, as the coefficient is below 0.2. Hence, we reject the null hypotheses and believe that age influences the PU.

H1.2b – Age is a significant predictor of PU of robots in tourism

Variables used to characterise the type of travellers were considered next. The *t* of Student test was used to compare the usual travel group, travel motivation, travel organization and accommodation regarding the PU and Table 6.19 presents the results.

Table 6.19 - t of Student test for H2b

		N	Mean	Levene's test	Sig. (2-tailed)
Group	Others	52	3.740	.027	.007
	Family and friends	338	3.471		
Motivation	Other	105	3.568	.755	.372
	Leisure	285	3.485		
Organization	Independent	346	3.495	.399	.420
	Organized	44	3.600		
Accommodation	Other	157	3.424	.223	.094
	Hotel/Hostel	233	3.564		

The Levene's test results show equal variances can be assumed to travel motivation, organization and accommodation. Travel group is the only variable with $p \leq 0.05$, thus we can reject the null hypothesis and assume travelling with family and friends contributes to the PU of robots in tourism.

H2.3a – Travelling with f&f contributes to a more positive PU of robots in tourism

For the remaining variables, travel motivation, organization and accommodation, we fail to reject the null hypothesis, hence their influence in the PU is not sustained.

H2.1a – Leisure travellers have a more positive PU of robots in tourism

H2.2a – Independent travellers have a more positive PU robots in tourism

H2.4a – Tourists who stay at hotels have a more positive PU of robots in tourism

Spearman's correlations were once again used to test the Motivation toward technology in general and attitude toward technology in general relation with the PU of robots in tourism. Besides, the relation between the PEOU and the PU was tested using the same method. Results are presented in Table 6.20

Table 6.20 - Spearman's correlations for H3b and H4b

		PU
Motivation toward technology	Sig (2-tailed)	.000
	Correlation Coefficient	.303
Attitude toward technology	Sig (2-tailed)	.000
	Correlation Coefficient	.245
PEOU	Sig (2-tailed)	.017
	Correlation Coefficient	-.121

The test result indicates that there is an association between each of these three variables and the PU, thus we reject the null hypotheses. Regarding the motivation and attitude toward technology,

the correlations are positive and weak as both values are between 0.2 and 0.4. This means the better the motivation and attitude toward technology is the better the PU is. The PEOU is also correlated to the PU, however the correlation is negative and weak, meaning the higher the PEOU is the lower the PU.

H3b - Motivation toward technology will have a positive effect on the PU of robots in tourism

H4b - Attitude toward technology will have a positive effect on the PU of robots in tourism

H5 - Perceived ease of use will have a positive effect on the PU

A multivariate regression analysis was also conducted for the PU to determine the linear regression equation that reasonably describes the relationship between various explanatory variables and a dependent variable. In this case, the independent variables are gender, age, place of residence, education, income, usual travel group, motivation, organization and accommodation, motivation toward technology, attitude toward technology and PEOU. The regression used the Enter method and is presented inTable 6.21.

Table 6.21 - Multivariate regression analysis for PU

Independent variables	Unstandardized Coefficients		Standardized coefficients	t	p-value
	B	Std. Error	Beta		
Constant	1.822	.387		4.705	.000
Age	-.047	.016	-.147	-2.949	.003
Gender	-.141	.084	-.082	-1.691	.092
District	.293	.080	.176	-2.949	.003
Education	-.120	.098	-.064	-1.232	.219
Income	.007	.026	.013	.272	.786
Travel group	-.267	.129	-.112	-2.068	.039
Travel motivation	.011	.101	.006	.107	.915
Accommodation	.058	.084	.035	.697	.486
Trip organization	-.016	.125	-.006	-.127	.899
Motivation toward technology	.340	.078	.227	4.378	.000
Attitude toward technology	.304	.081	.200	3.751	.000
PEOU	-.033	.075	-.021	-.435	.664
Model summary					
R	.440				
R Square	.194				
Adjusted R Square	.168				

Std. Error of the estimate	.73881
F-statistic	.900
Multicollinearity	
Tolerance	>0.69
VIF	<1.5

The results show the correlation coefficient R^2 = 0.194 and the adjusted R^2=0.168, meaning the independent variables explain around 17% of the dependent variable variation. The Durbin-Watson test result (2.028) shows that the residuals are not correlated, and the multicollinearity tests show there is no significant correlation between the independent variables, hence, no multicollinearity. Every assumption has been verified, so the t-test can be analysed.

The regression analysis shows a statistically significant model, demonstrating that age (B = -.147; t = -2.949; p<0.05), district (B = .176; t = -2.949; p<0.05), travel group (B = -.112; t = -2.068; p<0.05), motivation toward technology (B = .227; t = 4.378; p<0.05) and attitude toward technology (B = .200; t = 3.751; p<0.05) are predictors of the PU. The linear equation should be as follows:

$$PU = 1.822 - .147(Age) + .293(District) - .267(Travel\ group) + .340(Motivation) + .304(Attitude) + \varepsilon$$

Table 6.22 shows a summary of the validation of the hypotheses. Out of the 23 tested hypotheses, eight were supported

Table 6.22 - Hypotheses validation

Hypotheses			Validation
H1 – Sociodemographic variables	**H1a -** Sociodemographic variables influence the perceived ease of use of robots in tourism	**H1.1a** – Gender influences the PEOU of robots in tourism	**Supported**
		H1.2a – Age is a significant predictor of PEOU of robots in tourism	**Rejected**
		H1.3a – Higher education has a positive effect on the PEOU of robots in tourism	**Rejected**
		H1.4a – Income is a significant predictor of PEOU of robots in tourism	**Rejected**
		H1.5a – Living in a developed area contributes to the PEOU of robots in tourism	**Rejected**
	H1b - Sociodemographic variables influence the perceived usefulness of robots in tourism	**H1.1b –** Gender influences the PU of robots in tourism	**Rejected**
		H1.2b – Age is a significant predictor of PU of robots in tourism	**Supported**
		H1.3b – Higher education has a positive effect on the PU of robots in tourism	**Rejected**
		H1.4b – Income is a significant predictor of PU of robots in tourism	**Rejected**
		H1.5b - Living in a developed area contributes to the of PU of robots in tourism	**Supported**
H2 – Type of traveller	**H2a** - Type of traveller influences the perceived ease of use of robots in tourism	**H2.1a –** Leisure travellers have a more positive PEOU of robots in tourism	**Rejected**
		H2.2a – Independent travellers have a more positive PEOU of robots in tourism	**Rejected**
		H2.3a – Travelling with family and friends contributes to a more positive PEOU of robots in tourism	**Rejected**
		H2.4a – Tourists who stay at hotels have a more positive PEOU of robots in tourism	**Rejected**
	H2b - Type of traveller influences the perceived usefulness of robots in tourism	**H2.1a –** Leisure travellers have a more positive PU of robots in tourism	**Rejected**
		H2.2a – Independent travellers have a more positive PU robots in tourism	**Rejected**
		H2.3a – Travelling with family and friends contributes to a more positive PU of robots in tourism	**Supported**
		H2.4a – Tourists who stay at hotels have a more positive PU of robots in tourism	**Rejected**
H3 – Motivation toward technology	**H3a** - User's motivation toward technology will have a positive effect on the PEOU of robots in tourism		**Rejected**
	H3b - User's motivation toward technology will have a positive effect on the PU of robots in tourism		**Supported**
H4 – Attitude toward technology	**H4a** - User's attitude toward technology will have a positive effect on the PEOU of robots in tourism		**Supported**
	H4b - User's attitude toward technology will have a positive effect on the PU of robots in tourism		**Supported**
H5 - PEOU	Perceived ease of use will have a positive effect on the PU		**Supported**

Source: Own elaboration

6.6. Discussion

Looking at the analysis performed, it is possible to infer that women are slightly more positive toward the perceived ease of use of robots in tourism. Gender has been proven as a predictor in several studies although in different ways. This finding generally supports the findings of Ivanov, Webster and Seyyedi (2018), opposing to Ivanov, Webster and Garenko (2018). Age, education level, district of residence and income do not seem to influence the PEOU, unlike what was found in previous studies (Ivanov, Webster & Seyyedi, 2018; Ivanov, Webster & Garenko, 2018; Tung & Law, 2017).

Looking at the type of traveller variables (usual travel group, motivation, accommodation and organization), none of the null hypotheses was rejected. These finding oppose to Xu et al. (2019) findings, that state that each type of traveller considers specific satisfaction/dissatisfaction determinants.

Considering the motivation toward technology in general, there was no evidence of significant correlation between this variable and the PEOU. Contrary to this finding, Park et al. (2007) found that motivation to use technology systems had a positive impact on the PEOU.

The user's attitude toward technology in general proved to be correlated with the PEOU. Even though the correlation is weak, the finding go along with the studies carried out by Cruz-Cárdenas et al. (2019) and Yang (2013).

When analysing the multivariate regression, it is possible to see that only gender and attitude toward technology figure in the equation. The percentage of variation that these two variables explain is very low (around 4%), however as this study falls under the social sciences category, lower values as expected considering human behaviour is hard to predict.

Contemplating the second depend variable, out of the sociodemographic variables and opposing to the results for PEOU, age and district of residence influence the PU. In accordance with Ivanov, Webster and Seyyedi's (2018) findings, younger respondents showed a less positive attitude towards the PU of robots in tourism. Living in a more developed area also has a positive impact on the PU of robots in tourism, as mentioned by Ivanov, Webster and Garenko (2018).

When looking at the type of traveller variables, the travel group has a positive influence on the PU, meaning travelling with friends and family contributes to a more positive PU of the use of robots in tourism. Even though the variables are not the same, this finding is in accordance with Xu et al.'s (2019) findings that different types of travellers consider specific determinants.

The user's motivation toward technology and attitude toward technology both have a positive correlation with the PU, as prove in other studies (Cruz-Cárdenas et al., 2018; Yang, 2013; Park et

al., 2007). The PEOU was found to have a negative correlation with the PU, opposing to the finding by Yang (2013), Blut et al. (2016) and Lee, Lin and Shih (2018).

Analysing the multivariate regression model, the equation including district, age, travel group, attitude toward technology and motivation toward technology explains 17% of the dependent variable variation. The findings reinforce Cruz-Cárdenas et al. (2019)'s idea that PU is a fundamental predictor in western cultures.

6.7. Limitations of the analysis

This study focusses on two main parts of the Technology Acceptance Model – the design features (external variables) and the cognitive response (Perceived Ease of Use and Perceived Usefulness) – leaving out the affective response and the behavioural response.

The main limitation of this analysis is fact that the study does not consider the attitude toward using and the actual use of robots. As it was possible to see in the analysis, only 10% of the respondents (39 participants) have ever been hosted in a hotel that uses robots. Even though the use of robots in the tourism industry is growing, the percentage of the population that has interacted with it is very low, making it hard to study those two constructs of TAM. Hence, the aim of this study was do help define what are the variables that may affect the perceived ease of use and the perceived usefulness of using robots in tourism, so that in the future when more people have had this interaction, a more accurate study can be conducted.

Chapter 7. Conclusion

7.1. Introduction

This chapter presents the main conclusions drawn from the present research in section 7.2, and the main contributions in section 7.3 but also the main limitations of the study in section 7.4. Finally, some suggestions for future research are presented in section 7.5.

7.2. Main conclusions

The application of the TAM to the Portuguese context aimed at understanding the Perceived Ease of Use and Perceived usefulness of the use of robots in tourism. To reach conclusions in this regard, an extensive literature review was carried out first, to understand the relation between robots and tourism and the importance of studying such areas.

The tourism sector is undoubtedly important to the global economy. However, this industry is very sensitive to disasters, attacks, epidemics or even to consumer's behavioural preferences and trends. To avoid some of this uncertainty, it is important for stakeholders to know these trends and prepare for them. The use of technology in services, and particularly in tourism, is one of the greatest emerging trends. Even though the COVID-19 pandemic caused the sector to have major losses, technology may be a lifeline as it provides new and exciting experiences.

The on-going advances in technology cause a new era to bloom: the industry 4.0. This represents a new way of thinking, producing and living, focusing more on the connection and interaction between people and things. The Internet of Things and Artificial Intelligence enabled de creation of Smart Cities, Smart Factories and even Super-smart Societies. These advances are also used in services, including in the tourism industry, where each day there are more examples of technological solutions. The implementation of technology for customers to use is only as good as its use, and sometimes consumers have negative attitudes toward technology. Investigators have tried to clarify what demographic and cultural variables affect this attitude, but the results are not clear. Nevertheless, predicting the use of new technology is extremely important for investors, hence several models for technology acceptance have been designed.

Robots are a part of AI that has been rapidly developing and used in several areas, both in industry, services and everyday life. Service robots are now used, for example, in the medicine field and in the tourism industry. From robotic arms to fully staffed robotic hotels, the chances to interact with robots while travelling are growing and not everyone is a fan on that. The costs associated with implementing robots are still considerably high but the labour shortages and cultural barriers, especially in developed countries and the unique opportunity to create a memorable experience are conducting the hospitality industry to invest more in robots. Studies in human-robot interaction are

fundamental for both academics and managers, to learn what influences customer's willingness to use service robots and what features may robots have that can help in this process.

After the literature review process and to fulfil the objectives of this study, primary quantitative data was collected. To evaluate how the Portuguese look at the use of robots in tourism, a survey by questionnaire was applied to 390 respondents, residents in Portugal and not younger than 18 years old. The questionnaire was based on the original Technology Acceptance Model and four possible predictors were identified: sociodemographic variables, travel characteristics, motivation toward technology in general and attitude toward technology in general. Data was analysed using SPSS, and univariate, bivariate and multivariate tests were performed. After analysing each variable individually, *t* of Student tests and Spearman Correlations were presented to test if there were statistically significant differences between groups. Subsequently, a multivariate regression analysis was performed for each dependent variable (Perceived Ease of Use and Perceived Usefulness).

Data analysis begun with a detailed characterization of the respondents, sociodemographic and according to travel behaviour, followed by univariate analysis of the variables, using measures of dispersion. To test the Internal Consistency reliability of the model, the Cronbach's alpha was calculated and proved constructs to be valid. Inferential statistics then took place, where bivariate analyses were performed to compare differences between groups and a multivariate regression tested the cause-and-effect relationships between the independent and dependent variables.

The results show that women are slightly more positive regarding the perceived ease of use of robots in tourism than men. However, this assumption was not proven for the perceived usefulness as there were no statistically significant differences between the groups. Contrary to what other studies have proved, age, education level, area of residence and income did not influence the PEOU of the respondents. Though, for the PU, age and area of residence proved to be significant and were considered as predictors of the dependent variable. For the remaining variables (gender, income and education level), the study failed to reject the null hypotheses.

Regarding the variables that were used to characterize the type of traveller – usual travel group, most frequent travel motivation, most used type of accommodation and trip organization – none was significant in predicting the PEOU of robots in tourism. Nevertheless, there were statistically significant differences between those travelling with family and friends and others (alone, business partners or others) regarding the perceived usefulness of robots in tourism.

User's attitude toward technology in general proved to be positively correlated with PEOU and PU, even though the correlation was weak in both cases. Nonetheless, user's motivation toward technology was only proven positively correlated to the perceived usefulness of robots in tourism.

Contrary to what was initially expected the PEOU and the PU were negatively correlated, although the correlation coefficient was very low. These variables were expected to be positively correlated, according to what was found in other studies, as it was expected for people who perceive robots ease to use to also perceive their usefulness, but this was not the case.

The multivariate regression analyses show that only gender and the attitude toward technology in general should be considered in the linear equation for the PEOU and district, age, travel group, attitude toward technology and motivation toward technology should be considered for the PU. These equations explain around 4% of the first dependent variable and around 17% of the second. The low value of these percentages is expected to be due to two factors: i) the model used and ii) the nature of the study. The Technology Acceptance Model is a general model, used to measure the acceptance of any new technology in any field, hence it is not specific for robots' acceptance, lacking important aspects such as the robots' appearance or the tasks it performs. On the other hand, the fact that this study falls under the scope of social sciences explains the low percentage of the variation explanation, as human behaviour is hard to predict.

Overall, the study helped explaining the importance of some variables in robots' acceptance, eliminating other that were not significant. Besides, considering the global context and available literature, this study positioned Portugal in the map for robots' acceptance, as there were no other studies in this area.

7.3. Contributions

This dissertation intends to identify possible predictor for the perceived ease of use and perceived usefulness of robots in tourism. Using the Technology Acceptance Model, several independent variables are tested as predictors. Even though the linear equations explain around 4% of the PEOU and around 17% of PU, the study helped clarifying the role of sociodemographic variables like gender and age, excluding non-relevant variables, mostly related with the type of traveller.

This was also the first time the TAM was applied to the Portuguese context regarding the use of robots, bringing new data to the cultural aspects that may influence robot acceptance.

The obtained results have essentially academic implication, but it also provided knowledge to the stakeholders, or managerial implications, concerning how Portuguese residents react to the use of robots in tourism.

Regarding the theoretical contributions, this study helped to identify and clarify fundamental concepts related to AI and tourism, human-robot interaction, service robots and concrete examples of technological solutions applied to the travel and tourism industry.

7.4. Limitations

As mentioned before, the main limitation of this study is fact that it does not consider the attitude toward using and the actual use of robots. Only 10% of the respondents (39 participants) have had previous experiences with robots in hotels, making it hard to study those two constructs of TAM accurately.

Another limitation of the study in the fact that TAM was designed for the acceptance of new technology in general, thus is does not consider specific aspects of robots' acceptance, such as the robot's appearance, having human-like features, the tasks it performs or the jobs it replaces or creates.

7.5. Suggestions for future research

Future research areas may implement TAM but also considering the attitude toward using and the actual use of robots in tourism, to have a more accurate idea of costumer's behaviour. However, it will still take some time before the use of robots is widespread and a concrete idea can be formulated. Furthermore, other technology acceptance models should be applied to the use of robots in tourism, like UTAUT, and possibly a specific model for service robots in tourism could be developed.

Also, considering the results of this study, further investigation should be done to clarify the importance of sociodemographic characteristics, travel behaviour, motivation towards technology and attitude toward technology in predicting PEOU and PU of robots in the tourism industry, in other countries.

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Appendices

Appendix 1 – Survey (original version)

Robots em Turismo - aplicação do Modelo de Aceitação Tecnológica

O meu nome é Mariana Martins e o presente questionário enquadra-se no âmbito da minha dissertação de mestrado em Gestão e Planeamento em Turismo, na Universidade de Aveiro, sob orientação do Professor Doutor Carlos Costa.

O questionário tem como objetivo perceber o nível de aceitação do uso de robots em turismo dos residentes em Portugal e quais as variáveis que o influenciam, tendo por base o Modelo de Aceitação Tecnológica (TAM). Apenas poderá responder a este questionário se tiver idade igual ou superior a 18 anos e residir em Portugal.

Os resultados serão tratados de forma agregada, assegurando-se a devida confidencialidade da informação e, em momento algum, será disponibilizada informação individual.

O questionário demora cerca de 7 minutos a preencher, pelo que agradeço, desde já, toda a atenção disponibilizada.

Para qualquer questão pode contactar-me através do e-mail marianasantosmartins@ua.pt

Parte I – comportamento em viagem

1- Quantas viagens (nacionais e internacionais) fez nos últimos três anos?

1 a 4 viagens
5 a 8 viagens
9 a 12 viagens
13 a 16 viagens
Mais de 16 viagens

2- Em média, quanto tempo costumam durar as suas viagens?

1 a 2 dias
3 a 5 dias
1 semana
2 semanas
Mais de 2 semanas

3- Com quem viaja com mais frequência?

Parceiro/a
Familiares
Sozinho/a
Amigos
Colegas de trabalho/parceiros de negócios
Outro: qual?

4- Qual é a sua principal motivação para viajar?

Lazer
Visita a familiares e amigos
Negócios/eventos
Saúde e bem-estar
Razões médicas
Outro: qual?

5- Habitualmente viaja de forma independente (viagem organizada por si ou por outro membro do grupo de viagem) ou organizada ("pacote" de viagem organizado por uma agência)?

Independente ___ Organizada ____

6- Em que tipo de alojamento fica hospedado com mais frequência?

Casa de familiares ou amigos
Hotel
Aldeamento turístico
Apartamento turístico
Conjunto turístico (resorts)
Turismo em Espaço Rural
Parques de campismo e caravanismo
Alojamento local/Hostel
Airbnb
Outro: qual?

7- Já esteve hospedado em algum alojamento que utilize robots ou inteligência artificial? (ex. self check-in, porteiro robot, serviço de quartos entregue por robot, etc.)
Sim ____ Não ____

Parte II – Motivação e atitude face à tecnologia em geral

8- Indique a importância das seguintes motivações em relação à tecnologia, utilizando a escala entre 1 e 4, em que 1 significa nada importante e 4 muito importante.

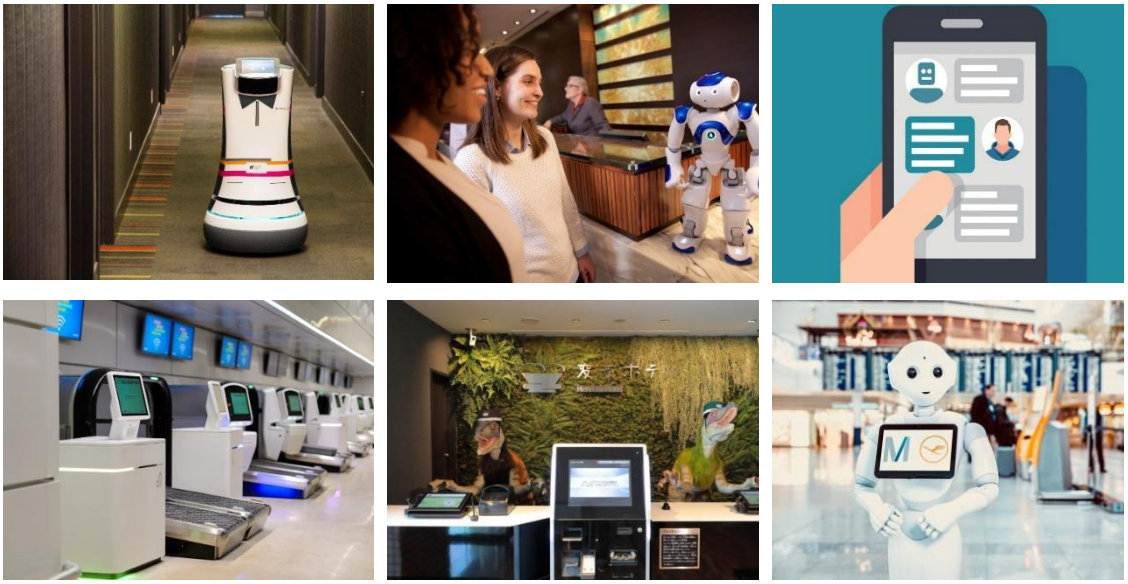
	1 Nada importante	2 pouco importante	3 importante	4 muito importante
Manter-me atualizado face à tecnologia emergente.				
Poupar tempo utilizando tecnologia.				
Aprender mais sobre tecnologia.				
Ajudar outras pessoas a utilizar tecnologia.				

9- Classifique as seguintes afirmações numa escala de 1 a 5, em que 1 significa "discordo completamente" e 5 significa "concordo completamente"

	1 Discordo completamente	2	3 Nem concordo nem discordo	4	5 Concordo completamente
As novas tecnologias contribuem para uma melhor qualidade de vida.					
A tecnologia dá às pessoas mais controlo sobre as suas vidas.					
A tecnologia torna-nos mais produtivos.					
As outras pessoas procuram-me quando precisam de conselhos sobre novas tecnologias.					
Em geral, sou um dos primeiros no meu ciclo de amigos a adquirir novas tecnologias.					
Normalmente consigo descobrir novos produtos e serviços de alta tecnologia sem a ajuda de outras pessoas.					
Acompanho os últimos desenvolvimentos tecnológicos nas minhas áreas de interesse.					
As linhas de suporte técnico não são úteis porque não explicam as coisas em termos que eu entenda.					
Às vezes penso que a tecnologia não foi projetada para o uso de pessoas comuns.					
Não existem manuais para produtos/serviços de alta tecnologia escritos em linguagem simples.					
As pessoas são muito dependentes da tecnologia.					
O excesso de tecnologia distrai as pessoas a um ponto que se torna prejudicial.					
A tecnologia diminui a qualidade dos relacionamentos ao reduzir as interações pessoais					
Não me sinto confiante em fazer negócios com empresas online.					

Parte III – Facilidade de utilização e utilidade percebida

Considere agora o uso de máquinas automáticas em turismo, como por exemplo, máquinas de check-in automático no aeroporto, em estabelecimentos de alojamento ou em restaurantes, robots porteiros, robots que entregam serviço de quartos, chatbots, etc.



10- Facilidade de utilização percebida

	1 Discordo completamente	2	3 Neutro	4	5 Concordo completamente
Muitas vezes fico confuso quando uso máquinas automáticas.					
Cometo erros com frequência ao usar tecnologia.					
A minha interação com a tecnologia costuma ser frustrante.					
Interagir com tecnologia requer muito do meu esforço mental.					
Acho fácil fazer com que uma máquina automática faça o que eu quero.					
As máquinas automáticas que utilizo geralmente comportam-se de maneira inesperada.					
Acho complicado usar máquinas automáticas.					
É fácil para mim lembrar-me de como executar uma tarefa numa máquina automática.					
No geral, acho as máquinas automáticas fáceis de usar.					

11- Utilidade percebida

	Nunca	Raramente	Às vezes	Muitas vezes	Sempre
Viajar seria difícil sem tecnologia.					
A tecnologia dá-me maior controlo sobre as minhas viagens.					
Usar máquinas automáticas melhora o meu desempenho nas viagens.					
A tecnologia atende às minhas necessidades relacionadas com as viagens.					
Utilizar máquinas automáticas poupa-me tempo nas viagens.					
As máquinas automáticas permitem-me realizar tarefas mais rapidamente.					
As máquinas automáticas apoiam aspetos críticos das minhas viagens.					
Usar máquinas automáticas melhora a qualidade das minhas viagens.					
Usar máquinas automáticas torna as minhas viagens mais fáceis					
No geral, acho as máquinas automáticas úteis nas minhas viagens.					

Dados sociodemográficos

Idade _____

Género Feminino ___ Masculino ____

Distrito de residência: _____

Habilitações literárias
Ensino básico ___
Ensino secundário ___
Ensino superior ___

Rendimento mensal líquido do agregado familiar
___ <635€
___ 635€ - 999€
___ 1000€ - 1499€
___ 1500€ - 1999€
___ ≥2000€