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THE INFLUENCE OF TECHNOLOGICAL INNOVATION ON TOURISM SUSTAINABILITY: AN INSIGHT INTO ALGARVE

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Work Authorship Declaration

I declare to be the author of this work, which is unique and unprecedented. Authors and works consulted are properly cited in the text and are included in the listing of references.

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ABSTRACT

This work addresses the problem of digital transformation and technological advancement in rebranding of tourism & hospitality business facilities, the products offered and influencing customer's perception to patronage. The tourism industry in Portugal has given rise to impressive growth over the last few decades particularly from the post-pandemic period. It is currently one of the socio-economic sectors of the country that has required innovative strategies in integrating the way business engage with customers, drive trends and competitiveness. This study aims to examine the influence of technological Innovations on the sustainability of tourism industry in Algarve, Portugal. The contributing factors were highlighted to foster innovation in Portugal. Structured digital questionnaire was employed as instrument for data collection and data was collected from 95 participant conveniently comprising of hospitality/tourism workers and guest. The study employed a multi-dimensional analytical approach using correlation analysis to establish interdependency relationship between contributing factors driving technological innovations, diverse adoption patterns, and tourist experiences. The heat map visualization revealed the determining factors that can provide deeper insights into user perceptions and experiences with available technological innovations in the selected facilities if the hotelier, managers and stakeholders can look into it. The conclusions reached led to the presentation of the innovation success of the technological infrastructure in influencing customer's patronage, enhancing competitive advantage of tourism businesses and demonstrate their continuous interest in developing various digital capabilities to facilitate tourists' experiences. From the findings, an overwhelming majority of 89% of guest and tourist indicated that technological innovations positively (Yes) influenced their perception of tourism facilities.

Keywords: Tourism in Portugal, Technological Innovation in Tourism, Tourism Sustainability

Resumo

A indústria do turismo em Portugal tem dado origem a um crescimento impressionante ao longo das últimas décadas, particularmente desde o período pós-pandémico. É atualmente um dos setores socioeconómicos do país que tem exigido estratégias inovadoras na forma como as empresas interagem com os clientes, impulsionam tendências e competitividade. Assim, é necessário investigar a proficiência da força de trabalho com a tecnologia, a extensão do uso do consumidor e a sua influência na criação de novos produtos e destinos. Este trabalho de investigação foi conduzido para abordar o problema da transformação digital e do avanço tecnológico no *rebranding* das instalações de negócios de turismo e hotelaria, os produtos oferecidos e a influência da perceção do cliente para a clientela no Algarve, uma região que está a experienciar um aumento tanto nos seus setores de viagens e hotelaria nacionais como estrangeiros, com a intenção de expandir o espaço de envolvimento digital nas empresas de turismo e hotelaria através da inovação tecnológica. Os objetivos visam examinar a influência das inovações tecnológicas na sustentabilidade da indústria do turismo no Algarve, Portugal, identificando os fatores que influenciam as inovações tecnológicas no turismo, os desafios que enfrentam a implementação de inovações tecnológicas nas três instalações turísticas selecionadas, os tipos de inovações tecnológicas empregues, a influência destas inovações tecnológicas no comportamento e envolvimento dos turistas, investigar o impacto destas inovações tecnológicas na sustentabilidade turística das três instalações turísticas selecionadas no Algarve. As perguntas de investigação foram formuladas em consonância com os objetivos específicos do estudo. O quadro teórico do Modelo de Aceitação de Tecnologia (MAT) introduzido por Fred Davis em 1986 foi adotado, e explica a motivação e adoção da inovação tecnológica no setor do turismo por utilizadores com três fatores; perceção de utilidade, perceção de facilidade de uso, e atitude em relação ao uso. No entanto, uma vez que o MAT ignorou a influência social na adoção da tecnologia, tem sido limitado a ser aplicado para além do local de trabalho. Em 2022, os serviços de turismo de Portugal geraram uma receita de vendas próxima de 33 mil milhões de euros com aumento do visitante noturno internacional, sinalizando o início da recuperação para este setor desde a pandemia (researchhub.wttc.org). Enquanto o setor do turismo e hotelaria de Portugal se continua a desenvolver, nem todas as regiões estão a experienciar este desenvolvimento, mas o Algarve continuou a ser o destino turístico mais popular de Portugal, registando um aumento de 3,2 milhões de dormidas em agosto de 2024 (ETIAS.COM, 2024). A aplicação da inovação tecnológica na indústria do turismo para influenciar a sustentabilidade nas operações dos negócios de turismo e hotelaria abrange a inovação de produto, inovação de processo, inovação organizacional e inovações de marketing. Por exemplo, usar inovação tecnológica como realidade virtual para fornecer

exploração única de produtos turísticos para turistas. A implementação de pagamento sem contacto ou Inteligência artificial *chatbot* para melhorar a experiência dos clientes em hotéis, aeroportos e centros recreativos. No contexto organizacional, é usado para melhorar as estruturas de trabalho, facilitando a carga de trabalho dos funcionários. O uso de marketing digital tem ajudado as empresas de turismo e hotelaria a reestruturar o seu método de marketing e as preferências dos clientes. Isto mostra que o setor do turismo e hotelaria não é apenas considerado como um motor para o lazer ou atrações, mas também como uma instituição para investigação sobre desenvolvimento e estratégias inovadoras. A pesquisa quantitativa foi empregue para o método de recolha e análise de dados. Os dados foram recolhidos usando uma técnica de amostragem de conveniência. O número total de questionários recebidos convenientemente de trabalhadores de hotelaria/turismo, hóspedes, turistas e viajantes foi de 95 através de meios digitais. No entanto, apenas 93 amostras foram consideradas para análise. É significativo salientar que a análise final não incluiu as respostas do teste piloto. A primeira versão do questionário foi validada por uma amostra de 10 respondentes, mas não incluídos na população alvo, a fim de verificar a clareza do questionário. Pequenos ajustes foram feitos com base no feedback recebido do teste piloto e revisão dos supervisores antes de prosseguir para o campo para a recolha de dados. A análise usou uma abordagem analítica multidimensional usando análise de correlação para estabelecer a relação de interdependência entre os fatores contribuintes que impulsionam as inovações tecnológicas, diversos padrões de adoção e experiências turísticas. Média, mediana, frequências e desvios-padrão foram calculados sobre os dados recolhidos para uma melhor compreensão da distribuição das respostas e destacar quaisquer padrões ou tendências que possam surgir. A análise de correlação das relações entre os fatores foi examinada e visualizada através de uma matriz de correlação *heatmap* para determinar as interdependências e a intensidade dos desafios em todas as instalações. A análise comparativa sobre as perceções de sustentabilidade entre as instalações foi comparada usando estatísticas descritivas e tabela comparativa para resumir as métricas de sustentabilidade. O *heatmap* mostrou o padrão e as variações dos múltiplos fatores que influenciam a adoção de variações tecnológicas nos setores de hotelaria e turismo no Algarve. Esta análise fornece orientação e perceção mais profundas sobre como os *stakeholders*, hoteleiros, gestores e investidores podem trabalhar nestes fatores para melhorar as perceções e experiências dos utilizadores com as inovações tecnológicas nas instalações selecionadas. As conclusões alcançadas levaram à apresentação do sucesso da inovação da infraestrutura tecnológica em influenciar a clientela dos clientes, melhorar a vantagem competitiva das empresas de turismo e demonstrar o seu contínuo interesse em desenvolver várias capacidades digitais para facilitar as experiências dos turistas. A partir dos resultados, uma esmagadora maioria de 89% dos hóspedes e turistas indicou que as inovações tecnológicas influenciaram positivamente (Sim) a sua perceção das instalações

turísticas. Além disso, no momento da recolha de dados, a fonte de dados limitava-se apenas a dados primários, portanto, o estudo pode não capturar dados e resultados de análises literárias recentes. Para pesquisas futuras, os académicos do turismo devem considerar examinar a análise qualitativa sobre a gestão da transformação digital das organizações de hotelaria e turismo e a sua sustentabilidade no mundo digital, explorando ao mesmo tempo os quadros regulamentares, normas e diretrizes para reger o uso da tecnologia nas operações de turismo, privacidade de dados e cibersegurança. Desde o período pós-pandémico, o uso da inovação tecnológica para criar consciência de destinos turísticos menos conhecidos e promover negócios, especialmente no setor de turismo e hotelaria, aumentou. As empresas agora usam o meio digital para comercializar os seus produtos e serviços para atrair turistas e hóspedes e aumentar a receita que foi seriamente afetada durante a pandemia. Como resultado, este estudo sugere que os setores do turismo devem priorizar como a tecnologia e a comunicação/feedbacks digitais podem satisfazer as preferências e escolhas individuais dos clientes. Isto ajudará a aumentar a satisfação e a lealdade dos clientes.

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ABBREVIATIONS LIST

IoT	Internet of Things
UNWTO	United Nations World Tourism Organization
WIPO	World Intellectual Property Organization
GDP	Gross Domestic Product
PwC	Pricewater Cooper
PORDATA	Portugal Database
TAM	Technology Acceptance Model
AI	Artificial Intelligence
VR	Virtual Reality
AR	Augmented Reality
QRcode	Quick Response Code
NFC	Near Field Communication
RFID	Radio Frequency Identification
DMOs	Destination Marketing Organizations
GPS	Geographical Positioning System
ICT	Information Communication Technology

CHAPTER ONE

INTRODUCTION

The tourism and hospitality industry are a significant tertiary sector of a country because it contributes a higher percentage in the nation socio-economic (revenue and workforce) development. Tourism facilities include bar, tourist attraction centers, parks and garden, recreational centers, natural reserves, arts and cultural heritage centers. Hospitality sector refers to all the unit functioning in an accommodation facility either on land, water, or by air established to generate revenue and satisfy the comfort and relaxation desire of guest such as hotel, resort, apartment etc. By definition, tourism is the movement of people to places outside of their usual environment for not more than one consecutive year for leisure, business, or other purposes (UNWTO, 2017). This further classified the visitation of tourists within the national boundaries of the home country (domestic tourist) and the visitation of places outside the national boundaries (International). Certain motivating factors pull the desire of a tourist to want to leave the comfort of her home to visit an unknown/unfamiliar destination for site seeing and lodging.

The drive to acquire satisfaction motivates tourist to strives to survive by performing better in the tourist destination and the environment (Physical), the desire to bond (for friendships, trust, empathy and belonging) motivates individuals to make social contacts and relationships with others (Social), the desire to motivate tourist to want to understand, satisfy the curiosity and value the environment (Cultural), the drive to defend motivates tourist behavior to avoid the occurrence of danger from the other motivations (Personal) (Rivera, Chandler, &Winslow, 2010). The motivational factors of tourist visiting a destination is matched with the purpose of travelling, for example, for leisure, business, visiting and others. For these travelers, accommodation and tourist facilities are more than just a place but a destination, attractions and facilities (Heitmann, 2011). As a result, the development, promotion and effective management of tourist destinations are pull factors for a sustainable tourism industry (Heitmann, 2011). Sustainability is a concept of sustainable development. It refers to continuous development of a system, facilities, resources without jeopardizing its need in future and having a resistance capacity against external factors. In a socio-economic context, sustainability is not a fixed dimension, but rather a constantly

regenerating process of exchange within and across various societies (Knox-Hayes, Chandra, & Chun, 2020).

The adoption of technological innovation has influence tourism sustainability because of it increase in service demand from tourist offers, and its account for higher profit. It has helped to develop and manage tourism resources, facilitating a technology-mediated approach for tourists to relate to the destination (Loureiro & Nascimento, 2021). The application of technological innovations in tourism becomes very relevant in integrating the way business engage with customers, drive trends and competitiveness. Technologies like 3D printing and scanning technologies, virtual reality, Internet of Things (IoT), and tangible user interfaces are emerging innovations to enhance the tourism experience in airports, museums, and hotels (Özdemir, 2021).

Following the 2011, economic crisis faced in Portugal, the adoption of digital technologies, development of skills, and the promotion of investment and innovation were considered crucial measures put in place by the government to bail out from the economic crisis (OECD, 2012). In 2022, the GII, 2022 stated that the country innovation system occupies the 32nd position in the universe of 132 countries but in the same year, EIS 2022, showed that Portugal's performance is below the average of its group (Moderate Innovators) (85.8% vs. 89.7%) and that growth between 2015 and 2022 is below the EU average (6.4% vs. 9.9%) (WIPO, 2022). Despite her innovation growth occurring at a slower rate compared to her European counterparts with similar populations (Ireland, Belgium, and the Czech Republic), Portugal is one of the third country that gives proper recognition to wellbeing of her citizen, residence (PwC, 2023). Among the countries in the comparison (Ireland, Belgium, and the Czech Republic) which have not attained the levels of development far beyond the learning possibilities, Portugal has the lowest growth in GDP per capita (purchasing power parity) in the last four years (WIPO, 2022), and it has the most aged population in comparison to her European counterparts (Ireland, Belgium, and the Czech Republic) (CIA, 2023). Therefore, it is best to use this factor to understand why Portugal is lagging and has not advanced innovatively with its counterpart. The tourism industry in Portugal has given rise to impressive growth over the last few decades even during the economic crisis. It is currently one of the socio-economic sectors of the country that has required innovative strategies and create the opportunity for competitiveness within the economy (Lillebø, Heliana, Mariana, Javier, Martínez-L, Asya, Gonzalo, Pierre, & António, 2019). As the tourism and hospitality sector in Portugal starts to emerge from the effects of the pandemic, the business owners and stakeholders

were confident that tourism and hospitality businesses needed to be more technologically enabled and digitally enhanced to optimize business marketing, enrich connectivity and satisfaction with global tourists.

The advancement in services started in integrating sales and marketing with online platforms linked to internet and mobile access to boost the tourism and hospitality economy. Many of the larger firms seen the value of investment and potential of digitalization in transforming many aspects of customer interactions, along with the opportunities for big-data and analytics for tracking customer preferences and building ongoing relationships. This development was backed up by adding evolving advanced technologies like virtual reality (VR) and augmented reality (AR), artificial intelligence (AI), the 'internet of things' (IoT), to some aspects of workflow and task automation (OECD, 2021). The idea of cultural and heritage tourism activities performed in museums has now been considered a strong tool for smart city and a milestone of economic development (Angelidou, Karachaliou, Angelidou, & Stylianidist, 2017). This renowned interest in technological adoption from both domestic and international investors to invest in the country's tourism industry will contribute to the growth of the nation and the societies in which they are located, by offering jobs and also competitive development in tourism business.

Generally, worldwide, before the adoption of technologies, tourism business was monotonous in nature, they produce relatively low income and desires of leisure and relaxation. The advent of technological innovation in tourism and hospitality industry has set high expectation for guest and tourist from the facilities they visit and also a drive to revisit if such expectations are met. The opinion of consumers after they have consumed the tourism product and services is a key factor for business to improve customer's satisfaction and services. Primarily by 2028, it is projected that tourism would account for nearly 10% of global production (Statista, 2022). As at 2022, tourism activities in Portugal have contributed 8.8% to the national GDP and also accounted for 47.8% of total exports of services in same year (PORDATA, 2022a & 2022b). These revealed that the economy recovered from the downtown caused during the pandemic and tourism industry is still major contributing sector, both at global and national level. The global economy registering 6.02 % growth in GDP as at 2021 after the pandemic (IMF, 2021). As regards, the need to further adopt various types of technological innovations in addition to digitization such as Artificial Intelligence, Big Data Analytics, Internet of Things, Augmented Reality and Virtual Reality among others in the hospitality and tourism business has increased and consequently respond to different

tourist behaviors and preferences on their trips (Zeqiri, Dahmani, Ben & Youssef, 2020); Stankov & Gretzel, 2020)

The challenges related to researching the impact of technological innovations in tourism sector that needs to be considered are financial capacity, training and differentiated adaptation (beyond age and education) in order to enhance the diversification of tourism product, transform business operations and marketing, and on the other hand, change the consumer experience. The requirements of the European Union in the sphere of tourism and the prospects for development of national tourism are primarily expressed in the quality of the tourist product and the way tourism services are provided and the overall strategy has been prioritizing innovation, sustainability, accessibility, inclusion, and local community engagement with tourists (Ivars-Baidal, Vera-Rebollo, Perles-Ribes, Femenia-Serra & Celdran-Bernabeu, 2023); UNWTO, n.d.)

1.1 Research aims

This study aims to examine the influence of technological Innovations on the sustainability of tourism industry in Algarve, Portugal**.**

Specific objectives

The particular objectives we hope to accomplish with this study are:

- To identify the factors that influence technological innovations in tourism.
- To explore the types of technological innovations employed in the three selected tourism facilities.
- To examine the influence of these technological innovations on tourist behavior and engagement within different tourism facilities in Algarve.
- To investigate the impact of these technological innovations on tourism sustainability of the selected three tourism facilities.
- To identify the challenges facing the implementation of technological innovations in the selected three tourism facilities**.**

1.2 Research questions

What are the holistic contributing factors through which technological innovations contribute to tourism sustainability in Algarve, Portugal?

1.3 Problem statement

The tourism and hospitality industry are a significant contributor of economy development in Portugal. Since this sector has a huge effect on the country's economy, it is necessary to examine how the current era of technological and digital connectivity will influence the sustainability of this sector should there come an unexpected change in the near future with lessons learnt from the pandemic era. The types of services provided at different tourism and hospitality business is not uniform but one common goal they all share is to be more customer-centric, responsive, and relevant in maintaining customer satisfaction not only during guest stay but also for repeat patronage. Therefore, there is need to explore the competency of technology usage amongst the workforce, the level of use by customers, it's impact on product and destination development. To this end, this study was undertaken to broaden the space for digital engagement in tourism and hospitality firm with technological innovation. This study covered the city of Algarve in Portugal. A city booming with tourism and hospitality market for both domestic and international tourist

1.4 Significance of study

This study is significant as the basis of tourism development for countries that are in line with Portugal to provide developmental framework for the definition of policies to improve innovation in the tourism and hospitality sector. It is crucial to understand the combined effects of the implementation factors, trending technological type and customers perception in motivating them to revisit their choice of facilities, as well as to understand the sustainability for the future and what competitive advantage can the tourism business benefit to accelerate their continuous implementation of innovation and digital transformation. This study contributes to the literature with an insight on the influence of technological innovation in the tourism and hospitality business in Algarve, Portugal, and provides clues to entrepreneurs and governments on what to do better to contribute to creating a strong commitment to innovation, sustainability, accessibility, inclusion, and local community engagement with stakeholders, investors, hoteliers, guest and tourists, and business managers.

1.5 Justification of study

The justification of this research addresses a dynamic topic that has gained attention since the evolution of Generation Y (Millenials) contribution to digital transformation. Despite that the concept of innovation is evolving from a business perspective to regional, national, or global investment, Portugal has been registering a decrease in the various economic sectors that act as indicators in evaluating the country's performance. Examining how technological innovation affects tourism facilities is essential given the rapid digital development, in Algarve region, Portugal. The conventional tourism facilities cannot be sustainable and stay competitive without the feedback or preferences from tourist/guest experience through innovations which make this study relevant. Algarve is known tour destination in Portugal and recent trend in the adoption of emerging technologies influences its shift to improve guest/ tourist encounters and operational productivity. As a result, give stakeholders the opportunity to maximize their technological investments to the region of Algarve.

1.6 Research element

This work is made up of five main sections:

Chapter One: It presents relevant information on the background of the study, research aim and objectives and has explained the scope, significance, and justification.

Chapter two: It consist of the theoretical framework within the research background, existing literature review within the research scope.

Chapter three: It includes geographical information on the insight area, research design, and method of data collection and statistical analysis employed.

Chapter four: It presents the results and discussion from the statistical analysis carried out.

Chapter five: It presents the summary of findings, conclusion, limitations and recommendations that can be adopted for future responses.

CHAPTER TWO

LITERATURE REVIEW

Tourism is one of the prioritized activities and economic product for a nation cultural and economic development. This development directly or indirectly draw influence to the social and humanitarian services of the nation which it develops (Juvan, Podovšovnik, Lesjak, & Jurgec, 2021). The tourism industry is sensitive to changes in trends; therefore, stakeholders must consider trends to ensure prosperity and realize the impact of the relationships between socio-economic sectors and the synergy among tourism service providers and tourist experience to success of the tourism sphere (Ferreira, 2022). Following the hit on the tourism industry during the pandemic, the demand for digitalization in tourism begin to rise, all components of tourism have to adapt to a new normal to permit its return (Marques, Madrid, Haegeman & Rainoldi, 2020). Technological advancement and digitalization in tourist activity begin to significantly change the society, and contributes to meeting the needs of the population in spending leisure time in a meaningful way (Pecheniuk & Kisium, 2022).

Since the potential has been realized and the tourism and hospitality sector restored its operations, the situation is now optimal for satisfying demand for tourism and regaining its effect on the socioeconomic growth of the EU countries (Panasiuk & Wszendybył-Skulska, 2021). The financial capacity of the populace in developed and developing countries is influencing the cost of tourism products, how desirable they are to tourists, and how long it will continue to draw an increasing number of visitors (UNWTO, 2017). For example, Barcelona's tourism industry is concentrated on marketing the city to be more technologically savvy and tourist-friendly. As such, they wanted the city and its tourism assets to work together as a single, unified brand. The Virtual Tourist Office (VTO) created an initiative to provide information to tourists in a readily accessible manner. This entails using a bilingual mobile app that connects consumers to social media and provides easy access to a plethora of geo-localized tourism content. The city council also aimed to reinvent the city using technology, leveraging the notion of a creatively stimulating smart city. This featured a range of mobile device management, communication/collaboration tools, internal security, and identity services. (Microsoft, 2013).

2.1 Theoretical framework

The theoretical framework that has been developed to explain user adoption of new technologies and introduce factors that can affect the user acceptance of technological innovation in this study is Technology Acceptance Model (TAM) that was introduced by Fred Davis in 1986. TAM explains the motivation of users by three factors; perceived usefulness, perceived ease of use, and attitude toward use. Therefore, it is a belief that perceived importance and ease of use in technology have considerable impact on attitude of the users. Sometimes, other factors known as external variables (user training, system characteristics, user participation in design and the implementation process nature) are considered (LIN, 2016). TAM is probably one of the most widely cited models in the field of technology acceptance (WU, 2009). During the past decades, it received empirical support. Since TAM ignored the social influence on adoption of technology so it has limitations in being applied beyond the workplace. Besides, some variables as external variables need to be added to provide more consistent prediction of system use (Taherdoost & Masrom 2009). Since the intrinsic motivations are not addressed in TAM, the ability of TAM to apply in a customer context where the acceptance and use of information technologies is not only to achieve tasks but also to fulfil the emotional needs may be limited.

2.2 Tourism in Portugal

Tourism is defined as a temporary movement of people to destinations outside of where they normally live and work. The movement of people for tourism purposes may or may not involve overnight stays away from home (Cooper, 2006; Holloway & Taylor, 2006). World Tourism Organization defined tourism as activities of persons traveling to and staying in places outside of their usual environment for not more than one consecutive year for leisure, business or other purposes. At this stage, one could differentiate between domestic and international tourism (Yuksel, 2004). The former refers to travel exclusively undertaken within the national boundaries of the traveler's home country while the latter refers to travel within the borders of one's home country. The demand for tourism is based on the existence of different needs, expected result, motivations, and characteristics such as the price of tourism services offered, airline services, types of holidays or resorts chosen. The tourism opportunity should physically and socially correspond to identified demands different from the environment in which the prospective tourist resides (Truong, Lenglet & Mothe, 2018); Vigolo, Simeoni, Cassia & Ugolini, 2018). Travel motivation

for tourists can be factored based on his/her leisure time and disposable income. They are called facilitators because they are factors that may facilitate or enable individuals to travel (Hall, 2008).

Tourism will only be sustainable if it's development and management is in consideration with both visitors and local communities (UNWTO, 2018). The tourism plan should also encapsulate the protection of natural, historical, and cultural resources and long-term tourism product marketing, improvement in the technical facilities and social conditions of tourist activities (Fyall *cited in* Fayos-Solà & Cooper, 2019, pp 271-283). The promotional aspect should be geared towards enhancing the existing tourist facilities and developing new areas; control over factors that adversely affect the environment; ensuring the adequate provision of transport and communication systems. Therefore, the hospitality industry should re-orientate its development towards tourist needs, such as models, structures, technology, and management skills (Fyall *cited in* Fayos-Solà & Cooper, 2019, pp 271-283). Tourism is an industry with a vast product marketplace which includes several players such as airlines, hospitality suppliers, rental suppliers, etc. The application of digital innovation in tourism marketplace have increasingly come to the frontline and have the potential to maximize customer satisfaction, loyalty, and usage not only during guest stay but also for repeat patronage. This shift come with financial capacity and leveraging the right enabling technology to broaden the space for digital engagement in tourism and hospitality firm with technological innovation address not only current competition and issues but also prepare for future changes and threats in the external environment. (Lam & Law, 2019). These changes have capitalized changes in the business environment to sustained success (Zheng Xiang, Vincent & Fesenmaie, 2014).

The coronavirus (COVID-19) pandemic in 2020 caused the Portuguese tourism industry's yearly sales to fall to fewer than 15 billion euros. Portugal experienced a recovery of over 30 percent in the total travel and tourism contribution to its gross domestic product (GDP) in 2021 post-pandemic with August reaching the annual peak of 1.96 million traveler. (WTTC, 2024). Around 18.9 billion euros were made in Portugal in 2021 from the sale of tourism services, a 26.5 percent increase from the year before. In 2022, Portugal's tourism services generated a sales revenue close to 33 billion euros with increase from international overnight visitor signalizing the start of the recovery for this sector (researchhub.wttc.org). Tourism service sales income increased gradually to 38.7 billion euros in 2023 (Statista, 2024). 2024 saw a record 10.5 million overnight stays, up 3.8% from the year before. 6.9 million overnight stays were made by foreign visitors,

while 3.6 million were made by Portuguese citizens, a 4.6% increase over the previous year. While not every region had increase, Algarve continued to be Portugal's most popular travel destination, with 3.2 million overnight stays by the 2024 quarter (ETIAS.COM, 2024).

This increasing growth and economic contribution of the tourism and hospitality industry in Portugal is known world-wide and has greatly increased the inflow of foreign visitors each year. Therefore, it is significant to realize the importance of the contribution of travel and tourism by residents and non-residents to tourism development plans or programs in the long term. According to the National Institute of Statistics, the motives for tourists traveling to Portugal are for leisure, recreation, and holidays but tourists by resident's travel to visit families or friends, both types of tourists are significant tools for tourism development in Portugal. Domestic tourism provides job opportunities to the residents and also generates opportunities for the visiting tourists to spend their holidays in Portugal even in off-season months (Camilleri, 2018). Tourism industry in Portugal is in a very competitive world, technological innovation is increasing becoming a significant adoption in most tourism facilities (Cooper, 2006).

Tourism entrepreneurs are beginning to understand that technological innovations are capable of generating a competitive advantage thus increasing the value of their products and services (Trimarjoko, Hardi & Aina, 2021). Countries like Portugal with a strong domestic tourism sector are usually better prepared to endure fluctuations in international demand due to economic depression, terrorist attack or even natural disaster. In Portugal, particularly Algarve, it is one of the country's most visited Tourism spot with main economic activities and a strategic area for the competitiveness of the economy (Lopes-Costa & Munoz-C, 2015). It has yielded impressive growth in the last decades especially during the economic crisis, making it a milestone for economic development. The digital transformation of tourism facilities in Portugal is set on three main vision (i) to be one of the fastest growing touristic destinations in Europe through (ii) a qualified and competitive offer which will (iii) transform the sector in one of the Portuguese economic growth drivers (Turismo de Portugal, 2017). However, the tourism sector shouldn't be considered only as a tool for leisure or attractions, but as institution for research and innovation strategies. The reason for this concept is to apply the principle of concentrating knowledge and resources to various tourism facilities and not limiting the number of economic activities that will maintain competitiveness in the global economy in the region (Lillebø, Heliana, Mariana, Javier, Martínez-L, Asya, Gonzalo, Pierre & António, 2019).

2.3 Technological innovation in tourism and hospitality facilities

Innovation can be defined as the process of conception, development, or management of activities and that results in the commercialization of new or improved products (Matsuo, 2006). Innovation means: (i) the renewal and enlargement of variety of products and services within the associated marketplace; (ii) the establishment of new methods of production, supply and distribution; (iii) the introduction of changes in management, work organization, working conditions and skills of the workforce (European Commission, 2004). Tourism sector can offer both services and products because it encompasses of tangible and intangible elements. The intangible elements are the services or characteristics embodied in tourism personnel being offered to tourist while the tangible are the tourism products, both elements have the capacity to influence the tourist and tourism experience (Weiermair, 2006). The technological advancement that affects the profitability and sustainable operation of tourism businesses includes WOM, online reviews, digital or communication platforms, geotag, e-services, augmented reality, virtual reality, interactive mobile applications to mention a few. The increase in the penetration of artificial intelligence technologies into the operation of modern tourism companies and marketing in tourism have helped to understand tourists in a better and more comprehensive way (Loureiro & Nascimento, 2021). Destination management organizations (DMOs) and tourism businesses are increasingly investing in cutting-edge technologies to foster creativity and develop solutions to meet the demands of tourist. The mobile applications, wearable devices, empower tourists with real-time information and personalized recommendations (Loureiro & Nascimento, 2021). It also eases itinerary planning and provide navigation assistance across various touchpoints of their journey, thereby enhancing their overall satisfaction and engagement during their visit including pre-trip planning, on-site activities, and post-trip engagement (Buhalis, 2020).

Digital transformation is a fundamental change process that enables the innovative use of digital technologies accompanied by the strategic leverage of key resources and capabilities, aiming to radically improve an entity and redefine its value proposition for its stakeholders (Gong & Ribiere, 2021). Tourism entrepreneurs are adopting various digital innovations, implementing new value chains, and facilitating personalization of tourists' experiences to meet the global trend (Buijtendijk, Heiningen & Duineveld, 2021). The transformation into digital world has the potential to interfere with existing organization and management structures of the business, i.e

employees need to respond to ongoing change stemming from digital transformation and to develop digital mindsets (Solberg, Traavik & Wong, 2020). Technological innovations in tourism facilities largely depends on level of heterogeneity. The tourism facilities established on a non-innovative basis and with less-skilled workers and low quality of hospitality services will have low survival rate in the innovative competitive market while the one that invest in quality and product diversification are more competitive. The former is more common in small medium enterprise (SME's), and can restrict innovation in the sector. Therefore, competitiveness within the tourism sector and its adaption to new market environments depend on investing in the quality of staff and managers (OECD, 2000). In fact, the determinants of innovation in tourism sector are stakeholders that are not directly related to the tourism industry. These agents or stakeholders develop innovation through their investment and interaction with the tourism entrepreneurs (Hjalager, 2002).

The classification of innovation types for the tourism sector are:

i. Product innovation (an incrementally changed or radically new good or service that can be commercialized);
ii. Process innovation (the implementation of an incrementally changed or radically new production process or delivery method);
iii. Organizational innovation (the implementation of a new or incrementally changed organizational method or managerial form) and
iv. Marketing innovations (the implementation of a new or incrementally changed marketing strategy that develops the sales market)

2.3.1 The types and impact of technology driven innovations in the hospitality industry

Information Communication Technology

The massive progress of Information Communication Technology (ICT) positively affects the tourism industry through several channels. ICT is used by tourism firms as a tool for promotion through online platforms. In addition to this, it can be used for trading or providing information to consumers about the product or service they offer (Agiomirgianakis, Bertsatos & Tsounis,2018). For instance, photo and graphic designs, GPS, google maps or other real-time crowd control technologies, or even recommendation and booking information, offer tools for a tourism business to apply its marketing more

efficiently and increase the prospects being chosen as a travel destination. The use of ICT in the tourism industry has been found to boost tourism demand (Adeola & Evans, 2020). ICT is also considered as a factor that significantly affects tourism, travel, and other related industries and can improve the quality of the provided tourism services for specific sectors, such as medical tourism (Adeola & Evans, 2020). The positive effects of ICT apply not only in the short run but also in the long-term suggesting that the proper use of ICT can become an asset of tourism firms towards achieving sustainable tourism development (Kumar, Stauvermann, Kumar & Shahzad, 2019).

Social media

Tourists should maximize their satisfaction and utility when they visit a destination, without polluting the environment and with every respect to the local communities. Towards this direction, information provided via social media by tourists, local residents, or even professionals in the field of tourism can assist in restarting tourism (Zarezadeh, Rastegar & Gretzel, 2018). Taking into account the fact that the current generation uses social media on a daily basis, it is easily understood that social media can promote responsible behavior for sustainable tourism. Social media plays a significant role in many dimensions of tourism and in the communication and interaction process with the consumers (Zeng & Gerritsen, 2014).

Internet and websites

Tourists change their ways of thinking before, during and after a trip as a result of the use of internet. Within this framework, it seems appropriate to incorporate into our analysis the impact of the internet on the tourism industry. Digital technologies have altered the way we approach a destination, and the massive use of the internet certainly is a factor that all firms should consider, adjust for and make the best use of it (Gössling 2020). In addition, the websites of tourism companies can affect the decisions of customers in various ways. The attainment of the information, the evaluation of the alternatives or even the purchase of a tourist product (trip or holiday package) are often the outcome of using a website and other internet tools. Undoubtedly, the internet and websites are also employed as a marketing tool so as to promote a tourism destination (Türker, 2020).

Mobiles and smartphones

Mobile phones and smartphones, with their applications, have significantly involved the tourism process, since they enhance the trip experience and influence tourist behavior by implicitly affecting their judgment and choices. In general, it has been reported that mobile phones and broadband subscriptions have a positive impact on tourism demand (Kumar et al., 2020). More specifically, the development of mobile applications for travel organizations and movement, and even QR codes, are some ways in which travelers' satisfaction is boosted (Lalicic & Weismayer, 2016).

Hotel Guest Technology (HCT) refers to the technologies adopted in hotels with the intention to enhance customer experience in rooms (Cobanoglu, Berezina, Kasavana & Erdem, 2011). These technologies are highly valued by guests and has a positive impact on customer satisfaction and are factors that affects customers' hotel selection (Bilgihan, Smith, Ricci & Bujisic, 2016). However, while hotels continue to increase their investments in adopting technologies, there was limited understanding of its impact on customer's satisfaction and dissatisfaction which may result in retardation of tourism facilities. For example, TV has become a standard technology offered in every guest room, enhancing customer experience. However, malfunctions or limited entertainment offered through TV can lead to customers' complaints (Terry, 2019). While the wide connectivity of technological devices in hotel rooms can increase customers' convenience, it can also incur customers' concerns about security and privacy leading to guest dissatisfaction (Patel, 2019). There are four categories of hotel guest technologies are in-room technology, comfort technology, business essentials, and internet access.

i. In-room technology includes entertainment in hotel guest rooms, such as pay-per-view movies, game consoles, and fitness systems (Bilgihan et al., 2016).
ii. Comfort technology includes technological services that support customers' having a comfortable and convenient stay in guest rooms. These technologies may include electronic safes, control panels, mobile key cards, and TV (Cobanoglu et al., 2011).
iii. Business essentials are technologies specially offered for business travelers, such as business centers (e.g., computer, copy machine), express check-in/out, phones, alarm clocks, and outlets (Cobanoglu et al., 2011).
iv. Internet access includes high-speed internet and wi-fi services (Bilgihan et al., 2016).

Following the four classifications of innovations, the value of innovative technology is very important to guests and this provide insights into how hotels can use technology to enhance guest satisfaction and loyalty (Lam & Law, 2019). The adoption of innovative technologies in hotels has grown in recent years, which have in turn ushered in the consumption experience, streamlined operations and increase profitability (Ruiz-Molina et al., 2018). Technologies such as:

i. Mobile apps: The designated mobile app for each tourism facilities allow guests to check-in and check-out, order room service, and access hotel amenities through their smartphones. Likewise, the keyless room entry systems, using mobile devices or RFID technology, are becoming more prevalent in hotels thereby allowing guests to unlock their rooms with their smartphones (Law, Cheng, Chan & Wang, 2018)
ii. Self-service kiosks expedite the check-in and check-out process and reduce the need for front desk staff. In-room technology, such as smart TVs and voice assistants, are also becoming increasingly popular, enabling guests to access entertainment and information or control room features like lighting and temperature (Hao & Chon, 2022).
iii. Guest service robots are able to assist with room service, housekeeping, and concierge tasks, improving the efficiency of hotel operations. Energy-efficient systems reduce the hotel's environmental footprint and operating costs These technologies offer guests a more personalized and enjoyable experience while also enabling hotels to operate more efficiently and cost-effectively (Lee, Lee, & Kim, 2021).

Since some of these technologies are not as widespread in homes as they are in hotels, and majority of these customers are interested in the digital world, they will consider them priority technologies to be available in their lodging hotel increasing the demand for them giving hotels a competitive advantage (Femenia-Serra & Neuhofer, 2018).

2.4 Tourism sustainability

The use of digital technology has the potential to significantly impact the sustainability of tourist destinations, both positively and negatively (Neumannová, 2022). However, limitations in using

technology for sustainable tourism can stem from a variety of reasons, such as insufficient experience and training of destination managers; a lack of understanding and unwillingness to change established practices among destination managers, residents and visiting tourists in the destination itself. Sustainable tourism has gained significant attention in recent years as a means of balancing economic development. A tourism destination can be said to be sustainable when it maintains balance between meeting the needs of tourists and host communities while preserving natural and cultural resources for future generations with environmental protection and cultural preservation (Lozano-Oyola, Francisco, Mercedes & Rafael, 2012). Sustainable tourism destinations refer to locations that prioritize environmental, social, and economic sustainability to ensure long-term viability and minimal negative impacts on the environment and local communities (Juandi, Andari & Setiyorini, 2018); Purwanda & Achmad, 2022). Technology adoption has the potential to support sustainable tourism practices by improving operational efficiency, reducing waste and emissions, and enhancing the tourist experience (Pan, Mengyao, Hyunook, Kinjal, Shah, Si-Lu, & Pen-Chi (2018). However, this potential can both positively and negatively impact the sustainability of tourist destinations, hence the need for a comprehensive understanding of the importance of responsible and sustainable practices in the tourism industry. The adoption and implementation of digital technologies in sustainable tourism destinations is still in its infancy (El Archi, Brahim, Kai Zhu, Zineb, László & Lóránt Dénes, 2023). Tourism businesses take into consideration the buying behavior of the tourists i.e the patronage power of tourism products or services (He, He & Xu, 2018). Meeting the needs of consumers can lead to a competitive behavior, which is why the economic dimension of sustainable tourism discussed the multiplying effect has multiple variables which have positive impact on the local community by increasing in the number of jobs, and in the number of small producing enterprises.

Sustainable development is a middle ground between the economic and the natural environment and it also represents an essential element in order for tourism to unfold in conditions that are friendly to the environment. The economic development of a region is largely depending on the efficiency of the production factors such as capital goods, land and labor, which relates to tourism (Dans & Gonzalez, 2019). With regards to the quantitative development of the tourism, this can be understood through the increase in the number of tourism types, in the services provided, and through tourist numbers. The qualitative development targets the intangible hospitality services provided to the tourist/visitors. Thus, there is an interdependent and an inter-

conditionality relationship between long-term development and sustainability, because tourism cannot be efficient on the long term without respecting these two conditions. Both sustainability, and long-term development are focused on the impact tourism might have over the environment and not on the impact tourism has on the economy (Lane, 2018).

The term "sustainability" is used in tourism from a psychological perspective, challenging the conscience of the tourists to consume responsibly the available resources (Pulido-Fernandez, Cardenas-García & Espinosa-Pulido, 2019). At the same time, the effects of globalization can also be felt in tourism, through the touristic service providers at a global level, but not limited to them. Emigration, for instance, has also seen increasing numbers, leading to both positive and negative outcomes in various fields. Some of the benefits of globalization are the opportunities for diversifying income sources through a more efficient usage of terrains and through the recovery of the eco-systems. (Aryal, Cockfield & Maraseni, 2018). Sustainable tourism is a process for tourism institution to be more responsible in policies and forms of corporate governance (Niñerola, Sánchez-Rebull & Hernández-Lara, 2019). To achieve tourism sustainability, it is crucial to develop collective plans to implement the pillars of sustainability i.e economic, environmental, social. However, supposing the stakeholders, e.g., a part that has an interest and can either affect or be affected by the sector policy, do not have shared visions on sustainability, in this case, governance faces significant obstacles, such as the difficulty to influence the private sector to implement strategies sustainability which should have been the priorities of the supposed stakeholders (Bramwell, 2011).

The role of stakeholders in sustainable tourism strategies is important for perceived self-efficacy influence and the capabilities and motivation to influence business managers to behave sustainably (Waligo, Clarke, & Hawkins, 2015); Kornilaki, Thomas & Font, 2019). There is a need for consensus between the government and stakeholders to better understood the difficulties in sustainable tourism policies and design adequate measures and plans (Kubickova & Martin 2020). For instance, implementing green marketing strategy based on a shared vision can help to define and implement a sound strategy, harnessing the capability of fast response to new environmental technologies and challenges, understanding the supply side of the tourism equation, like hotels and restaurants (Benur & Bramwell, 2015; Romero & Tejada, 2020)

CHAPTER THREE

METHODOLOGY

This chapter covers the research design to investigate the Influence of Technology Innovation on Tourism Sustainability: An insight into Algarve, Portugal. It explains each component of the questionnaire design, sampling, questionnaire administration, data analysis, and limitations. Each component is critical for assuring the study's findings' validity and reliability.

3.1. Research design

Quantitative research design is adopted in this study in which descriptive method is used to display analytical results and inferential statistics is used as mode of data analysis. Through empirical observation and the application of quantitative methods, the statistical analysis permits the gathering of objectively analysable numerical data.

3.2 Data collection

Quantitative data collection method is adopted for the study. The researcher designed a self-reporting scale and semi-structured questionnaire for the collection of responses from respondents from the key variables (technological innovation and tourism sustainability), impact and challenges prevailing in this study.

The questionnaire (Appendix A) is structured into sections to cover the objectives of study. The questions in each section are constructed into three reporting scale items: close-ended questions, fixed choice questions (yes or no), and double-barreled questions (questions with more than one question part) to provide quantitative data that will help answer the specific objectives guiding the study. The Likert form scale is used, such as (0=nothing at all – 6= Extremely), to rank each respondent’s opinion.

The sections include:

Section A: Socio demographic data
Section B: The factors that influence technological innovations in tourism.
Section C: The types of technological innovations
Section D: The influence of these technological innovations on tourist engagement.

Section E: The impact of these technological innovations on tourism sustainability.
Section F: The challenges facing the implementation of technological innovations.

A first version of the questionnaire was sent to a group of 10 respondents, not included in the target population, in order to check the clarity of the questionnaire and the need to correct any questions. Minor adjustments were made based on feedback received.

3.3 Population and sample size

Population sample refers to the population of respondents to which a researcher wants to base the objectives of the study (Bhardwaj, 2019). Convenience sampling method was employed to select respondent amongst the tourist, hotel guest, travelers that visited the three tourism facilities at the time of study. Data was collected from 95 participant conveniently**.** Conveniently collected data may lack generalizability but are considerable & reliable for collecting data from participant that are in motion (Cheah & Phau, 2011).

3.4 Data analysis

The dataset was exported to Excel for initial cleaning and then analyzed using Python (pandas, seaborn, and matplotlib libraries) for data processing and visualization. Descriptive statistics such as means, medians, and standard deviations were calculated for each factor influencing technological innovations in tourism, including government support, internet infrastructure, IT skills, and others. Frequencies was used to determine the number of responses falling into specific categories or response options. This will allow for a better understanding of the distribution of responses and highlight any patterns or trends that may emerge. The mean indicated the level of tourist engagement with the adoption of technological innovations. Standard deviations quantified the variability of the data points around the mean, providing insights into the degree of variation in response amongst the three facilities. Correlation analysis of relationships between factors were examined and visualized through a correlation matrix heatmap to determine interdependencies and intensity of challenges across facilities. Comparative analysis on perceptions of sustainability across facilities were compared using descriptive statistics and comparative table to summarize the sustainability metrics

3.5. Validation of the instrument

Validity and reliability were ensured by designing the questionnaire to cover the aim and objectives of the study. The first draft was given to the supervisor to read through and make corrections. All odds questions were reconstructed to ensure clarity of the data collection. In addition, the researcher conducted a pilot study to the supposed revealing case study tourism and hospitality facilities before the main data collection started. We observed that the Faro story spot isn't has populated and mostly visited on regular basis by tourist so there was expectation to draw smaller sample of respondent from the facility. At Faro airport and Conversas De Alpendre hotel because of the large number of patronages, the appropriate management body was met to validate the purpose of data collection and confidentiality policy.

3.6. Ethical considerations

Ethical principles guiding the use of human participants in studies were followed in this study. As the respondent to be included are tourist and hotel guest visiting the case studies, consent was therefore sought from them verbally before administering questionnaire to them. Those unwilling to participate in the survey were excluded.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION

This section includes the analysis result of the data collected across the three selected tourism facilities in Algarve. The dataset was exported to Excel for initial data inspection and data cleaning. After cleaning, 2 out of 95 data collected was deleted because of missing values and identified errors, the total of 93 data was analyzed. For visualizations, tables and bar charts were used to visualize the result from demographic profile of respondents, factors, technologies, and challenges Heatmaps were used to display correlation and challenges,

4.1 Demographic characteristics

The survey results showed in Table 4.1 below displayed the demographic characteristics of the respondents and offer valuable insights into age, gender and Income level distribution. There is a balanced gender representation (51.6% male, 49.4% female), with a minor non-disclosure rate (1.1%). Middle-aged adults (36–50 years) are the most engaged in tourism (42.9%), followed by young adults (26–35 years) at 35.2%. Both older adults and younger individuals (above 50 and below 25 years) represent smaller segments (12.1% each). Income data reveals that 68.1% of respondents earn ≤ $50,000, highlighting Algarve's appeal to lower to middle-income tourists, while higher-income brackets remain less represented.

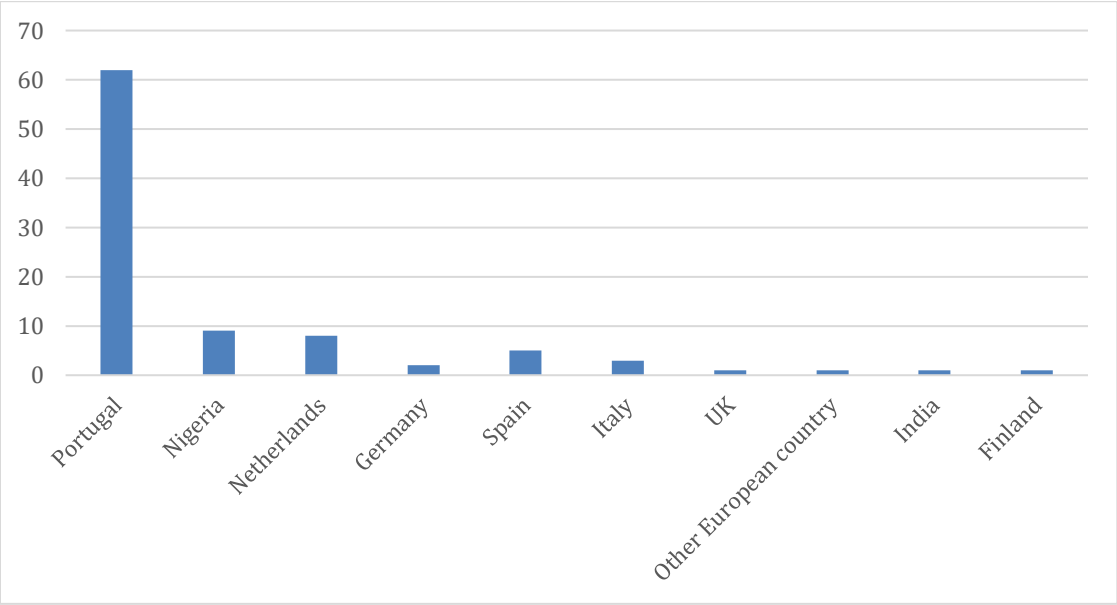
Table 4.1: Gender, Age and Income Distribution of respondents

Gender	**Count**	**Percentage**
Male	47	51.6
Female	45	49.4
Prefer not to say	1	1
Age Group		
36–50 years	39	42.9
26–35 years	32	35
Above 50 years	11	12
Below 25 years	11	12
Income Level (Annually)		
≤ $50,000	62	68
$50,000–$70,000	20	22
$70,000–$90,000	7	7.7
Above $90,000	4	2

Distribution of respondents by country

The distribution displayed in Figure 4.1 below highlighted the predominantly local nature of tourism activities in Algarve, with international visitors contributing a smaller, yet diverse, demographic. These demographic patterns provide essential context for understanding the characteristics of the tourists who are likely to engage with technological innovations in tourism. The findings suggest that technology adoption in tourism is largely influenced by middle-aged adults from diverse income backgrounds, with a notable inclination toward digital engagement in both middle and lower-income groups.

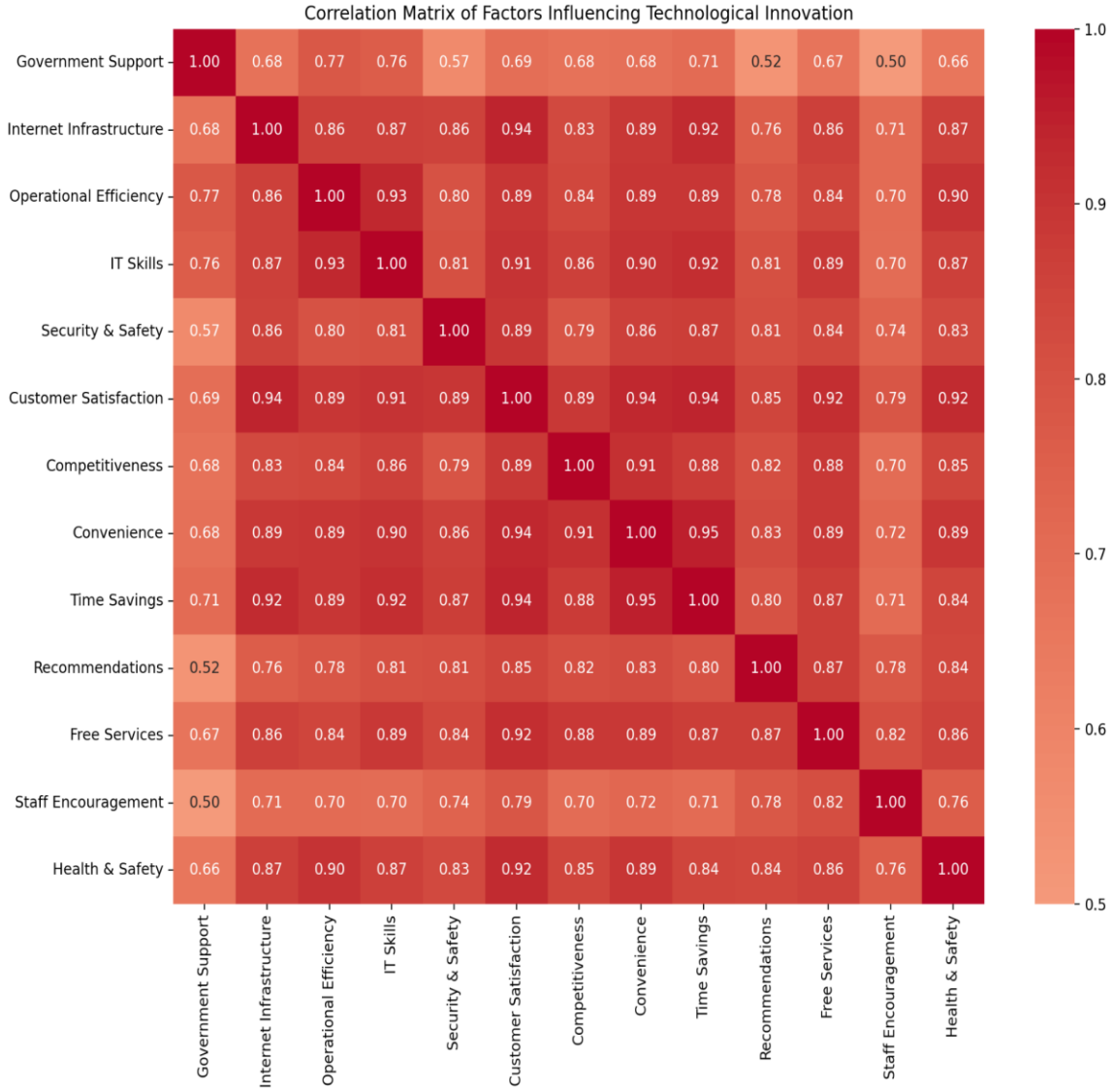
Figure 4.1: Distribution of respondents by country



4.2 Factors influencing technological innovation

Based on the correlation matrix analysis in Figure 4.2, the research findings reveal significant insights into the interconnected factors driving technological innovation in Algarve's tourism sector. The analysis demonstrates a complex web of relationships among thirteen key factors, with particularly strong connections emerging around digital infrastructure and customer-focused elements. The darker tones affirm strong interdependencies while lighter tones indicate areas where influence, though positive, is less dominant. Overall, the findings suggest that successful technological innovation in Algarve's tourism sector requires a holistic approach. The interconnected nature of these factors means that improvements in one area, such as digital infrastructure or staff training, are likely to have cascading positive effects across multiple aspects of tourism operations. By addressing these interrelated factors collectively, stakeholders can enhance the sustainability and competitiveness of tourism in Algarve.

Figure 4.2: Correlation matrix of factors influencing technological innovation



The correlation co-efficient Table 4.2 below revealed positive relationships of the factors influencing technological innovation adoption analysis matched with the heat map above. The most significant correlation is between convenience and time savings (0.945), this suggest that improving convenience directly leads to increased time savings. It is identified with the most intense shading in the heat map. On the other hand, the correlation between staff encouragement and operational efficiency (0.703) showed weaker but significant correlation, and the lighter shading in the heat map for this pairing visually emphasizes its comparatively lesser impact than other variables.

Table 4.2: Correlation Co-efficient

Factor Pair	Correlation Coefficient	Interpretation
Internet Infrastructure & Customer Satisfaction	0.944	Strong positive relationship.
Convenience & Time Savings	0.945	Convenience strongly enhances time-saving benefits.
Operational Efficiency & IT Skills	0.933	IT skills significantly improve operational efficiency.
Health & Safety & Customer Satisfaction	0.923	Health & safety measures strongly impact satisfaction.
Staff Encouragement & Operational Efficiency	0.703	Staff encouragement has a moderate influence.

The average score and standard deviation ratings in Table 4.3 below revealed compelling insights into stakeholder priorities and industry dynamics. The comparatively low standard deviations findings show that responses are consistent. This paints a comprehensive picture of how various factors influence technological innovation in tourism, with a clear emphasis on customer experience and basic infrastructure needs over institutional support mechanisms. This understanding can guide stakeholders in developing more effective strategies for technological implementation and policy development in the region's tourism industry.

Table 4.3: Importance of factors influencing technological innovation

Factor	Mean Score	Standard Deviation
Convenience	5	0
Time Savings	5	0
Internet Infrastructure	4.9	0.1
Security & Safety	4.9	0.1
Customer Satisfaction	4.8	0.1
Health & Safety	4.8	0.1
IT Skills	4.7	0.1
Operational Efficiency	4.7	0.1
Free Services	4.6	0.1
Competitiveness	4.6	0.1
Recommendations	4.5	0.1
Staff Encouragement	4.5	0.1
Government Support	4.4	0.1

4.3 The technological innovations used in the selected facilities

This Table 4.4 below provided a distinctive pattern in the types and levels of technological innovations each facility leverages to enhance their operations and visitor experiences of employed, reflecting the strategic priorities and customer-focused approaches of the three selected tourism facilities. This pattern suggests a strategic approach to digital transformation, where facilities prioritize technologies based on their specific operational needs and customer expectations rather than pursuing comprehensive digitalization uniformly across all areas.

Table 4.4: Type of technology innovation at the selected facilities

Technology Type	Faro Airport (%)	Conversas de Alpendre Hotel (%)	Faro Story Spot (%)
Smart room controls	39	56.5	4.3
Keyless Entry	52.8	43.4	3.8
Mobile check-in/check-out	69.2	23.1	7.7
Digital guestbook/concierge services	50	44.2	5.8
Virtual tours of local attractions	57.1	25	14.3
Contactless Reservation and Registration	58.5	33.8	10.8
Contactless payment with bill updates	55.3	36.8	7.9
Room Personalization (Master Remote control)	47.1	47.1	5.9
Online check-in	73.2	21.1	5.6
Contactless payment	73.1	23.9	6
Digital flight status notification	80.9	14.3	7.1
Self-service kiosks	83	12.2	4.9
Biometric e-gates	76.3	18.4	7.9
Mobile boarding passes	81.3	14.6	6.3
Smart luggage tracking	65.4	30.8	3.8
RFID baggage tracking	64.3	28.6	7.1
Automated parking systems	62.5	30	7.5
Audio guides via mobile apps	63	28.3	10.9
Interactive exhibits (VR/AR)	57.1	25	14.3
Online ticket booking	66.2	25.7	8.1
Automated Restaurant Reservation systems	50	41.3	10.9
Digital signage with historical information	53.8	32.7	15.4
QR code-enabled information points	58.3	33.3	11.1

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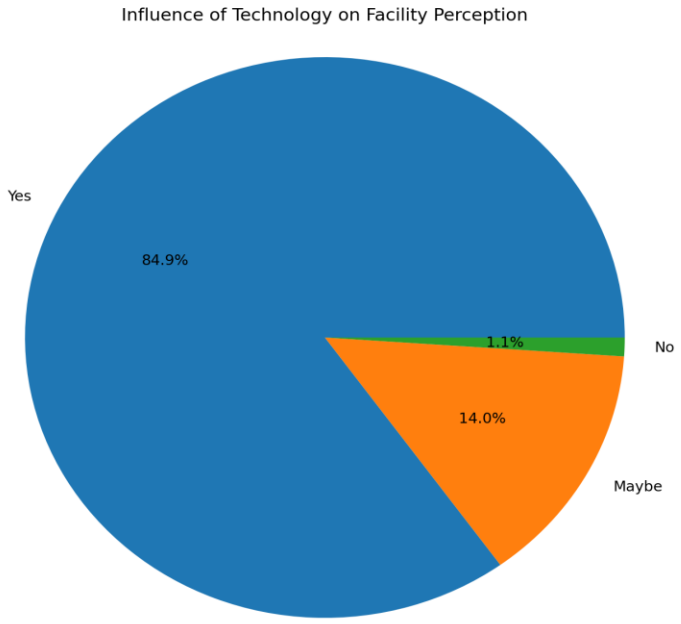
4.4 Influence of technological innovation on tourist behaviour

As seen below in the chart on Figure 4.3**,** the overwhelming majority of visitors (84.9%) indicated that technological innovations positively (Yes) influenced their perception of tourism facilities, while 14% expressed uncertainty (Maybe), and only 1.1% reported No influence.

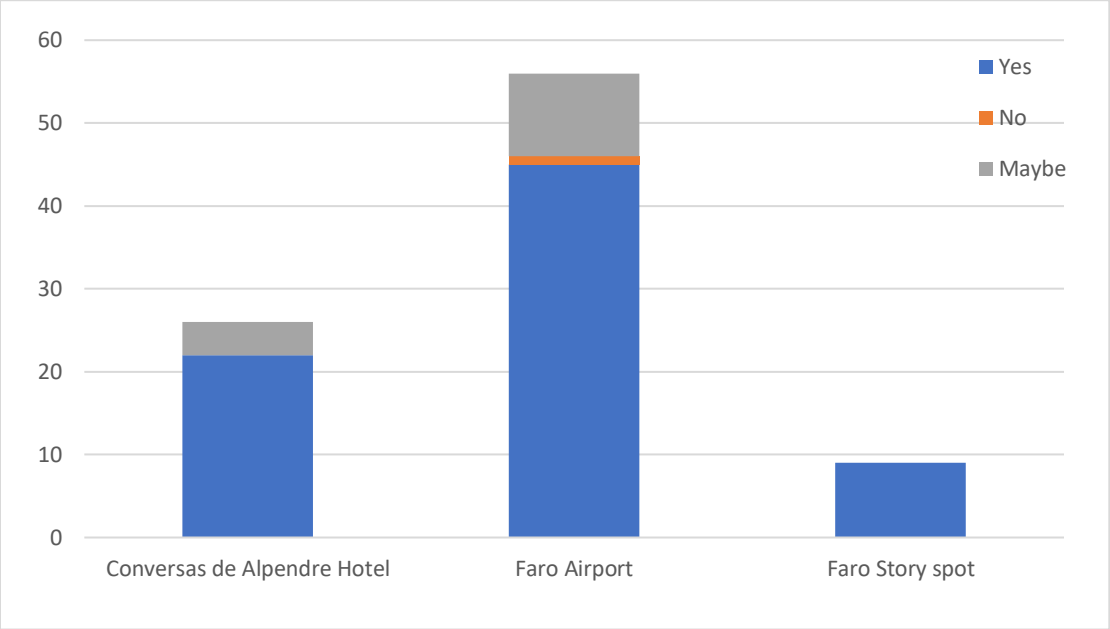
Figure 4.3: Technology influenced perception of tourist on the three facilities



Influence of technology on each facilities

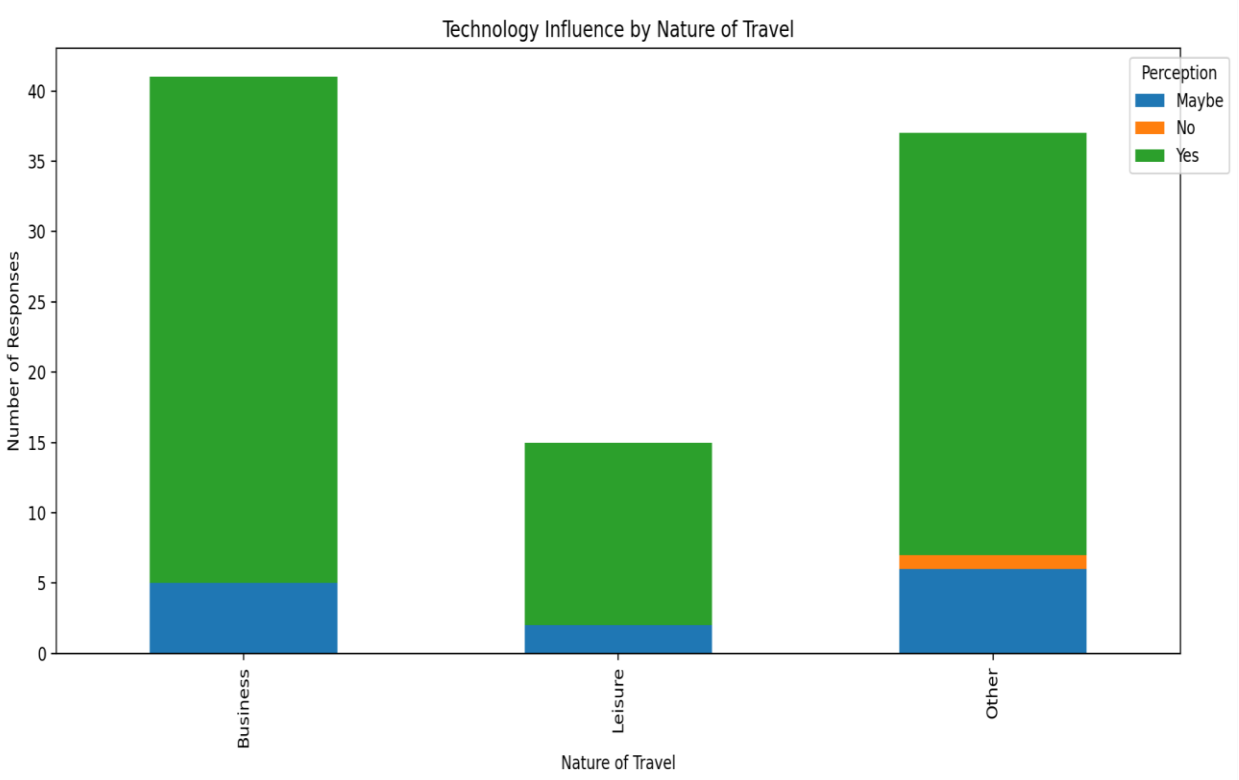
In Figure 4.4 below, the varying levels of technological influence across different facilities. Faro Airport demonstrates the highest level of positive engagement, with approximately 55 responses indicating satisfaction. Conversas de Alpendre Hotel follows as the second-highest in positive responses, with approximately 25 affirmations. Faro Story Spot, despite having a smaller sample size, maintains a consistent positive influence.

Figure 4.4 Influence of technology on each facilities



The labeled Figure 4.5 chart below provided detailed insights into the influence of technological innovations on tourist behavior, categorized by travel purpose. Notably, airport users demonstrate the highest engagement with technology, while hotel guests express strong appreciation for hospitality-focused innovations. Visitors to cultural facilities, such as Faro Story Spot, also respond positively to experience-enhancing technologies tailored to their needs. The findings reveal that technological innovations are effectively influencing tourist behavior and engagement across Algarve's tourism facilities, with particularly significant impacts observed in structured environments such as airports and hotels.

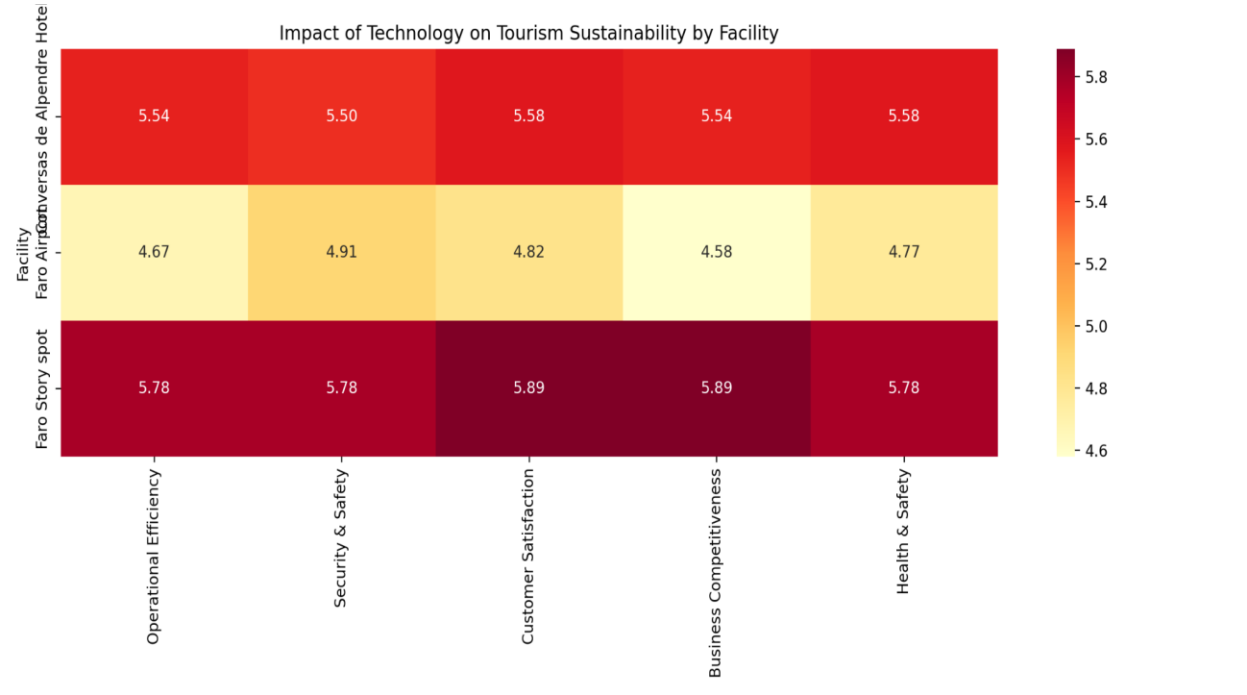
Figure 4.5: Technology influenced by nature of travel



4.5 Impact of technological innovations on tourism sustainability

From the heat map in Figure 4.6 below, Conversas de Alpendre Hotel performed higher in health and safety and customer satisfaction (5.58 each), with lower but high results in operational efficiency, business competitiveness (5.54), and security (5.50). This demonstrates efficient technological integration in hospitality for sustainability and service excellence. Faro Airport has a modest score of 4.91 for security and safety and 4.58 for business competitiveness, suggesting that it could do better at maximizing the use of technology in transportation. Overall, technology advancements continuously improve customer happiness, while safety and health play a major role in sustainable operations. Transportation is not as competitive as the hospitality industry.

Figure 4.6: Heat map showing impact of technology on tourism sustainability



Sustainability impact metrics

Table 4.5 below provided a comprehensive understanding of the influence of technological innovations on tourism sustainability across the selected facilities in Algarve. Overall, the findings illustrate that technological innovations have positively influenced tourism sustainability in Algarve, though the degree of impact varies by facility type and operational focus. Cultural tourism facilities, such as Faro Story Spot, appear to benefit most significantly from these advancements, indicating that targeted and context-specific technological applications can maximize sustainability outcomes. This emphasizes the importance of aligning technological strategies with the unique needs and characteristics of each tourism facility to achieve optimal results.

Table 4.5 Sustainability impact metrics

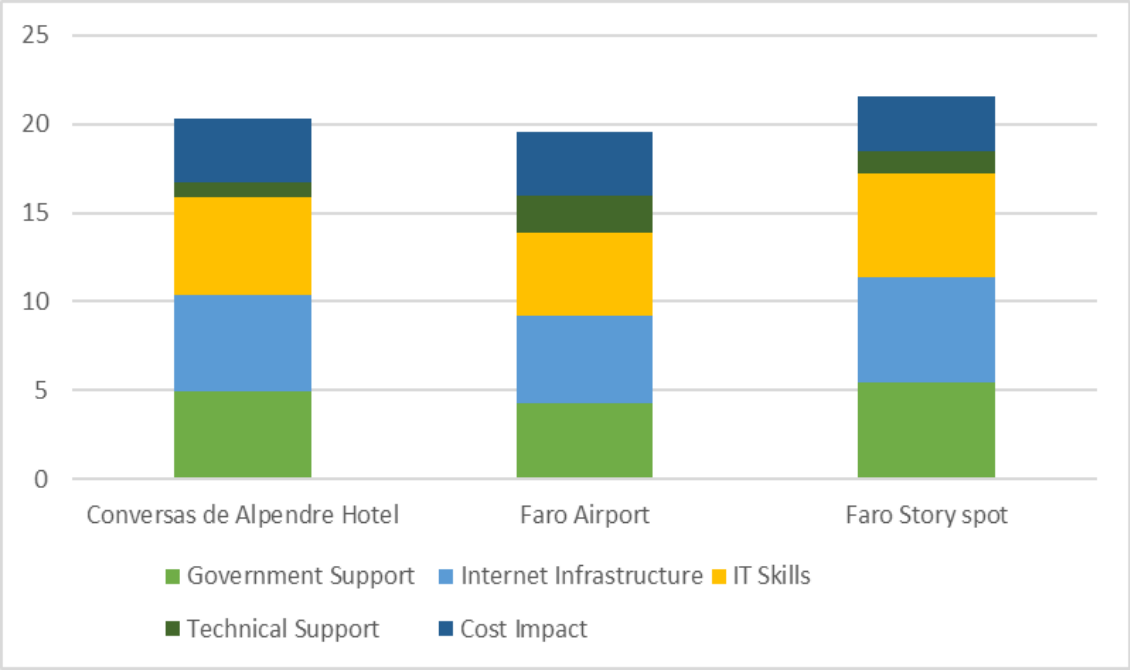
Facility	Operational Efficiency	Security & Safety	Customer Satisfaction	Business Competitiveness	Health & Safety
Conversas de Alpendre Hotel	5.54	5.5	5.58	5.54	5.58
Faro Airport	4.67	4.91	4.82	4.59	4.77
Faro Story Spot	5.78	5.78	5.89	5.89	5.78
Average	5.33	5.4	5.43	5.34	5.38
Standard Deviation	0.584	0.444	0.551	0.673	0.535

4.6 Challenges facing the implementation of technological innovations

The bar in Figure 4.7 chart provides a detailed examination of the challenges associated with implementing technological innovations across the three selected tourism facilities in Algarve. The analysis reveals key patterns of implementation challenges:

- **Infrastructure development** emerges as the most pressing issue across all facilities, with scores ranging from 4.88 to 6.00, particularly severe in cultural tourism settings like Faro Story Spot.
- **IT skills and expertise** represent the second most critical challenge, scoring between 4.74 and 5.78, indicating widespread difficulty in recruiting and retaining skilled personnel, especially in specialized facilities.
- **Government support** remains a substantial barrier, with scores between 4.37 and 5.44, highlighting the need for enhanced public policy and investment to support technological adoption.
- **Technical support** scores the lowest across all dimensions (0.85–2.7), reflecting relatively effective maintenance systems, though its intensity varies with facility complexity.
- **Cost impact** poses moderate challenges (3.11–3.62), indicating balanced financial management of technology implementations across the facilities

Figure 4.7: *Implementation challenges*



4.7 Discussion

Although our findings derive from a small sample, we believe they provide valuable insights into the technological innovation landscape of Algarve's tourism sector, highlighting the interconnected relationships between infrastructure, user experience, and operational efficiency. This demonstrates the fundamental role of digital infrastructure in driving innovation and enhancing visitor experiences, aligning with previous research by Buhalis and Leung (2018) who emphasized the critical nature of technological infrastructure in modern tourism operations.

The strong correlation between Internet infrastructure and customer satisfaction (r = 0.94) supports the findings of Law et al. (2018), who identified digital connectivity as a primary driver of tourist satisfaction in contemporary travel experiences. Similarly, the powerful relationship between operational efficiency and IT skills (r = 0.93) corresponds with research by Fuchs and Sigala (2021), who emphasized the importance of technical competency in delivering superior tourism services.

The adoption patterns of technological innovations across different facilities reveal interesting parallels with existing literature. The high implementation rate of digital payment and booking systems at Faro Airport (52 respondents) aligns with Ivanov and Webster (2019)

observations about the increasing automation in airport operations. The emphasis on contactless technologies and mobile solutions across the tourism facilities reflects the dynamic change in consumer preferences, as documented by Kim, Han & Ariza-Montel (2021) in their study of post-pandemic tourism technology adoption and Cobanoglu et al (2011) in their book on technology amenities and guest satisfaction who identified that guest selection of hotel is most times based the level of automated facilities available in the facility rather than the beauty of the building.

The overwhelmingly positive influence of technological innovations on tourist perceptions (84.9% positive response) corresponds with findings by Juandi et al. (2018), who documented similar levels of tourist satisfaction with digital tourism services. The particularly strong positive response from business travelers supports research by Bilgihan et al., (2016) on the technology expectations of business tourists.

Regarding sustainability impact, the study reveals significant variations across different facility types. Faro Story Spot's high sustainability ratings, particularly in customer satisfaction and business competitiveness (5.89), align with findings by Femenia-Serra & Neuhofer (2018) on the effectiveness of technology integration in cultural tourism settings. This supports Gössling's (2021) assertion that technological innovation can significantly enhance sustainable tourism practices when properly implemented. The strong performance of Conversas de Alpendre Hotel in health and safety (5.58) reflects trends identified by Andrés-Marques, Borges, Matos Pereira, & Magalhães (2022) regarding the growing importance of technology-enabled safety measures in hospitality settings.

However, the implementation challenges identified in the study present significant barriers to technological advancement which corresponds with the Adeola & Evans, (2020) in their research on the crises and resilience of technological enhancement and future for tourism industry. The high prevalence of infrastructure development issues (87.0% of respondents) aligns with research by Buhalis et al., (2019), who identified similar infrastructure constraints in developing tourism destinations. The IT skills gap (87.0%) mirrors findings by Fyall, (2019) regarding the persistent challenge of maintaining skilled technical personnel in tourism operations.

The relatively weaker correlations in staff encouragement ($r = 0.50$ to 0.82) highlight a potential gap in employee engagement, echoing concerns raised by Williams, Rodríguez Sánchez & Škokić (2021) about the importance of human resource development in technological transformation. This suggests a need for enhanced focus on staff training and development

programs, as recommended by Bikse, Lusena-Ezera, Rivza, & Rivza (2021) in their study of technology development and employee competence. The significant challenge of government support (72.8%) corresponds with findings by Bramwell (2011) who emphasized the critical role of policy frameworks in facilitating tourism technology adoption. This moderate the concern regarding cost impact (48.9%) aligns with research by Cheng, Xue, Yang, & Ma (2023) on cost impact to transforming technological innovation in tourism facilities.

The results suggest that while Algarve's tourism sector has made significant strides in technological innovation, there remains room for improvement in areas such as infrastructure development, IT skills enhancement, and government support frameworks. These findings align with broader industry trends identified by Gretzel, Fuchs, Baggio, Hoepken, Law, Neidhardt & Xiang (2020) regarding the evolution of smart tourism destinations and support Buhalis's (2020) framework for sustainable technological integration in tourism operations. The varying sustainability impacts across different facility types suggest the need for context-specific approaches to technology integration, as proposed by (Benur & Bramwell, 2015; Romero & Tejada, 2020) in their study of tourism product development and innovation in hotel industry.

CHAPTER FIVE

CONCLUSION & RECOMMENDATION

5.1 Summary of findings

The research examines the implementation of technological innovation in tourism sector in influencing the development of specific tourism facilities and measure customer's satisfaction and perception. As regards this, the literature reviews and first objective data analysis result made it glaring that generally, there are some certain underlying factors influencing the implementation of various types of technologies adopted in these facilities which can serve as tools in strategic planning for the facilities management. The presentation of findings from the second objective revealed the sustainability impact of the influence of the technologies from the user perspective based on the types of facilities used as revealing cases such as hotel facility, airport, tour center. This showed that even when the technology present in same facility type is not the same or changes over time and in trends, customers, tourist will still find the presence as a motivating factor to visit the tourism facilities. While in objective three, it shows the challenges to facing the adoption of technological innovation in the study area because there are so many factors to consider. The tourism industry management body can make the switch to digital smoother by addressing these concerns through thorough planning, involving stakeholders, and targeted interventions. This will ultimately lead to better customer experience and patronage results.

5.2 Conclusion

These findings contribute to the broader understanding of technological innovation in tourism sectors such as hospitality (hotel), Airport (transport), and tour center by identifying the types of various technologies used in these facilities, the factors that should be taken into account while implementing these technologies and their influence on the sustainability over time. This study revealed the innovation success of the technological infrastructure in influencing customer's patronage, enhancing competitive advantage of tourism businesses and demonstrate their continuous interest in developing various digital capabilities to facilitate tourists' experiences. Furthermore, the importance of government, business managers across different facility types to

develop effective strategies that will improve the challenges facing the implementation and acting as barrier to maximum optimization of these technological innovations was demonstrated. Additionally, it further emphasized that tourism business to engage in sustainability strategies such as staff engagement and training, guest satisfaction, community relationship, energy reduction, waste management and water efficiency, labor law and corporate sustainability measure to mention a few. key implementation challenges and their relative significance.

5.3 Value of work

The data highlights the socioeconomics survey of respondents such as sex, age, and salary level. This aids in evaluating how representative the results are. The investigation indicates solid relationships between components like internet infrastructure and client fulfilment. Convenience, time savings, security, and customer pleasure are among the most important factors that propel technology innovation. The data moreover breaks down innovation selection rates across facilities, uncovering differential designs that may stem from facility sort, client socioeconomics, and infrastructure. Office execution is compared on measurements like operational productivity, security, and client fulfillment, proposing openings for cross-facility learning. In terms of the overall value of this work, here are few key points:

1. It provided in-depth researched knowledge into the variables impacting innovation appropriation and perception within the hospitality/tourism sector. This information can educate key innovation planning and investment choices for comparable facilities.

2. The examination of the relationship between diverse variables offers direction on prioritizing and adjusting advancement activities for most extreme impact. By using this insight, facilities may elevate the experiences and expectations of their technology-enabled client.

3. Facilities can use comparisons in performance data to benchmark themselves to their competitors and recognize areas for targeted upgrades. This will drive solid competition and nonstop change.

4. As the factors and technological solutions are widely applicable in the hotel business, the conclusions presumably have more general application beyond the particular facilities evaluated. The research extends the observational information base in this domain.

5. By and large, the data analysis and interpretation give a deep, comprehensive understanding of the impact of innovation on facility operations and client recognitions. This value-added information can educate both organizational and industry-level initiatives and decision-making.

5.4 Limitations

In this study, there is disparity in the various technological innovations adopted in the various sector of tourism industry, therefore causes limitation for the study to include all the types of technology adopted at the airport and hotel as at the time of data collection. Second limitation for this study is the challenge of gathering information from the initial number of the hotel guest and airport travelers as many were reluctant to spare time in filling out the questionnaire. In addition, as at the time of data collection, the data source was limited to only primary data, therefore the study may not capture data and results from recent literature analysis. For future research, tourism academics should consider examining qualitative analysis on managing the digital transformation of hospitality and tourism organizations and its sustainability in digital world while exploring the regulatory frameworks, standards, and guidelines to govern the use of technology in tourism operations, data privacy, and cybersecurity.

5.5 Recommendations

The influence of technological innovation in tourism offers potential benefit to tourism business that is of competitive advantage and increase rate of patronages and recognition. However, this study recommends the increase in the invention of quicker user-friendly smart technologies like bar code for check in and check out instead of guest standing at the check in desk. Another recommendation is the need for the cultural tourism center to incorporate virtual reality into their system for improved visualization of cultural values and resources. Since the post-pandemic, the use of technological innovation to create awareness of lesser-known tourism destinations and promote businesses especially in tourism and hospitality sector has increased. Business now use digital medium to market their products and services to attract tourist and guest and increase revenue that was seriously affected during pandemic. As a result, this study would suggest that tourism sectors should prioritize how technology and digital communication/feedbacks to meet individual customer’s preferences and choices. This will help to boost customer’s satisfaction and loyalty.

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Appendix A

The Influence of Technology Innovation on Tourism Sustainability: An insight into Algarve, Portugal

Dear respondent, I am interested in examining the Influence of Technology Innovation on Tourism Sustainability: An insight into Algarve, Portugal. I am a master's student from the Department of Tourism Economics and Regional Development, Faculty of Economics, University of Algarve, Portugal. This research is carried out as the partial fulfillment of a Master of Management Degree. Please assist by answering the following questions as honestly as possible. All data is collected solely for research purposes, with the confidentiality of its treatment and exclusive use by the researcher being guaranteed, with its treatment carried out under the terms and conditions of the Privacy Policy

□ I confirm that I am aware of and accept the terms and authorize the collection, processing, and use of my data for the purposes of the research described above.

Section A: Respondents Demographic Profiles

1. Which of the following facilities are you associated with?
    a. Faro Airport □
    b. Faro Story Spot □
    c. Conversas de Alpendre □

2. Kind of respondent
    a. Visitor/tourist □
    b. Staff □
    c. CEO/manager □

3 Gender:
    a. Male □
    b. Female □
    c. Prefer not to say □

4 Age:
    a. Below 25 □
    b. 26-35 □
    c. 36-50 □
    d. Above 50 years □

5 Country of Residence: ……..

6 Income:
    a. ≤ $50,000 □
    b. $50,000 - $70,000 □
    c. $70,000 - $90,000 □
    d. Above $90,000 □

7. Is this your first visit to Algarve:
    a. Yes □
    b. No □

8. Nature of Travel:

   a. Business □
   b. Leisure □
   c. Other □

9 You' re travelling:

   a. Alone □
   b. With family (wife/husband and kids) □
   c. With wife/husband □
   d. Other □

Section B: Factors that Influence technological innovations in tourism.
In this section we want to understand your perception about the importance of following factors
The scale goes from 0= nothing at all to 6= extremely

	0 = Nothing at all	**1**	**2**	**3**	**4**	**5**	**6**= Extremely
Government support for digital transformation							
The availability of high-speed internet, reliable Wi-Fi, and 5G networks							
Operational Efficiency and increased revenue							
IT Skilled staffs							
Client's security and Safety concerns							
Customer Satisfaction							
Business Competitiveness							
Convenience and ease of use							
Time-saving benefits							
Recommendations from friends or online reviews							
Availability of free services (e.g., Wi-Fi, apps)							
Encouragement from staff or signage							
Health and safety (e.g., contactless payments)							

10. Did the use of modern technology in your overall travel experience influence your perception of the facility?

   a. Yes □
   b. No □

c. Not sure □

Section C: The types of technological innovations employed in the three selected tourism facilities.

11. Did you notice or use any of the following technologies? (Select all that apply)

□ Smart room controls
□ Keyless Entry
□ Mobile check-in/check-out that allows you to bypass the front desk
□ Digital guestbook/concierge services that provide Interactive customer experience
□ Virtual tours of local attractions
□ Contactless Reservation and Registration
□ Contactless payment technology that sends an updated bill statement to the guest before checkout, at any time during the stay
□ Room Personalization with the help of Master Remote control in the room which controls curtains, AC, TV, lights from one device
□ Online check-in
□ Contactless payment
□ Digital notification display of flight status and use of mobile apps
□ Self-service kiosks
□ Biometric e-gates
□ Mobile boarding passes
□ Smart luggage tracking
□ Radio Frequency Identification tags for real-time tracking of checked baggage.
□ Automated parking systems and license plate recognition technology
□ Audio guides via mobile apps
□ Interactive exhibits using virtual/augmented reality
□ Online ticket booking
□ Automated Reservation systems that help customers search for and reserve tables at restaurants at any time, based on cuisine, price, location, reviews, and other criteria
□ Digital signage with historical information
□ QR code-enabled information points

Section D: To investigate the impact of the technological innovations on the tourism sustainability
In this section we want to understand your perception about the importance of following factors
The scale goes from 0= nothing at all to 6= extremely

Item	**0** = Nothing at all	**1**	**2**	**3**	**4**	**5**	**6**= Extremely
Please rate how important the use of modern technology is in your overall travel experience?							
Rate your satisfaction							

with the use of technology							
Rate how the implementation of new technologies has allowed resources to be effectively allocated to staff training							
Would the availability of more user-friendly technology impact your decision to visit the facility again							

Section E: To identify the challenges facing the implementation of technological innovations in the
In this section we want to understand your perception about the importance of following factors
The scale goes from 0= nothing at all to 6= extremely

Items	**0** = Nothing at all	**1**	**2**	**3**	**4**	**5**	**6** = Extremely
I am familiar with the latest technological innovations available for at the tourism facilities.							
I would say that the use of new							

technologies has increased the prices of tourism products/ services offered							
I would say that there is no sufficient technical support available while the technologies were in use							
Please rate the ease of use of the technologies at these facilities							
Please rate the assistance provided by staff when using the technologies							
Please rate the extent at which the technological innovations meet your needs during your visit							
Complexity of technology							
Lack of user training or information							

Technical issues or malfunctions							
Resistance to change							
Insufficient staff support							

APPENDIX B

Table 4.5: Table Showing the correlation Matrix *of Factors influencing Technological Innovation*

	Government Support	Internet Infrastructure	Operational Efficiency	IT Skills	Security & Safety	Customer Satisfaction	Competitiveness	Convenience	Time Savings	Recommendations	Free Services	Staff Encouragement	Health & Safety
Government Support	1.00	0.68	0.77	0.76	0.57	0.69	0.68	0.68	0.71	0.52	0.67	0.50	0.66
Internet Infrastructure	0.68	1.00	0.86	0.87	0.86	0.94	0.83	0.89	0.92	0.76	0.86	0.71	0.87
Operational Efficiency	0.77	0.86	1.00	0.93	0.80	0.89	0.84	0.89	0.89	0.78	0.84	0.70	0.90

IT Skills	0.76	0.87	0.93	1.00	0.81	0.91	0.86	0.90	0.92	0.81	0.89	0.70	0.87
Security & Safety	0.57	0.86	0.80	0.81	1.00	0.89	0.79	0.86	0.87	0.81	0.84	0.74	0.83
Customer Satisfaction	0.69	0.94	0.89	0.91	0.89	1.00	0.89	0.94	0.94	0.85	0.92	0.79	0.92
Competitiveness	0.68	0.83	0.84	0.86	0.79	0.89	1.00	0.91	0.88	0.82	0.88	0.70	0.85
Convenience	0.68	0.89	0.89	0.90	0.86	0.94	0.91	1.00	0.95	0.83	0.89	0.72	0.89
Time Savings	0.71	0.92	0.89	0.92	0.87	0.94	0.88	0.95	1.00	0.80	0.87	0.71	0.84

Recommendations	0.52	0.76	0.78	0.81	0.81	0.85	0.82	0.83	0.80	1.00	0.87	0.78	0.84
Free Services	0.67	0.86	0.84	0.89	0.84	0.92	0.88	0.89	0.87	0.87	1.00	0.82	0.86
Staff Encouragement	0.50	0.71	0.70	0.70	0.74	0.79	0.70	0.72	0.71	0.78	0.82	1.00	0.76
Health & Safety	0.66	0.87	0.90	0.87	0.83	0.92	0.85	0.89	0.84	0.84	0.86	0.76	1.00

APPENDIX C

GANTT DIAGRAM

Task	May-June	July-September	October-December	December-January	February-March	April
Preparation & presentation of final thesis proposal						
Literature review and proof reading						
Presentation of methodology & material						
Data collection						
Data analysis & results						
Submission of Chapter 1-5 for proof reading & corrections						
Final proof and read						
Submission of thesis for review						
Defense and presentation of thesis						