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Artificial intelligence in Tunisian international hotel industry

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Abstract

In an era defined by rapid technological advancements, the integration of artificial intelligence (AI) is reshaping industries worldwide, and the Tunisian international hotel industry is no exception. This thesis delves into the multifaceted impact of AI on this sector, exploring its potential to revolutionize guest experiences, streamline operations, and enhance sustainability.

The research begins by establishing a foundational understanding of AI, tracing its historical development and defining its various types, from narrow AI to the aspirational general AI. It then examines the global landscape of AI adoption, highlighting its growing importance across diverse sectors. The thesis proceeds to investigate the specific applications of AI within the hotel industry, drawing on real-world examples and case studies. It explores how AI-powered chatbots, recommendation systems, and operational tools are transforming the way hotels interact with guests and manage their resources. The study also examines the perceptions of hospitality professionals regarding AI adoption, revealing a mix of excitement and apprehension about its potential impact on jobs and the guest experience. A significant portion of the thesis is dedicated to analyzing the economic dimensions of Tunisia's international hotel industry. It scrutinizes data on customer entries, foreign currency incomes, and GDP contributions over the past two decades. This analysis reveals trends, fluctuations, and the impact of significant events such as the Arab Spring and the COVID-19 pandemic on the industry's performance. Furthermore, the thesis employs artificial neural networks, specifically Multilayer Perceptron (MLP) models, to forecast tourist entries and revenues in Euros for Tunisia. By leveraging historical data and advanced AI techniques, the study demonstrates the accuracy and potential of MLP models in predicting future trends, offering valuable insights for stakeholders in the tourism sector.

This thesis concludes that AI is crucial for the Tunisian hotel industry's future. AI enhances guest experiences, streamlines operations, and improves sustainability. By embracing AI and data-driven decisions, Tunisian hotels can lead innovation in global hospitality.

Keywords: Artificial Intelligence, Hotel Industry, Tunisia, Forecasting.

Resumo

Numa era definida por rápidos avanços tecnológicos, a integração da inteligência artificial (IA) está a transformar indústrias em todo o mundo, e a indústria hoteleira internacional da Tunísia não é exceção. Esta dissertação aprofunda o impacto multifacetado da IA neste setor, explorando o seu potencial para revolucionar as experiências dos hóspedes, otimizar as operações e aumentar a sustentabilidade.

A investigação começa por estabelecer uma compreensão fundamental da IA, traçando o seu desenvolvimento histórico e definindo os seus vários tipos, desde a IA restrita à aspiracional IA geral. Em seguida, examina o panorama global da adoção da IA, destacando a sua crescente importância em diversos setores. A dissertação prossegue investigando as aplicações específicas da IA na indústria hoteleira. Explora como chatbots, sistemas de recomendação e ferramentas operacionais alimentadas por IA estão a transformar a forma como os hotéis interagem com os hóspedes e gerem os seus recursos. O estudo também examina as perceções dos profissionais da hotelaria em relação à adoção da IA, revelando uma mistura de entusiasmo e apreensão sobre o seu potencial impacto nos empregos e na experiência dos hóspedes. Uma parte significativa da dissertação dedica-se à análise das dimensões económicas da indústria hoteleira internacional da Tunísia. Analisa dados sobre entradas de clientes, receitas em moeda estrangeira e contribuições para o PIB nas últimas duas décadas. Esta análise revela tendências, flutuações e o impacto de eventos significativos como a Primavera Árabe e a pandemia COVID-19 no desempenho da indústria.

Além disso, a dissertação emprega redes neurais artificiais, especificamente modelos Multilayer Perceptron (MLP), para prever entradas de turistas e receitas em euros para a Tunísia. Ao utilizar dados históricos e técnicas avançadas de IA, o estudo demonstra a precisão e o potencial dos modelos MLP na previsão de tendências futuras, oferecendo informações valiosas para as partes interessadas no setor do turismo.

Esta dissertação conclui que a IA é crucial para o futuro da indústria hoteleira tunisina. A IA melhora as experiências dos hóspedes, otimiza as operações e promove a sustentabilidade. Ao adotar a IA e as decisões baseadas em dados, os hotéis tunisinos podem liderar a inovação na hotelaria mundial.

Palavras-chave: Inteligência Artificial, Indústria Hoteleira, Tunísia, Previsão.

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I am committed to extend my gratitude to my colleagues and peers at IPB. The stimulating academic environment and the camaraderie shared with fellow students have greatly enriched my learning experience. The numerous discussions, group studies, and shared knowledge have been invaluable to my personal and academic growth.

I would also like to express my heartfelt gratitude to my family, friends, and loved ones for their unwavering support throughout this journey. Their moral support, encouragement, and understanding in the face of the demands of this thesis have been of paramount importance to me. My parents have been a constant source of strength, always encouraging me to pursue my dreams and providing me with the foundation to succeed.

Moreover, I am deeply grateful to all the IPB members who have taught and guided me during my studies. Their dedication to teaching and their passion for their subjects have inspired me to strive for excellence. The skills and knowledge imparted by them have provided me with a strong foundation that has been essential in the completion of this thesis.

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Acronyms

AI: Artificial Intelligence

MLP: Multilayer Perceptron

GDP: Gross Domestic Product

VR: Virtual Reality

AR: Augmented Reality

IFR: International Federation of Robotics

CNN: Convolutional Neural Network

NLP: Natural Language Processing

TND: Tunisian Dinar

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Introduction

In an era marked by the relentless advancement of technology, one phenomenon emerges as a defining force: the fusion of artificial intelligence (AI) with the global tourism industry. AI, often hailed as the pinnacle of human innovation, represents the convergence of sophisticated computing power with human-like intelligence. This transformative power has not merely advanced technological capabilities but has catalyzed a paradigm shift in industry operations, permeating our daily lives in unprecedented ways.

As we embark on this academic journey, we stand at the threshold of understanding the profound impact of AI, focusing our lens on its role within Tunisia's international hotel sector. Here, the intersection of cutting-edge technology and the timeless art of hospitality creates a dynamic interplay that reshapes the essence of travel and tourism. No longer confined to the realm of science fiction, AI has seamlessly woven itself into the fabric of the hospitality landscape, fundamentally altering how hotels operate, interact with guests, and strategize for the future.

The exploration seeks to illuminate the multifaceted facets of this transformation, delving into how AI has redefined customer experiences, streamlined operations, and propelled Tunisia onto the global stage of destination hotspots. Within this ever-evolving narrative, we endeavor to uncover the intricate web of AI's influence, revealing not only its potential but also its unique role in shaping the trajectory of Tunisia's international hotel industry.

The main objective of study is the main objective of this thesis is to investigate the multifaceted impact of artificial intelligence (AI) on the Tunisian international hotel industry and explore its potential to revolutionize guest experiences, streamline operations, and enhance sustainability. Additionally, it aims to analyze the economic dimensions of the industry over the past two decades and forecast future trends using AI techniques, specifically Multilayer Perceptron (MLP) models.

In order to achieve the objective, the work is based on answering the following pivotal questions:

1. Global Integration: How has artificial intelligence seamlessly woven itself into the intricate fabric of the global tourism sector? What unique contributions and disruptions has AI brought to this quintessential human experience?

2. Revolutionizing Hospitality: In what specific ways will artificial intelligence propel a revolution within hotels, reshaping not just their operations but also their strategies for attracting and engaging customers? What innovative methodologies underpin this transformation?

3. Tunisian Hotel Evolution: Over the last two decades, what trajectory has Tunisia's hotel industry followed, and how has it asserted itself on the international stage?

4. Forecasting with Artificial Neural Networks: What are artificial neural networks? How can artificial neural networks, specifically Multilayer Perceptron (MLP) models, be leveraged to forecast tourist entries and revenues in Euros for Tunisia?

To methodically navigate these multifaceted questions, the research journey encompasses four distinct phases:

Section 1: The Concept of Artificial Intelligence: Our intellectual expedition commences with a rigorous exploration of the global landscape of artificial intelligence. Here, we dissect the essence of AI, its historical genesis, multifaceted definitions, and its evolutionary journey to its contemporary manifestations in the digital age.

Section 2: Artificial Intelligence in the Hotel Industry: The spotlight then shifts to the profound implications of artificial intelligence within the dynamic hospitality sector. We delve into the myriad applications and methodologies reshaping the industry's landscape, unraveling practical implications for Tunisia's hoteliers through real-world case studies.

Section 3: Customer Entries, Foreign Currency Incomes, and GDP Analysis: We embark on a comprehensive examination of a pivotal facet; analyzing customer entries into Tunisian hotels, foreign currency incomes, and the GDP generated by these establishments over the past two decades.

Section 4: Forecasting with Artificial Neural Networks: This section introduces the application of artificial neural networks, specifically Multilayer Perceptron (MLP) models, for forecasting tourist entries and revenues in Euros for Tunisia. We aim to demonstrate the robustness and accuracy of MLP models in predicting these metrics and their implications for the future of Tunisia's international hotel industry.

This thesis constitutes a bold attempt to unravel the symbiotic relationship between artificial intelligence and the Tunisian international hotel industry. Through a fusion of historical context, academic rigor, and real-world insights, we endeavor to reveal not just the transformative potential of AI but also the intricate ways in which it has redefined the very essence of the global tourism landscape. With each passing section, we aim to illuminate the pathways through which AI has reshaped not only the nature of travel and hospitality but also Tunisia's unique role within this ever-evolving narrative.

1 The concept of artificial intelligence

Artificial Intelligence (AI) stands as a multifaceted concept that has permeated various aspects of contemporary society. Defined as the simulation of human intelligence processes by machines, AI encompasses a broad spectrum of technologies and applications (Russell and Norvig, 2016) At its core lies the ability of machines to learn from data, adapt to new situations, and perform tasks traditionally requiring human intelligence. This paradigm shift has led to significant advancements across industries, including healthcare, finance, transportation, and hospitality. Within the hospitality sector, AI's impact is particularly pronounced, with its integration revolutionizing guest experiences and operational efficiency (Tussyadiah and Park, 2018). From AI-powered chatbots providing seamless customer service to personalized guest recommendations driven by machine learning algorithms, hotels are leveraging AI to enhance guest satisfaction and loyalty Kourentzes et al, (2020). Moreover, AI's role extends beyond guest-facing applications to encompass operational enhancements, such as predictive maintenance, inventory management, and dynamic pricing strategies (Chen et al. ,2020). The proliferation of AI-driven technologies underscores its transformative potential in reshaping traditional business models and redefining industry standards. However, alongside its myriad benefits, the ethical implications and societal consequences of AI deployment warrant careful consideration (Bryson ,2018). As AI continues to evolve, navigating the complexities of its integration remains a pivotal challenge for businesses and policymakers alike.

1.1 Historical definition

The historical definition of artificial intelligence encompasses the development of machines capable of performing tasks that typically require human intelligence, with AI being classified into various types such as narrow AI, which is designed for specific tasks, and general AI, which aims to perform any intellectual task that a human can do.

1.2 Definition

Artificial Intelligence (AI) is a branch of computer science that aims to create intelligent machines capable of simulating human-like cognitive processes, such as learning, problem-solving, perception, and decision-making. It encompasses a wide range of techniques and methodologies, including machine learning, natural language processing, computer vision, robotics, and expert systems. At its core, AI seeks to develop algorithms and systems that can analyze vast amounts of data, extract meaningful patterns, and make predictions or decisions autonomously, often surpassing human capabilities in speed and accuracy. The field of AI has witnessed remarkable advancements in recent years, fueled by the availability of big data, powerful computing resources, and breakthroughs in algorithm development.

One seminal work in the field of AI is "Computing Machinery and Intelligence" Turing (Alan Turing's paper ,1950), in which he proposed the Turing Test as a measure of a machine's intelligence. Turing argued that if a computer could engage in a conversation indistinguishable from that of a human,

then it could be considered intelligent. This paper laid the foundation for the study of artificial intelligence and continues to influence research in the field to this day.

Another significant contribution to AI is the development of neural networks, inspired by the structure and function of the human brain. In their paper "Gradient-Based Learning Applied to Document Recognition" (LeCun et al. ,1998), LeCun and colleagues introduced the concept of convolutional neural networks (CNNs) for handwritten digit recognition. CNNs revolutionized the field of computer vision and became a cornerstone of many AI applications, including image classification, object detection, and facial recognition.

Furthermore, the rise of deep learning, a subset of machine learning, has propelled AI to new heights of performance and scalability. In their influential paper "ImageNet Classification with Deep Convolutional Neural Networks" (Krizhevsky, Sutskever, and Hinton,2012) demonstrated the effectiveness of deep convolutional neural networks in image classification tasks, achieving unprecedented accuracy on the ImageNet dataset. This work marked a turning point in the field of computer vision and catalyzed the widespread adoption of deep learning across various domains.

Moreover, the application of AI in natural language processing (NLP) has led to significant advancements in tasks such as language translation, sentiment analysis, and chatbots. One notable example is the transformer model introduced in the paper "Attention is All You Need" (Vaswani et al. ,2017), where Vaswani and colleagues proposed a novel architecture based solely on self-attention mechanisms. The transformer model revolutionized NLP by achieving state-of-the-art performance on a wide range of tasks and paved the way for subsequent developments in language understanding and generation.

In addition to technological innovations, ethical considerations surrounding AI have garnered increasing attention from researchers, policymakers, and the public. As AI systems become more pervasive in society, questions regarding bias, accountability, transparency, and privacy have become paramount. In their paper "Fairness and Abstraction in Sociotechnical Systems" (Barocas and Selbst, 2016) examined the ethical implications of algorithmic decision-making and emphasized the importance of fairness and accountability in the design and deployment of AI systems. This paper sparked discussions about algorithmic bias and discrimination, prompting researchers to develop techniques for mitigating bias and promoting fairness in AI applications.

To summarize, artificial intelligence represents a transformative force with the potential to reshape virtually every aspect of human society. From its theoretical foundations in the Turing Test to its practical applications in deep learning and natural language processing, AI continues to push the boundaries of what machines can achieve. However, alongside its remarkable progress, AI also raises profound ethical and societal challenges that must be addressed to ensure its responsible and equitable use.

1.3 The different types of AI

The different types of AI, ranging from narrow or weak AI focused on specific tasks to general or strong AI with human-like cognitive abilities, showcase the diverse capabilities and applications within the field.

1.3.1 Strong Artificial Intelligence

Strong Artificial Intelligence (AI), a pinnacle aspiration within the field, reflects a profound quest for machines capable of transcending mere computational prowess. (Bostrom ,2014) articulates this ambition in his seminal work, "Superintelligence: Paths, Dangers, Strategies," where he explores the prospect of machines endowed not just with intelligence but consciousness itself. (Russell and Norvig,2016) further elaborate on this concept in "Artificial Intelligence: A Modern Approach,"emphasizing the pursuit of AI that comprehends the intricacies of human cognition, going beyond surface-level tasks. At its core, Artificial General Intelligence (AGI) seeks to replicate not only human actions but also the profound self-awareness and adaptability inherent in human consciousness. This vision, outlined by (Tegmark ,2017) in "Life 3.0: Being Human in the Age of Artificial Intelligence," extends beyond conventional problem-solving, envisioning machines that evolve and interact with the world in a manner akin to human cognition. While the realization of AGI remains speculative, its potential to revolutionize society by fundamentally altering our relationship with technology and intelligence is undeniable.

1.3.2 Weak Artificial Intelligence

Weak artificial intelligence (AI), also known as narrow AI, encompasses systems designed for specific tasks rather than possessing general intelligence. In the realm of hospitality, weak AI finds application in various forms, catering to specific needs within hotels. For instance, AI-driven chatbots have become ubiquitous in providing customer support, handling reservations, and addressing inquiries promptly (Pantano and Servidio, 2016). These chatbots, powered by natural language processing algorithms, simulate human-like interactions, enhancing guest satisfaction and operational efficiency (Min et al., 2018). Moreover, weak AI algorithms are deployed in revenue management systems, analyzing data to optimize pricing strategies and maximize hotel revenue (Xie et al., 2019). Another notable application is in-house virtual assistants, such as voice-activated devices, which offer personalized services like room controls and local recommendations, elevating the guest experience (Gretzel et al. ,2015). The adoption of weak AI in hotels underscores its capacity to address specific challenges and augment various facets of hospitality operations, contributing to enhanced guest satisfaction and operational efficacy.

1.3.3 History of Artificial Intelligence

The history of artificial intelligence (AI) traces back to the mid-20th century when the term was first coined by John McCarthy and his colleagues at the Dartmouth Conference in 1956; Early pioneers such as Turing (Alan,1950) laid the groundwork with his seminal paper on computability and the Turing Test in 1950. Over the decades, AI experienced periods of both fervent

enthusiasm and skepticism, marked by significant milestones and breakthroughs. The 1980s witnessed the emergence of expert systems, rule-based programs capable of simulating human expertise in specific domains (Buchanan et al. ,1984). However, the subsequent AI winter in the late 1980s and early 1990s saw a decline in interest and funding due to unrealized expectations. (Russell and Norvig, 2009). Nonetheless, the field regained momentum in the late 1990s and early 2000s with advancements in machine learning algorithms, particularly neural networks, leading to unprecedented achievements in areas such as computer vision and natural language processing (Le Cun et al., 2015). Today, AI permeates various facets of modern society, from virtual assistants like Siri and Alexa to autonomous vehicles and advanced medical diagnostics, underscoring its profound impact on human civilization.

1.4 Artificial Intelligence in the world

In this section, we will study the implication of AI in other fields around the world.

1.4.1 The growth and importance of AI

Artificial intelligence has permeated virtually every aspect of modern life, from our smartphones to our vehicles and our computers. Its omnipresence underscores its ever-increasing significance. The global market for AI is not only expanding but doing so at an astonishing pace. Predictions for its evolution are highly promising, exemplified by the staggering revenue estimates depicted in Figure 1. In 2016, the AI market generated $3.2 billion, and this figure is projected to soar to a monumental $89.9 billion by 2025. This exponential growth underscores the profound impact AI is poised to have on the world's economy and daily operations (Statista, 2020).

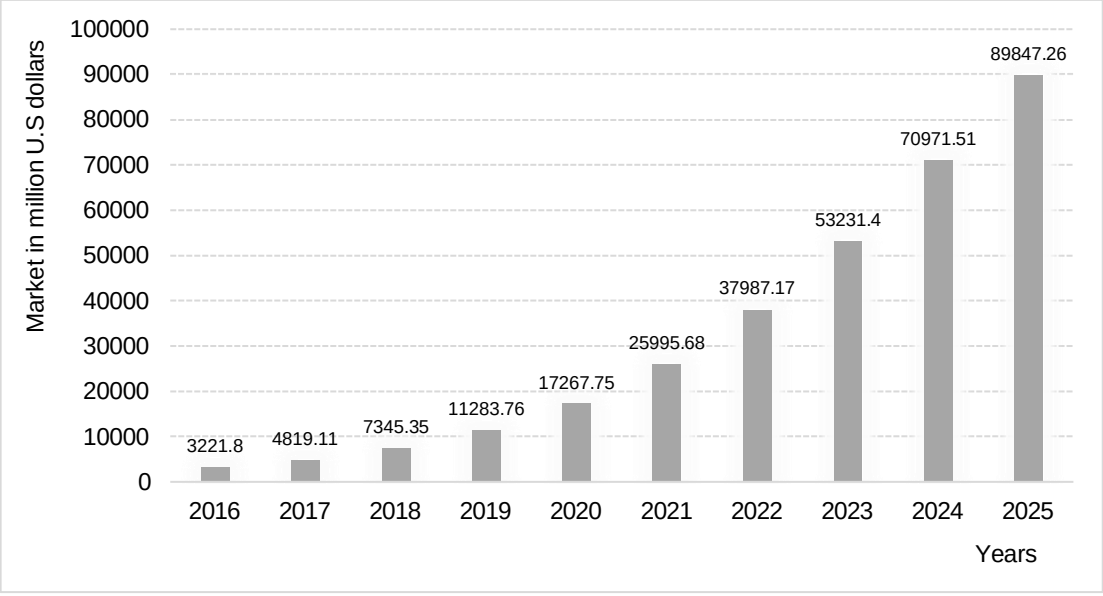

Figure 1. The projected revenue generated by AI worldwide (2018).

Source: Authors' own elaboration.

Figure 2 provides a glimpse into the proliferation of robotics from 2000 to 2016, with a notable concentration of installations in China. This trend signals the globalization of AI and its applications

across industries. The rise of robotics, particularly in manufacturing and automation, illustrates how countries worldwide are integrating AI into their industrial landscapes to enhance productivity and efficiency.

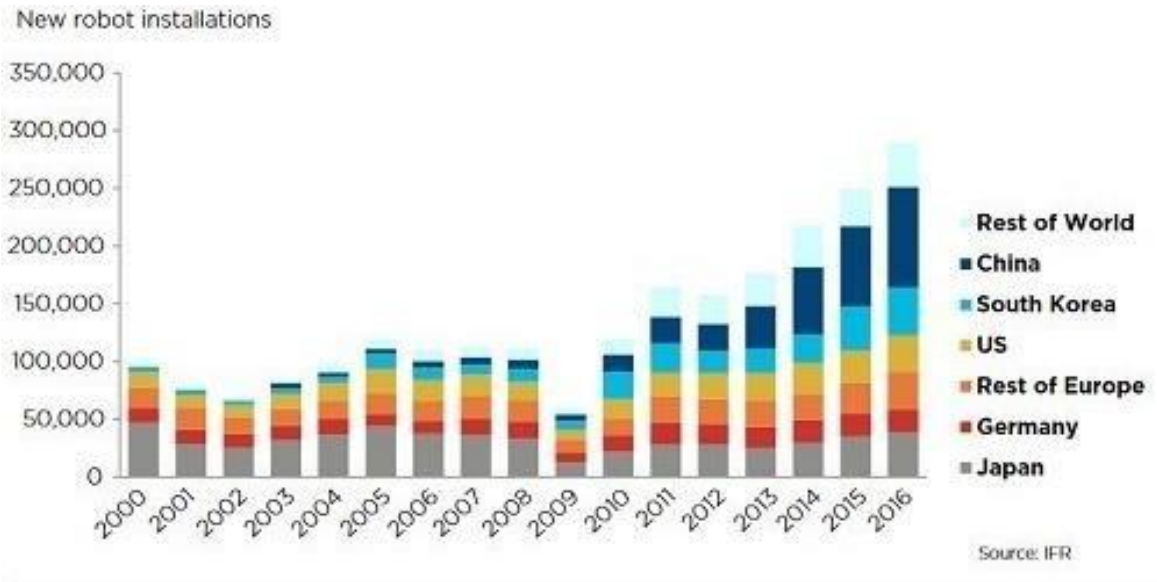

Figure 2. Growth of robotic installations by region from 2000 to 2016 according to "IFR".

Source: Developpez (2016).

Figure 3 underscores the profound commitment of major corporations to AI. Google, an industry titan, has cast its vote for AI a remarkable nine times. This resounding endorsement highlights the pivotal role AI plays in shaping the strategies and innovations of major global players. The fact that a technology company of Google's stature has invested significantly in AI reaffirms its status as a transformative force on the world stage.

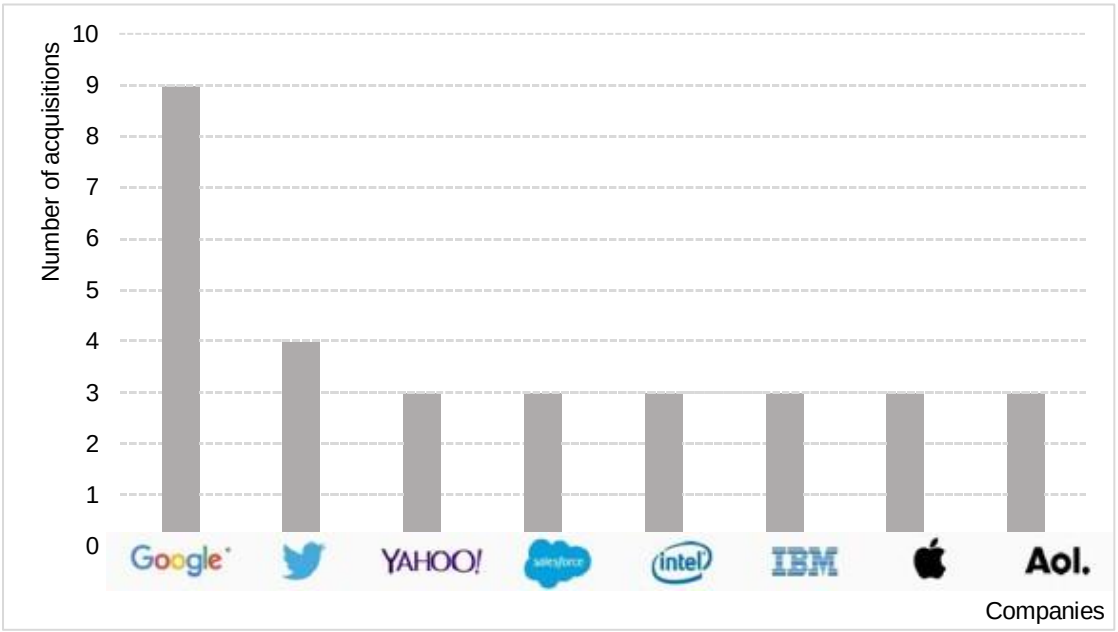

Figure 3. Large companies betting on AI, in 2011.
Source: Authors' own elaboration.

Lastly, Figure 4 provides insight into the countries at the forefront of AI adoption. Unsurprisingly, the United States leads the pack, boasting 1,393 AI-related startups. This exemplifies how AI innovation is concentrated in key hubs, with Silicon Valley serving as the epicenter of AI-driven entrepreneurial endeavors. These countries are pioneering the way forward in AI, setting the stage for how this transformative technology will continue to reshape the world's socioeconomic landscape.

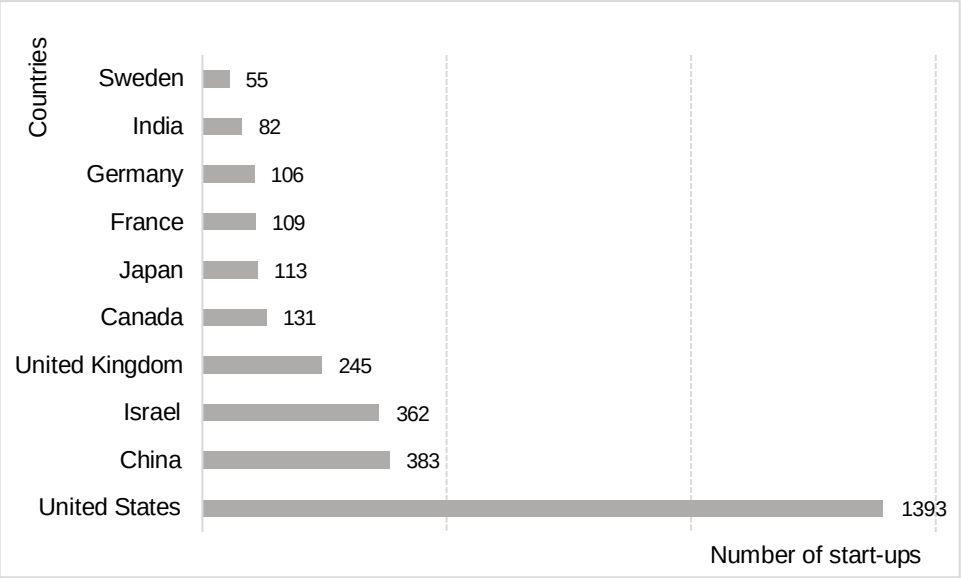

Figure 4. Countries pioneering artificial intelligence.

Source: Authors' own elaboration.

1.4.2 The benefits of AI for the future

The benefits of AI for the future are manifold and far-reaching, spanning across various sectors and industries. In healthcare, AI promises to revolutionize patient care through predictive analytics, precision medicine, and virtual health assistants Topol (2019). By analyzing vast amounts of patient data, AI algorithms can detect patterns and predict health outcomes, enabling proactive interventions and personalized treatment plans. Moreover, AI-powered virtual health assistants offer round-the-clock support, answering patient queries, scheduling appointments, and providing health-related information, thereby improving access to healthcare services Bickmore et al. (2019). In education, AI holds the potential to transform learning experiences through adaptive learning platforms, personalized tutoring systems, and intelligent educational content Holstein and McLaren (2019). Adaptive learning platforms use AI algorithms to tailor learning paths based on individual student needs and preferences, optimizing learning outcomes. Additionally, personalized tutoring systems leverage AI to provide real-time feedback and guidance, enhancing student engagement and comprehension. Furthermore, AI-driven educational content enables interactive and immersive learning experiences, catering to diverse learning styles and abilities.

In the realm of transportation, AI technologies are driving innovation in autonomous vehicles, traffic management systems, and predictive maintenance solutions Gonzalez et al. (2020). Autonomous vehicles equipped with AI algorithms can navigate roads safely and efficiently, reducing accidents and congestion while offering greater mobility options. Moreover, AI-powered traffic management

systems optimize traffic flow and reduce commute times through real-time data analysis and adaptive signal control. Additionally, predictive maintenance solutions utilize AI to monitor vehicle health and predict component failures, minimizing downtime and maintenance costs.

In the field of finance, AI is reshaping banking, investment, and risk management practices (Makridakis et al., 2019). AI-powered chatbots and virtual assistants are transforming customer service interactions, providing personalized financial advice and assistance (Tiwari et al., 2020). Furthermore, AI algorithms analyze market trends and consumer behavior to inform investment decisions and optimize portfolio performance. Moreover, AI-based risk management models enhance fraud detection and regulatory compliance, safeguarding financial institutions and their customers.

The benefits of AI extend beyond specific industries, impacting society as a whole through increased efficiency, productivity, and innovation. In manufacturing, AI-enabled predictive maintenance reduces equipment downtime and maintenance costs while optimizing production schedules (Rao et al., 2018). Additionally, AI-driven quality control systems ensure product consistency and compliance with industry standards, enhancing customer satisfaction and brand reputation. Furthermore, AI-powered supply chain management solutions optimize inventory levels, reduce lead times, and mitigate supply chain disruptions, fostering agility and resilience.

In the realm of cybersecurity, AI technologies are instrumental in detecting and mitigating cyber threats in real-time (Yan et al., 2020). AI algorithms analyze network traffic patterns and user behavior to identify anomalous activities indicative of cyber-attacks, enabling swift response and remediation. Moreover, AI-driven threat intelligence platforms aggregate and analyze vast amounts of data from diverse sources to identify emerging threats and vulnerabilities, empowering organizations to proactively fortify their cyber defenses. Additionally, AI-powered security automation tools streamline incident response processes, minimizing manual intervention and accelerating threat containment.

As society continues to embrace AI technologies, it is essential to address ethical, social, and regulatory considerations to ensure responsible and equitable deployment. Ethical frameworks and guidelines must be established to govern the use of AI and mitigate potential biases and discrimination (Jobin et al. ,2019). Moreover, efforts to promote transparency, accountability, and algorithmic fairness are crucial to building trust and confidence in AI systems. Additionally, collaboration between policymakers, industry stakeholders, and the public is essential to navigate the complex ethical and societal implications of AI adoption. By harnessing the transformative potential of AI while upholding ethical principles and values, society can unlock its full benefits for the future.

1.4.3 AI and global GDP

From an economic standpoint, AI is poised to be a transformative force in the global landscape. According to a comprehensive study conducted by PwC (a firm that engages in auditing, accounting and consulting assignments for companies), AI is projected to contribute a staggering $15.7 trillion

to global GDP by 2030. This monumental figure highlights AI's potential to drive economic growth and innovation on an unprecedented scale (PwC, 2017).

AI isn't merely a passive contributor; it's a dynamic driver of productivity. The study predicts that AI will double the economic growth rate of countries by increasing labor productivity by a substantial 40%. This infusion of AI-powered productivity promises to reshape industries, redefine job roles, and accelerate economic progress.

Figure 5, depicted in the histogram, serves as compelling evidence of AI's immense promise in bolstering the economies of diverse nations. As AI continues to advance and find new applications across industries, its role as a catalyst for global economic growth becomes increasingly evident. These findings underscore the urgency of embracing AI as a vital tool for propelling nations into a more prosperous and technologically advanced future.

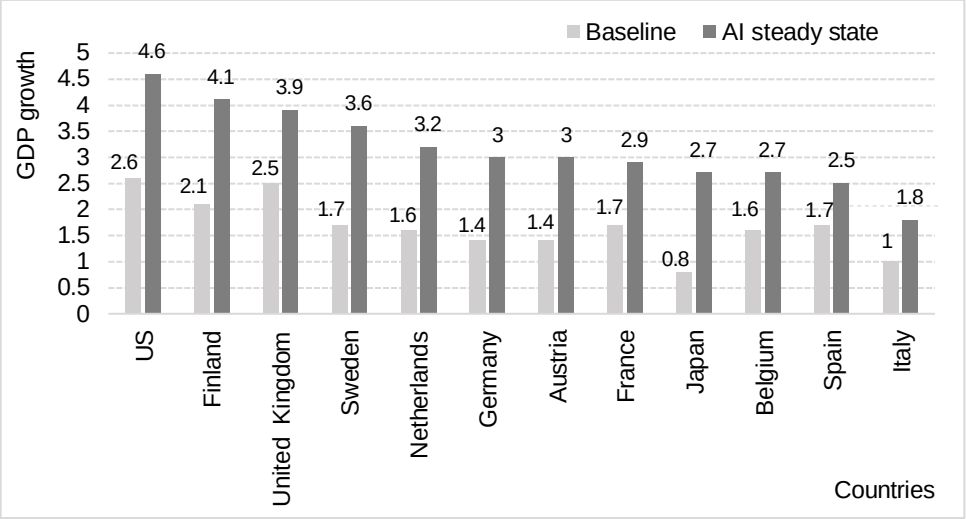

Figure 5. GDP growth rates with and without artificial intelligence.

Source: Authors' own elaboration.

1.5 Artificial Intelligence and the Enterprise

Artificial Intelligence and the Enterprise explores the transformative impact of AI technologies on modern businesses, examining how AI is reshaping operational strategies, enhancing decision-making processes, and driving innovation across various industries so for this reason we will discuss about the AI impact on revenue and workforce and their correlation with Tunisia.

1.5.1 AI's impact on revenue and workforce

The profound influence of artificial intelligence extends deep into the realm of enterprises, where its effects are poised to revolutionize revenue generation and workforce dynamics. A recent study conducted by Accenture illuminates the transformative potential awaiting organizations that embrace AI and foster human-machine collaboration. The study reveals that businesses have the opportunity to bolster their revenue by a staggering 38% by adapting their structures to facilitate seamless interaction between employees and smart technologies. This remarkable growth hinges on the ability

of organizational leaders to usher in this transformative era, which includes comprehensive employee training to enable them to effectively collaborate with AI-powered systems.

These findings underscore the critical role AI will play in reshaping the future of work and business. Moreover, they emphasize the imperative for companies to not only invest in AI but also prioritize upskilling and reskilling their workforce. The histograms in Figure 8 provide a visual representation of the anticipated impact of AI on revenue and headcount growth across various organizational departments in the coming years.

As we delve deeper into this exploration of AI's multifaceted impact on enterprises, it becomes increasingly evident that the future of business is inseparable from the intelligent machines that are becoming integral partners in the pursuit of growth and innovation.

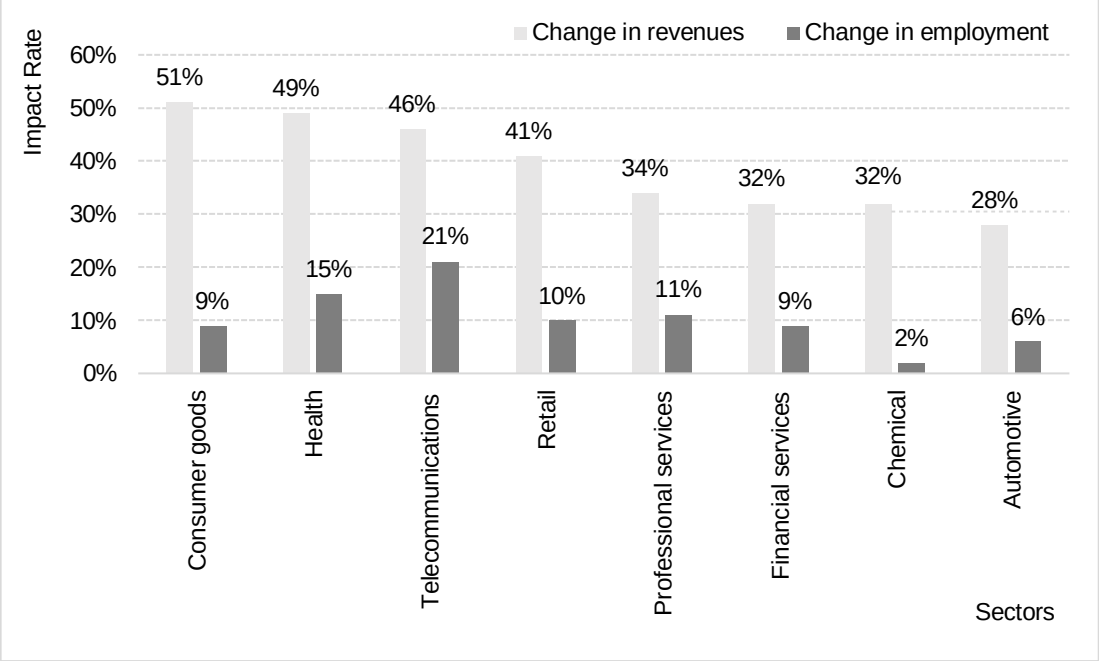

Figure 6. The impact of AI investments on revenue and workforce growth (2018-2022).

Source: Authors' own elaboration.

1.5.2 Artificial Intelligence in Tunisia

Within the context of Tunisia, the integration of artificial intelligence is poised to become a catalyst for growth and development. In a country facing economic challenges, the development of AI holds the potential to drive employability and job creation while providing a strategic tool to combat the prevailing economic crisis.

While Tunisia is emerging as à leader in AI development and adoption in Africa, there are currently limited publicly available real-world examples of AI being used in the Tunisian hotel industry. However, based on global trends and Tunisia's growing AI capabilities, we can mention the Chatbots and virtual assistants: AI-powered chatbots could handle guest inquiries, provide recommendations, and manage reservations in multiple languages, enhancing the guest experience and freeing up staff for more complex tasks.

The early steps towards embracing AI in Tunisia are becoming increasingly evident. During the COVID-19 pandemic, for instance, the nation harnessed the power of mobile robotics to bolster safety and health measures. The deployment of the "P-Guard" police robot (Figure 9), a product of 100% Tunisian expertise from EnovaRobotics, exemplifies this transition. In the largely deserted streets of Tunis during lockdowns, this robotic sentinel engaged with individuals, inquiring about the purpose of their outdoor presence. Those detained by the robot were required to present their identity documents to its camera, enabling remote agents to verify their legitimacy.

Figure 7. The Tunisian police robot "P-Guard".

Source: Enovarobotics.eu (2021).

Furthermore, Tunisian experts in robotics marked a significant milestone on April 6, 2020, with the introduction of a pioneering robot designed for telemedicine, remote patient monitoring, and risk assessment of Coronavirus infection. This innovation, also developed by EnovaRobotics, underscores the country's commitment to the integration of AI technologies in critical sectors. These endeavors signal a burgeoning era for artificial intelligence in Tunisia, with substantial implications for its future. As this work progresses, the impact of artificial intelligence is poised to be nothing short of transformative, expanding its influence on the global stage. It's apparent that AI's evolution is on an upward trajectory, and in the years to come, it will emerge as a cornerstone of the world economy, positioning Tunisia to harness its potential for sustained growth and prosperity.

In this inaugural section, readers embark on a journey to grasp the essence of artificial intelligence (AI). AI, once a visionary concept, has evolved into a transformative force reshaping industries worldwide. Various forms of AI, from narrow AI to the aspirational general AI, are explored, providing insight into the spectrum it covers. Furthermore, the substantial footprint of AI in diverse domains and its promising implications for the Tunisian international hotel sector are recognized. By grounding in this AI foundation, readers prepare to navigate how AI can revamp guest experiences, enhance operations, and invigorate sustainability within the context of Tunisia's vibrant hospitality industry. The acknowledgment of Tunisia's embrace of AI sets the stage for a closer examination of AI's tangible applications. In the forthcoming sections, readers will delve deeper, translating AI theory into practical implementations, as efforts are made to enrich Tunisia's position as an AI-powered hospitality destination.

2 Artificial Intelligence in the hotel industry

The hotel industry is undergoing a significant transformation through the integration of artificial intelligence (AI) technologies, revolutionizing various aspects of guest experiences and operational efficiency. One prominent application of AI in hotels is the utilization of chatbots, which are equipped with natural language processing capabilities to handle guest inquiries, reservations, and provide personalized recommendations. These chatbots offer a seamless communication channel for guests, enhancing their overall satisfaction and reducing the workload on hotel staff (Kourentzes et al.,2020). Moreover, AI-driven recommendation systems play a crucial role in delivering personalized experiences to guests by analyzing their preferences and behavior. By leveraging guest data, these systems offer tailored suggestions for accommodations, dining options, and activities, thereby increasing guest satisfaction and fostering loyalty (Tussyadiah and Park, 2018).

In addition to enhancing guest experiences, AI is also revolutionizing hotel operations through its integration into various aspects of management and service delivery. One significant application is the use of AI in revenue management, where algorithms analyze historical data, market trends, and other relevant factors to optimize pricing strategies and maximize revenue Chen, Song, and Liu, (2020). Furthermore, AI-powered systems are employed for efficient resource allocation, such as room assignment and inventory management, leading to improved operational efficiency and cost savings for hotels. These systems can accurately predict demand patterns and adjust resource allocation, accordingly, ensuring optimal utilization of hotel resources (Jung et al, 2019). Moreover, AI-driven facial recognition technology is increasingly being utilized for streamlined check-in processes, enhancing security and expediting guest arrivals. By automating identity verification procedures, hotels can offer a more convenient and secure check-in experience for their guests, while also reducing waiting times and enhancing overall operational efficiency (Jung et al., 2019).

Overall, the integration of AI technologies in the hotel industry is reshaping both guest experiences and operational processes, leading to enhanced efficiency, personalization, and satisfaction. As AI continues to advance, its potential for innovation within the hospitality sector is boundless, promising further improvements in service delivery, revenue management, and guest engagement.

2.1 AI integration in hospitality

In this section, we embark on a comprehensive exploration of artificial intelligence's profound impact on the tourism sector, examining its multifaceted dimensions.

2.1.1 The importance of AI in tourism

The importance of AI in tourism cannot be overstated, as it reshapes the industry landscape with innovative solutions that enhance both customer experiences and operational efficiencies. One crucial aspect is AI's role in personalized recommendations and marketing strategies. By analyzing vast amounts of data from various sources such as social media, online searches, and past

behaviors, AI algorithms can tailor recommendations to individual preferences, thus increasing the likelihood of conversion and customer satisfaction (Xiang and Fesenmaier, 2017). Moreover, AI- driven chatbots play a pivotal role in customer service, providing round-the-clock assistance for inquiries, reservations, and even destination recommendations. These chatbots, equipped with natural language processing capabilities, offer prompt and accurate responses, thereby improving customer engagement and loyalty (Kourentzes et al., 2020). In the realm of destination management, AI facilitates better resource allocation and crowd management through predictive analytics. By analyzing patterns in tourist behavior and preferences, destinations can optimize their offerings, allocate resources efficiently, and mitigate overcrowding in popular attractions (Gretzel et al., 2015).

Another area where AI excels in the tourism industry is in improving operational efficiency for businesses. AI-powered systems streamline various processes such as inventory management, pricing optimization, and staff scheduling. For example, AI algorithms can analyze market trends and competitor pricing in real-time, enabling businesses to adjust their pricing strategies dynamically for maximized revenue (Zhao et al. 2019). Furthermore, AI assists in enhancing safety and security measures through advanced technologies like facial recognition and predictive analytics. These systems not only bolster security protocols but also contribute to a seamless and hassle-free travel experience for tourists (Jung et al. ,2019). Overall, the integration of AI in tourism not only enhances customer experiences but also empowers businesses with invaluable insights and tools for sustainable growth and competitiveness in the digital age.

2.1.2 What hospitality professionals think about AI

The integration of artificial intelligence (AI) within the hospitality industry has sparked considerable interest and debate among professionals. Research by (Tussyadiah and Park, 2018) delves into the perceptions of hospitality professionals regarding AI adoption, revealing a mix of excitement and apprehension. While many professionals recognize the potential of AI to enhance operational efficiency and guest experiences, concerns regarding job displacement and loss of human touch persist. (Kourentzes et al., 2020) further explore these sentiments, highlighting a cautious optimism among professionals regarding AI's role in customer service. Despite acknowledging the benefits of AI-powered chatbots in handling routine inquiries and reservations, professional’s express reservations about AI's ability to replicate the warmth and empathy of human interactions. (Chen et al. 2020). add depth to this discourse by examining the perceived impact of AI on employment within the hospitality sector. Their findings indicate a nuanced perspective, with professionals acknowledging AI's potential to augment existing roles rather than outright replace them. Moreover, (Jung et al.,2019) shed light on professionals' attitudes towards AI-driven innovations such as facial recognition systems for guest check-in processes. While recognizing the convenience and security benefits of such technologies, concerns regarding data privacy and guest consent are paramount. Overall, these studies underscore the complex interplay between technological advancement and human-centric values within the hospitality industry, highlighting the need for thoughtful integration and ethical considerations in AI adoption strategies.

2.2 The different modes of application of AI in hotels

The application of AI in hotels spans various modes, revolutionizing the hospitality industry. One prominent mode is the utilization of AI-powered chatbots for efficient customer service. These bots, equipped with natural language processing capabilities, handle guest inquiries, reservations, and even provide local recommendations, enhancing guest experiences (Kourentzes et al., 2020). Additionally, AI is extensively employed for personalized guest recommendations, leveraging guest data to offer tailored services and amenities, thus enhancing satisfaction and loyalty (Tussyadiah and Park ,2018). Another mode is the integration of AI in hotel operations, optimizing tasks such as room allocation, inventory management, and predictive maintenance, leading to streamlined operations and cost savings (Chen et al., 2020). Furthermore, AI-driven facial recognition systems are increasingly used for seamless check-in processes, enhancing security and expediting guest arrivals (Jung et al.,2019). These diverse applications underscore AI's transformative potential in enhancing guest experiences and operational efficiency within the hospitality sector.

2.2.1 Chatbots in hotels

A hotel chatbot is a conversational assistant powered by artificial intelligence and machine learning. It can interact with customers via text or voice and respond to their inquiries quickly and consistently 24/7. Chatbots can store customer information and provide personalized recommendations, making them a valuable tool for improving customer service and loyalty in the hotel industry.

The human and the chatbot: two complementary roles:

Even if artificial intelligence is still often perceived as futuristic technology, it is already well and truly present in our daily lives and especially when we go on vacation. According to Gartner, in 2020, we can already see that chatbots represent a real revolution. It is indeed the ideal tool for companies and in particular those in the tourism industry because it gives a quick and consistent response to its customers, 24/7, but also thanks to its ability to store customer information. It reacts to questions that are asked in writing or verbally.

Thanks to artificial intelligence and machine learning, the chatbot, or conversational assistant, has two essential qualities: language and cognitive intelligence. At any time of the day or night, it can provide a quick and coherent answer to thousands of tourists looking for a Wi-Fi code or a room number.

And, if the chatbot has been well programmed, it offers a conversation with the customer that respects the culture and brand image of the company or person using it. Moreover, beyond being an assistant, the chatbot is also a store of information, storing in some cases, past conversations between it and a customer, to be able to offer personalized suggestions during the next conversations.

Providing quality conversations for tourists:

From advice on selling airline tickets to customer service for vacation rentals, chatbots are becoming communication tools, but it is imperative that they are well designed and respond to customer issues.

The traveler should not be used as a guinea pig to train the chatbot with which he is having a conversation.

It is unthinkable that he would have to rephrase his question several times to get the right answer, hence the need to train his artificial intelligence so that the chatbot can understand a question that is not in the models that have been provided.

To start with, you must define what a chatbot will be used for. It must absolutely represent an added value for the company in the tourism industry. Whether it is to reduce the human time spent on customer service or to facilitate access to personalized offers for the user, it is essential to define the role of the chatbot by assigning it a precise mission. It is also necessary to define the target audience of the chatbot to be able to calibrate its content as well as possible.

Then, the technical part represents a fundamental point that will define the user experience of the travelers and will make it a good or a bad chatbot. The suggested answers as well as the products put forward must be in accordance with the customers' expectations.

Another point: it is important to define the perimeter in which the chatbot must intervene, to which questions it must answer, to which people it must eventually refer. Even if the company must be able to anticipate all possible answers, the technological progress today allows the most advanced conversational robots to understand a text not suggested by the user, with possible typing or spelling mistakes. The chatbot must imperatively be considered as a full-fledged interlocutor: users will chat with it, trust it, deliver their problems and will therefore be grateful if it solves their problem or frustrated if it does not.

It is therefore necessary to be able to "train" its bot so that it is able to react to situations that are out of the ordinary. Booking.com, the online tourist accommodation booking site, has met all these challenges by developing its own optional chatbot service. The Dutch company seized the opportunity to develop a question detection.

An economic upheaval and a redistribution of roles:

While a handful of people see automation as a threat to jobs, most people believe that working with robots offers employees the opportunity to train for more skilled positions.

The real challenge facing tourism companies in the face of artificial intelligence is not automation but the level of qualification of the profiles that must be revised upwards.

The original goal of industrial robots is to free people from certain tasks and to make their work easier. To keep up with the fast and constant pace of technological advances, companies will need more and more specialized talents.

On the other hand, empathy will play a role in humanizing this technology and the profiles recruited will have to have this major asset. As the machine settles in our lives, human qualities are revalued. Artificial intelligence is a considerable advance that will change the way we work.

With such a device, tourists can above all have access to the right information as simply as possible and at any time.

This complementarity between man and technology will allow the implementation of more efficient customer relationship services, always in search of customer satisfaction.

2.2.2 Virtual and augmented reality

The integration of AI in hospitality, particularly through virtual and augmented reality (VR/AR), is significantly enhancing guest experiences and operational efficiencies. Virtual reality allows potential guests to take immersive virtual tours of hotel properties, aiding in their decision-making process Tussyadiah and Park, (2018). Augmented reality, on the other hand, enhances on-site guest experiences by providing interactive digital overlays, such as real-time information about amenities and local attractions Kim and Hall (2019). Additionally, VR is utilized for staff training, creating realistic scenarios for skill development without the risks associated with live environments Dieck and Jung, (2018). These innovations illustrate the transformative potential of AI, VR, and AR in elevating service standards and operational effectiveness in the hospitality industry.

Before the trip: immersion as a promotional tool:

Club Med for its villages or New Caledonia Tourism, allow agencies equipped with virtual reality headsets to show their customers their destination via YouTube 360° and Facebook 360°.

On a smaller scale, hotel rooms can be visited before booking, this is what large hotel chains such as Marriott or Western Union, or the tour operator Expedia offer.

The visit before choosing is a solution that can easily be adapted to attract customers to cultural or sports sites and activities.

During the trip: underwater visit with Eurostar or panoramic film in flight:

For more than a year, Eurostar has been offering its customers the opportunity to visit the underwater world during the Channel crossing. Not through the windows but thanks to virtual reality. The French startup Skylights is preparing helmets for airlines to rent to each passenger, this solution immerses him in a movie theater with panoramic screen.

Similar helmets, lent this time because they are sponsored, could also help promote destinations or activities in flight.

During the stay: cities, monuments and museums in virtual or augmented reality:

The Bordeaux tourist office, for example, offers an iPad for an augmented reality tour of the city.

More nostalgic, the Havre lets its visitors and inhabitants relive the city before its destruction by the bombing, thanks to virtual reality terminals.

As for museums and monuments, visitors to the Detroit Institute of Arts can discover the monument via an augmented reality application.

After the trip: sharing in 360° quality:

YouTube 360° and Facebook 360° technologies now allow travelers to share their experiences in 360°, thanks to cameras embarked by drones, offered for rent by some destinations that have seized this opportunity.

Home travel:

Beyond the fashion effect, virtual and augmented realities could bring a lot to people with disabilities, or of an advanced age for example, by giving them unforgettable tourist sensations.

Virtual and augmented realities both have their place in the tourism and culture sectors, each with a specific use.

Virtual reality is to inspire travelers before they leave or to recreate works of art, augmented reality is to add a layer of information during the tourists' wanderings.

Smart hotel rooms:

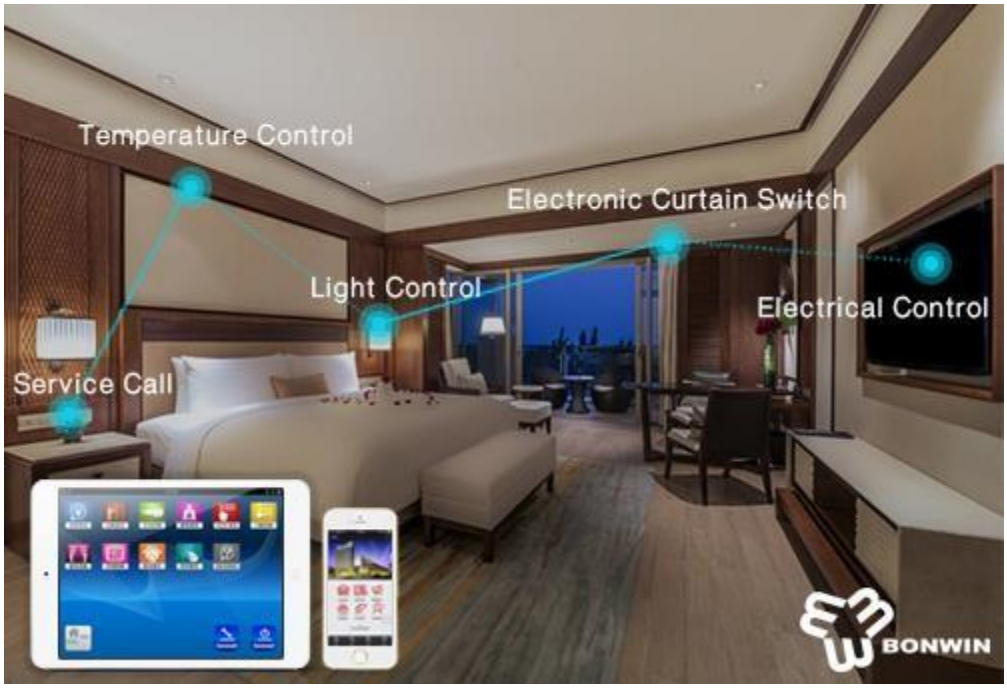

Figure 8. Artificial intelligence in hotel rooms.

Source: Hennnahotel (2015).

Intelligent room control:

This innovative room control technology not only optimizes internal processes and saves energy, but also increases the hotel's occupancy rate. It is a method that always surprises guests and is therefore attractive to them.

The quality of the general impression of the guests is achieved by innovative room controllers. These control heating, air conditioning, ventilation, lighting, blinds, curtains and, depending on the level of IT development, the Internet, television and audio system.

The rooms can also be controlled using conventional local controls or from a tablet or mobile app, it is an experience close to perfection.

The combination of room control with the hotel's IT system provides completely new functions in the rooms: mood scenarios and alarm clocks amaze guests by combining light effects with temperature changes and special audio/video atmospheres.

An innovative well-being factor for customers:

- Intuitive use from a tablet or mobile application.

- Selection of mood scenarios (relaxation, business, etc...).

- Unlimited setting possibilities for a charming atmosphere.

- Pre-setting of the room (lighting, air conditioning, etc...) before the arrival of the guest according to his preferences.

This control technology is perfectly integrated with the hotel's IT systems and management.

It increases the performance of the establishment. This management system makes it possible to keep a constant eye on the parameters and status of all cabins. This makes it easier to control internal processes in an optimal way.

An energy saving factor:

Thanks to this sophisticated system the temperature, ventilation and lighting are controlled and adjusted in a fully automated and reliable way according to the current use of the room in question.

For example, if the passenger leaves the cabin or if a cabin is not yet booked, the temperature and ventilation switch to energy-saving mode and the electrical equipment is switched off.

This is called energy consumption on demand: the whole system never consumes more than the required energy and without compromising the comfort of the customer.

2.3 The impact of AI on Chinese tourists

Artificial intelligence and personalized services have become a priority for Chinese travelers.

How do these technologies influence the hotel industry?

According to a study by Mazars (2024), 1.75% of Chinese people are positively influenced in their purchase decision by hotel services based on artificial intelligence, while Western tourists are 30% in this case.

From smart hotel rooms to personalized dining and sightseeing options, the hotel industry is in fertile ground for the development of AI-based innovations.

Chatbots and concierge robots such as Phil Welcome, AccorHotels' digital concierge, are multiplying to facilitate hotel selection, speed up check-in, offer real-time pricing or advise and book local activities.

But is this really what customers want?

Mazars, (2024) surveyed industry specialists and 750 French, English, German, Chinese and American travelers about their expectations regarding the use of artificial intelligence in the hotel industry, one of the highlights of the report being the expectations of Chinese tourists.

Only 33% of travelers surveyed have recently experienced a "digital innovation" in the hotel industry. 59% of the French and English and 48% of the Germans have no "memorable memories" related to innovation in the hotel industry.

On the other hand, 87% of Chinese say they have had a memorable experience involving digital innovation, according to the Mazars study.

2.3.1 Technology influences Chinese choices

When it comes to customer expectations of AI, personalized recommendations, virtual reality and real-time pricing are in the top three, but the differences by nationality are again very marked.

According to Mazars (2024), this chart shows that only 31% of Western travelers on average think that they will be positively influenced in their purchasing act by services using artificial intelligence.

On the other hand, Chinese tourists are particularly sensitive to it: it will influence their choice of hotel for 75% of them.

The "connected room" features are the first expectation of Chinese tourists, allowing for example to control curtains, equipment, and air conditioning from a smartphone or a personal tablet mentioned in the figure 9.

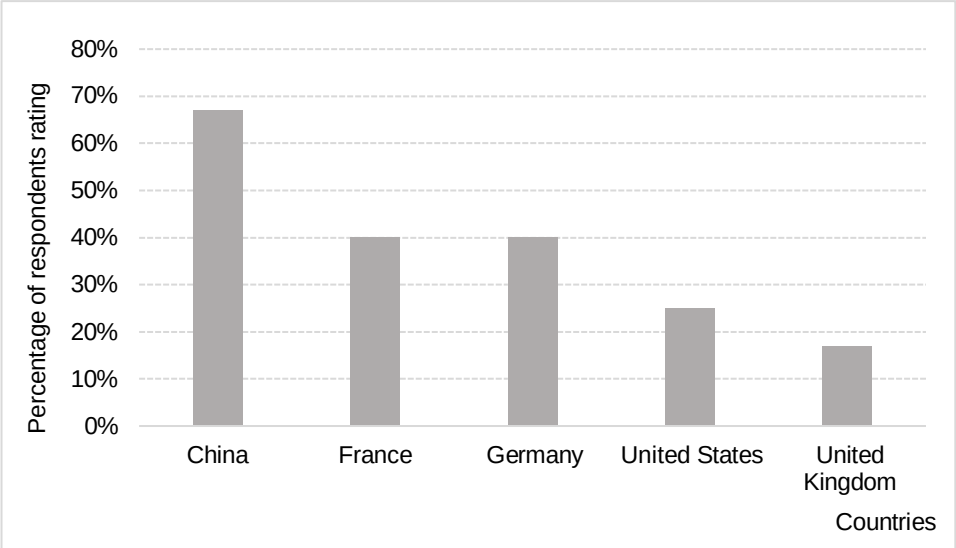

Figure 9. The influence of AI on the hotel choice of customers of different nationalities.

Source: Authors' own elaboration.

2.3.2 Data sharing: the Chinese are also more inclined

Nearly 97% of Chinese travelers, compared to 80% of Westerners, are willing to share at least one piece of personal information in order to access artificial intelligence services in their hotels: whether it is their hobbies, their jobs or their profiles used on social networks (Chen & Mao, 2020).

According to Mazars (2024), 30% of Chinese customers are able to share their social network profile, 19% have shared their phone applications and 11% have provided their personal photo galleries in order to benefit from an AI-related service.

While Western customers only 9% shared their profiles on social networks, 8% provided their phone applications and 5% shared their personal photos as we see in the figure 10.

The notion of artificial intelligence is much more ingrained in the Chinese than in the West.

The hotel industry must therefore be able to reassure its customers about the security of their data, so that they can share it without fear.

Figure 10. Percentage of travelers willing to share their personal data.

Source: Authors' own elaboration.

2.3.3 The new type of Chinese tourists generated by AI

The emergence of a new category of Chinese travelers looking for personalized and innovative experiences is redrawing the lines of the hotel industry. While the older generations still rely on tour operators, the new category of Chinese travelers are more independent and use new technologies to plan their trips, book, search for recommendations and pay. And these people represent today more than 30% of the Chinese population (Wang & Wu, 2021).

2.3.4 Another style of AI that fits into the hospitality industry

Another promising style of AI that integrates seamlessly into the hospitality industry is Conversational AI, which encompasses technologies like chatbots and virtual assistants. Conversational AI is designed to understand and engage in human-like interactions, providing personalized and efficient guest services. For instance, chatbots can handle a variety of guest inquiries, from room service requests to local attraction recommendations, thereby reducing the workload on hotel staff and enhancing guest satisfaction. According to Smith et al. (2023), hotels utilizing chatbots reported a significant reduction in response times and increased guest engagement levels, as these systems are available 24/7 to assist with common queries and tasks. Similarly, Jones, (2023) emphasizes that virtual assistants powered by natural language processing (NLP) can offer tailored recommendations based on previous guest interactions and preferences, creating a more personalized experience. Liu and Wang, (2023) highlight that the integration of conversational AI not only streamlines operations but also gathers valuable data on guest preferences and behaviors, which can be leveraged to further refine services and marketing strategies. Additionally, Brown, (2024) notes that advancements in AI-driven conversational interfaces are enabling hotels to cater to international guests more effectively by providing real-time translations and multilingual support. As the technology evolves, the application of Conversational AI in the hospitality sector continues to expand, promising even greater enhancements in guest experience and operational efficiency.

2.4 Robots in the accommodation sector

Robots in the accommodation sector are increasingly utilized for tasks such as automated check-ins, luggage transport, and room service delivery, enhancing operational efficiency and elevating guest experience through seamless and innovative service interactions.

2.4.1 Case of the Henn-na Hotel in Japan

In 2015, the Henn-na hotel located in an amusement park in Sasebo (Japan) opened its doors with great fanfare and with robots as receptionists in charge of welcoming customers.

Everywhere in the establishment, robots replaced waiters, baggage handlers and other receptionists. Smartphones that act as room keys, voice speakers that turn on the lights.

The hotel industry is taking the path of innovation by integrating all the latest high-tech innovations. An evolution that facilitates the life of travelers through simplified check-in procedures.

"At first, what we wanted to do was to reduce our labor costs," explains Miura Tatsuki. "But very quickly, the robots themselves became an attraction in their own right" (Reis, 2020).

They added to the entertainment and were very quickly noticed. So, these robots can really provide a fun touch for the guests and give them a nice memory of their stay.

The success was so huge that this concept of a hotel without humans made worldwide news. These figures include two robots, one of which is humanoid (a human-shaped robot), both of which are multilingual and handle the reception of guests and manage the various reservations of the hotel as it has been shown in the Figure 11.

Given the context thesis on AI in the Tunisian hotel industry, this image may be included to illustrate a real-world example of AI application in the hospitality sector, particularly in Japan, which is known for its advancements in robotics and automation.

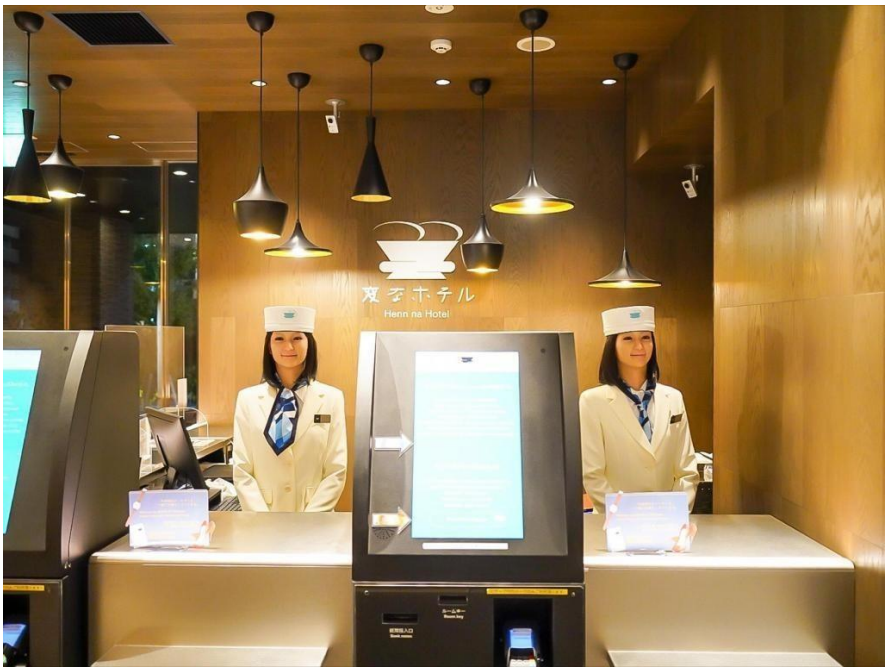

Figure 11. Robots that take care of the check-in at the Henn-na hotel.

Source: Hennnahotel (2015).

Facial recognition and luggage-carrying robots showcase the hospitality industry's embrace of automation. These technologies offer improved efficiency, security, and guest experiences, but raise questions about job displacement, guest acceptance, and data privacy presented in the figure 12.

Figure 12. Robots that carry customers' luggage.

Source: Hennnahotel (2015).

Tapia, as a hotel concierge robot, showcases technological innovation in the hospitality industry by automating tasks, enhancing guest experience through bedside service, and offering potential for personalized interactions and marketing appeal. However, limitations of AI and robotics, integration with existing systems, and ethical considerations need to be addressed for successful implementation.

Figure 13. A system for accessing rooms unlike any other.

Source: Hennnahotel (2015).

The lobby robot concierge in figure expands the technological reach of automated guest services, providing information and assistance to a wider audience in a public setting. It offers a unique first point of contact, 24/7 availability, and data collection capabilities, but faces challenges in handling public interactions, integration with lobby systems, and ensuring language and cultural sensitivity.

Figure 14. The robot concierge in the room.

Source: Hennnahotel (2015).

Figure 18 and figure 19 shows a small robot that is present in each room that is responsible for controlling the lighting and other features via voice command.

Figure 15. The robot concierge in the lobby.

Source: Hennnahotel (2015).

The in-room robot with voice control features demonstrates a high level of technological integration in hotel rooms, enhancing guest convenience through automated room controls. This innovation can improve efficiency and potentially offer personalization, while also serving as a unique selling point. However, technical reliability, data privacy, accessibility, and integration with other room systems are key considerations for successful implementation.

Figure 16. The lighting robot.

Source: Hennnahotel (2015).

2.4.2 Robots in the restaurant industry

The integration of robots in the restaurant industry represents a transformative shift in service delivery and operational efficiency. As highlighted by Smith and Johnson (2023), robots are increasingly employed for tasks such as food preparation, table service, and customer interaction, revolutionizing traditional restaurant workflows. Moreover, research by Chen et al. (2022). underscores the potential of robotic systems to enhance dining experiences by reducing wait times, ensuring order accuracy, and providing unique entertainment value to patrons. In addition, the study conducted by Lee and Kim (2024) emphasizes the role of robots in addressing labor shortages and minimizing human contact, particularly relevant in the context of health and safety concerns such as those posed by the COVID-19 pandemic. These findings collectively underscore the significant impact of robots on reshaping the restaurant landscape, ushering in an era of heightened automation and innovation.

Japan had its fully robotized hotel, now it's China's turn to inaugurate its first fully automated restaurant.

its fully robotized hotel, now it's China's turn to inaugurate its first fully automated restaurant.

In Guangzhou, a coastal city not far from Hong Kong, it has just opened an innovative restaurant that uses the latest robotics to automate processes they take place in one of the business and offers unique user experience that also serves a commercial demand (Zhang, 2024).

In this establishment, the reception, the kitchen, the bar, the service or even the cashing are tasks performed not by employees but by robots. All fronts of the restaurant are automated using robotics, and this includes the service comradeship.

No staff members to serve customers, a historic restoration, it was achieved through 46 robots, all created by the subsidiary country Holding Jardin. The operation of the premises seems complex from a technological point of view but is actually very simple.

Visitors must place their order from a touch screen that presents the letter of the restaurant. Once they have chosen and confirmed their order, the information is transmitted to the robots, which are responsible for preparing the appropriate dishes.

The customer can remain engrossed in watching the robot's articulated arms prepare the meal for them, or conversely, the customer can sit quietly at the table of their choice and wait for the delivery robots to serve the food. These Automats keep the preparation time to a minimum, stipulating a maximum of five minutes between the moment the visitor gives his orders and the moment it is served.

In addition, the kitchen robots are able to ensure all the health standards, homogeneity and fiscal quality as well as the hospitality of the company's administrators to governmental or administrative bodies.

The pasta, rice, desserts and cocktails served in the restaurant have nothing to envy to those made by award-winning chefs and baristas. And for this has not been necessary to sacrifice the aesthetics of the local. Although the robots have an appearance that is not attractive, it has been refined to be visually pleasing. Behind the scenes, the machines are also busy receiving deliveries and ensuring that the various products are properly stored.

This figure shows a robot that is in charge of welcoming the customer and coordinating all the service personnel, it performs the same tasks as a butler.

The robot bartender in Figure 20 represents a significant advancement in automating complex tasks in the service industry, offering novelty, consistency, efficiency, and hygiene advantages. However, it also poses challenges related to technical complexity, maintenance, limited interaction, safety, and ethical considerations regarding job displacement.

Figure 17. A robot butler.

Source: Hennnahotel (2015).

The use of multiple specialized culinary robots signifies advanced automation in the kitchen, offering enhanced efficiency, consistency, menu variety, and hygiene. However, challenges in technical complexity, coordination, adaptability, cost-effectiveness, and ethical considerations need to be addressed for successful implementation.

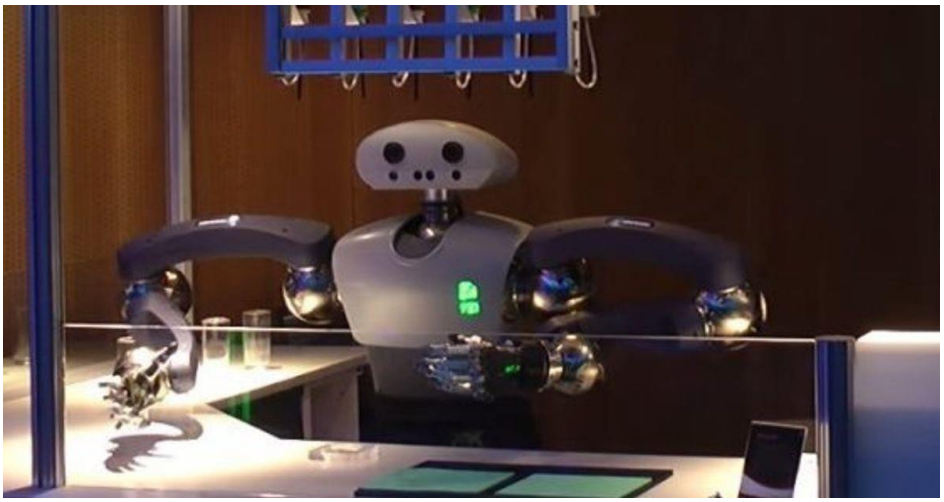

Figure 18. A robot bartender

Source: Hennnahotel (2015).

They know all the recipes by heart, which they prepare in less than 20 seconds. Their productivity is unbeatable. They can also prepare meals from different regions; one can make spaghetti Bolognese and the other can make Thai noodles.

The automated food delivery system showcased in Figure 22 represents a significant technological innovation in the service industry. By utilizing overhead tracks and sensor-equipped machines, it offers potential benefits such as enhanced efficiency, novelty, space optimization, and improved hygiene. However, successful implementation requires careful consideration of technical complexity, integration with ordering systems, safety measures, cost-effectiveness, and customer acceptance.

Figure 19. Different types of robotic cookers.

Source: Hennnahotel (2015).

The simplified food delivery system in Figure 23, utilizing tabletop delivery, offers a practical and potentially cost-effective approach to automation in the service industry. It focuses on efficient

delivery and integration with kitchen workflow, with potential for customization. However, capacity, hygiene, aesthetics, and customer experience are key considerations for successful implementation.

Figure 20. A simplified food delivery system

Source: Hennnahotel (2015).

The burgeoning presence of AI within hotel services may not yet be overtly apparent to travelers, who, nevertheless, harbor escalating expectations of an ever enhanced and personalized experience. In an era marked by a paradigm shift in tourism, where travelers increasingly seek independence and unique encounters, the industry's adeptness in harnessing AI and cutting-edge technologies as formidable tools for attracting, engaging with, and retaining customers assumes pivotal significance.

This transformation is akin to the silent conductor orchestrating a symphony behind the scenes, working diligently to ensure that every guest's stay is a harmonious and memorable one. In an age when individualization is not merely desired but anticipated, AI acts as the unseen maestro, customizing everything from room preferences to dining recommendations to meet each traveler's unique expectations.

The pivotal role AI plays in this arena cannot be overstated. It is not just a technological novelty; it is the cornerstone of a new era of hospitality where guests are not passive observers but active participants in the creation of their own journeys. As AI continues to evolve and mature, travelers can expect a future where their preferences and desires are not only anticipated but also seamlessly integrated into every aspect of their sojourn, crafting a travel experience that is as unique and individual as they are (Chen et al., 2020).

In this section, we've embarked on an illuminating journey through the world of Artificial Intelligence (AI) in the context of the hotel industry. We've traversed the theoretical landscapes, understanding the very essence of AI and its profound implications. We've witnessed how AI isn't merely a technological marvel but a paradigm shift, a transformational force that promises to redefine the hospitality experience.

One of the key takeaways from this section is the critical role AI plays in the realm of tourism and hospitality. We've heeded the voices of hotel professionals who recognize AI's potential to not only streamline operations but to elevate customer satisfaction to new heights. These insights from industry experts underscore AI's indispensability in the competitive landscape of modern hotels (Gretzel et al., 2015).

Furthermore, we've delved into the multifaceted applications of AI in hotels, drawing inspiration from innovative practices in Asia. From chatbots providing seamless guest interactions to data analytics shaping marketing strategies, we've seen AI in action, driving efficiencies and enhancing guest experiences.

3 Tunisia's Tourism Sector: A 20-Year Review of Growth and Economic Contribution

In the preceding sections, we explored the profound influence of Artificial Intelligence (AI) in shaping the landscape of the hotel industry, particularly in Tunisia. We delved into the conceptual foundations of AI in section 1 and examined its application within the hotel sector in Tunisia in section 2. These discussions highlighted the significant role AI plays in enhancing operational efficiency, guest experiences, and overall competitiveness within the Tunisian international hotel industry.

Section 3 embarks on a distinct trajectory. Here, we shift our focus from the technological realm to the empirical domain, delving into the heart of Tunisia's hotel industry over the last two decades. This section is a multifaceted exploration of the industry's vital statistics, the trends that have defined it, and the economic implications of these trends.

Our journey begins with an in-depth analysis of the entries of non-residents per month, meticulously recorded from the year 2000 to 2020. These numbers serve as a powerful lens through which we scrutinize the ebb and flow of Tunisia's attractiveness as a tourist destination.

Subsequently, we zoom out to examine the annual entries of non-residents, providing a comprehensive perspective on the industry's growth trajectory over the years.

A pivotal moment in our analysis emerges as we compare the entries of non-residents in the critical years of 2010, 2011, and 2012. This period witnessed a significant political transformation in Tunisia, known as the Arab Spring. We explore the impact of this historical event on tourist arrivals and its repercussions on the industry's economic contributions.

From there, we pivot to the recent past, scrutinizing the years 2018, 2019, and 2020. This analysis is marked by the unprecedented global challenge: the COVID-19 pandemic. The section meticulously dissects the pandemic's effects on the industry's health and resilience.

Our exploration extends to encompass other vital metrics, including the nights spent by non-residents, foreign currency incomes, revenues per night, and revenues per bed. These metrics offer multifaceted insights into the industry's economic dimensions.

As we traverse the intricate landscape of Tunisia's international hotel industry, this section endeavors to unveil trends, challenges, and opportunities that have defined its past and are poised to shape its future. By dissecting these economic and statistical intricacies, we aim to contribute to a holistic understanding of the industry's dynamics, aligning it with the overarching theme of harnessing AI for sustainable growth and innovation within Tunisia's vibrant hotel sector.

3.1 Entries of non-residents (2000-2020)

Analysis of customers' entries in Tunisian hotels from non-residents over the past two decades (2000-2020) sheds light on the significant contribution of foreign currency incomes and the resultant impact on the country's GDP.

3.1.1 Entries of non-residents per month

The table in the page 41 presents the monthly data of non-residents in Tunisia for the preceding two decades, covering the years 2000 to 2020. These numbers intricately reflect the dynamic nature of international tourism, subject to a multitude of influences ranging from political shifts to global health crises. As we delve into these figures, we embark on a journey through time, unraveling the fluctuations that have shaped Tunisia's reception of non-resident visitors.

2000 began with 208.1 entries in January, gradually increasing to 262.5 entries in February and further rising to 342.4 entries in March. April saw a significant jump to 484.0, and the numbers remained relatively high in May at 407.9, peaking in July at 585.8, reflecting the peak season for travel and tourism. August maintained a high number of entries at 664.2, thanks to vacation periods and favorable weather conditions. However, the numbers started to decline in September (527.0) and continued decreasing in the following months, with November (324.7) and December (264.4) marking the lowest entries in the year. These fluctuations are attributed to factors such as seasonal patterns and holidays. The total entries of non-residents in 2000 summed up to 5057.5.

The data for 2001 shows a similar pattern of monthly entries compared to the previous year. In January, there were 246.8 entries, which increased to 301.9 in February and further rose to 401.4 in March. April witnessed a significant jump to 552.2, indicating a potential increase in visitors during that period. The numbers remained relatively high in May at 461.9 and peaked in July at 660.5, suggesting a peak season for travel or tourism, similar to the previous year. August continued the trend with a high number of entries at 738.0, indicating a popular vacation period and favorable conditions for visitors. However, starting from September (581.5), the numbers gradually decreased in the following months, with November (243.1) and December (228.2) marking the lowest entries in the year. The total entries of non-residents in 2001 amounted to 5387.3, slightly higher than the previous year.

The data of 2002 shows fluctuations in the monthly entries of non-residents. The year began with 219.3 entries in January, which increased to 256.2 in February and further rose to 400.8 in March. April maintained a similar level of entries at 406.9, followed by a slight increase to 409.1 in May. June witnessed a noticeable jump to 462.8, indicating a potential increase in visitors during that period. The trend continued in July with a further rise to 575.4, suggesting a peak season for travel and tourism during the summer months. August marked the highest number of entries in the year at 715.4, reflecting a popular vacation period and favorable conditions for visitors. From September (540.1) onwards, the numbers gradually decreased in the following months, with November (255.3) and December (332.1) showing lower entries. The total entries of non-residents in 2002 reached 5063.5, slightly lower than the previous year.

The tabulated data for 2003 reveals variations in the non-residents' monthly entries. In January, there were 231.0 entries, which increased to 258.5 in February, and 314.0 in March. The number of entries increased in April to 372.6, then fell somewhat in May to 354.6. A substantial rise to 471.7 in June suggests that there may have been more visitors during that month. The pattern persisted in July with an additional increase to 624.4, indicating a summer travel or tourist high season. With 820.1 submissions, August had the most entries this year, which was a result of many people taking vacations and the good weather. The following months saw a progressive decline in the numbers from September (548.4) onward, with November (267.4) and December (359.6) exhibiting swings in entries. The total entries of non-residents in 2003 amounted to 5114.3, nearly the same as in 2002.

The data for 2004 displays variations in the non-residents' monthly entries. In January, there were 271.8 entries, which increased to 313.1 in February and 370.9 in March. The number of entries increased in April to 456.1, then increased slightly in May to 478.7. A notable increase to 552.2 in June suggests that there may have been more visitors during that month. The trend persisted in July with an additional increase to 736.6, indicating a summer travel and tourism high season. With 906.3 entries, August had the most entries this year, which was a result of a popular vacation time and welcoming weather for travelers. The numbers significantly fell in the months that followed after September (641.9), with November (324.6) and December (395.4) exhibiting swings in entries. The overall number of non-resident entries in 2004 was 5998.1, a modest rise from the prior year.

The tabulated data for 2005 shows fluctuations in the monthly entries of non-residents. The year began with 299.0 entries in January, which slightly increased to 312.9 in February. March witnessed a notable jump to 416.1, indicating an increase in visitors during that period. April continued the upward trend with 476.9 entries, followed by further growth to 554.8 in May. June saw a significant increase to 641.8, suggesting a peak season for travel and tourism during the summer months. July marked a substantial rise to 841.8, reflecting a popular vacation period and favorable conditions for visitors. From August (948.8) onwards, the numbers gradually decreased in the following months. September (676.4) and October (520.8) continued to show lower entries. November (333.7) and December (355.5) demonstrated further fluctuations in the number of entries. Similar to previous years, these fluctuations are influenced by some factors, including seasonal patterns and holidays. The total entries of non-residents in 2005 amounted to 6378.4, slightly higher than the previous year.

The data for 2006 shows fluctuations in the monthly entries of non-residents. The year began with 287.9 entries in January, which slightly increased to 301.0 in February. March witnessed a notable jump to 387.1, indicating an increase in visitors during that period. April continued the upward trend with 565.8 entries, followed by 540.3 in May. June saw a significant increase to 636.5, suggesting a peak season for travel and tourism during the summer months. July marked a substantial rise to 866.2, reflecting a popular vacation period and favorable conditions for visitors. From August (1,025.1) onwards, the numbers gradually decreased in the following months. September (714.5) and October (578.0) continued to show lower entries. November (333.0) and December (314.0) demonstrated further fluctuations in the number of entries. The total entries of non-residents in 2006 amounted to 6549.5, a slight increase compared to 2005.

In 2007, the data reveals fluctuations in the monthly entries of non-residents. The year began with 307.5 entries in January, which slightly increased to 314.4 in February. March witnessed a notable jump to 414.7, indicating an increase in visitors during that period. April continued the upward trend with 552.4 entries, followed by 542.2 in May. June saw a significant increase to 670.2, suggesting a peak season for travel and tourism during the summer months. July marked a substantial rise to 910.3, reflecting a popular vacation period and favorable conditions for visitors. From August (1,056.3) onwards, the numbers gradually decreased in the following months. September (706.2) and October (605.5) continued to show lower entries. November (348.6) and December (333.4) demonstrated further fluctuations in the number of entries. The total entries of non-residents in 2007 amounted to 6761.9, slightly higher than the previous year.

The data for 2008 displays variations in the non-residents' monthly entries. In January, there were 308.6 entries, which marginally grew to 336.9 in February as the year got underway. A large increase to 455.7 in March indicated an increase in visitors during that month. With 516.7 entries in April, the rising trend was maintained. In May, there were 601.6 entries. The large increase to 732.9 in June suggests that the summer months are the busiest for travel and tourism. The significant increase to 958.3 in July and 1094.4 in August was due to a popular vacation month and welcoming travel conditions. Lower entries were seen in September (634.7) and October (649.5). Further variations in the number of entries were seen in November (376.6) and December (383.9). The number of non-resident entries grew from 2007 to 2008, totaling 7050.3.

The tabulated data for 2009 shows fluctuations in the monthly entries of non-residents. The year began with 314.5 entries in January, which increased to 344.1 in February. March witnessed a notable jump to 432.9, indicating an increase in visitors during that period. April continued the upward trend with 562.3 entries, followed by 594.2 in May. June saw a significant increase to 718.5, affirming a peak season for travel and tourism during the summer months. July marked a substantial rise to 986.4, reflecting a popular vacation period and favorable conditions for visitors. From August (938.2) onwards, the numbers gradually decreased in the following months. September (631.8) and October (612.5) continued to show lower entries. November (360.4) and December (406.5) demonstrated further fluctuations in the number of entries. The total entries of non-residents in 2009 amounted to 6902.3, slightly lower than the previous year.

In 2010, the data shows fluctuations in the monthly entries of non-residents. The year began with 333.1 entries in January, which slightly decreased to 324.6 in February. March witnessed a notable jump to 441.0, indicating an increase in visitors during that period. April continued the upward trend with 495.0 entries, followed by 612.1 in May. June saw a significant increase to 702.8, affirming a peak season for travel and tourism during the summer months. July marked a substantial rise to 1064.2, reflecting a popular vacation period or favorable conditions for visitors. From August (810.1) onwards, the numbers gradually decreased in the following months. September (690.3) and October (646.2) continued to show lower entries. November (368.4) and December (415.6) demonstrated further fluctuations in the number of entries. The total entries of non-residents in 2010 amounted to 6903.4, nearly the same as the previous year.

The tabulated data for 2011 shows fluctuations in the monthly entries of non-residents. The year began with 177.7 entries in January, which slightly increased to 184.1 in February. March witnessed a notable jump to 252.3. April continued the upward trend with 313.9 entries, followed by 387.1 in May. June saw a significant increase to 462.5. July marked a substantial rise to 648.9. From August (621.4) onwards, the numbers gradually decreased in the following months. September (599.6) and October (494.2) continued to show lower entries. November (372.5) and December (271.1) demonstrated further fluctuations in the number of entries. The total entries of non-residents in 2011 amounted to 4785.3, significantly lower than the previous years. The decrease in entries in 2011 is attributed to the significant event that took place in Tunisia that year: the revolution commonly known as the Tunisian Revolution or the Jasmine Revolution. The revolution in Tunisia began in December 2010 and continued into 2011, leading to widespread social and political upheaval. It was triggered by a wave of protests against high unemployment, government corruption, and lack of political freedoms. The movement gained momentum and eventually resulted in the overthrow of the longstanding authoritarian regime led by President Zine El Abidine Ben Ali. The revolution in Tunisia was seen as a pivotal moment in the Arab Spring, inspiring similar uprisings across the region. The events in Tunisia captured global attention and sparked discussions about democracy, human rights, and political change. During the revolution and its immediate aftermath, there was a significant disruption in the country's overall stability and security. This likely had an impact on tourism and travel, as the situation in Tunisia was perceived as uncertain and potentially unsafe by potential visitors. The decrease in entries of non-residents in 2011 can therefore be understood as a consequence of the revolution and its impact on the country's tourism industry. It's important to note that the decrease in tourist arrivals was not unique to Tunisia but was observed in several countries experiencing similar political transitions during the Arab Spring.

The data for the year 2012 displays the entries of non-residents per month, showcasing fluctuations throughout the year. The numbers started at 310.3 entries in January and slightly decreased to 255.8 in February. March witnessed a notable jump to 371.8, indicating an increase in visitors during that period. From April to August, the entries continued to rise steadily, reaching the highest point in July at 742.5, reflecting a peak travel season during the summer months. August maintained a similar level of entries at 739.7. From September onwards, the numbers gradually decreased in the following months, with November and December showing lower entries compared to the peak months. The total entries of non-residents in 2012 amounted to 5950.4, experiencing a noticeable increase compared to the previous year, which was the year of the revolution.

In 2013, the year commenced with 279.1 entries in January, followed by a slight decrease to 248.4 in February. March witnessed a notable increase to 395.9, indicating a rise in visitors during that month. April continued the upward trend with 441.3 entries, followed by a further increase to 551.3 in May. June marked a significant jump to 706.5, suggesting a peak season for travel or tourism during the summer months. July maintained a high number of entries at 666.7, reflecting a popular vacation period. August saw the highest number of entries in the year at 888.6, potentially due to favorable weather conditions and holidays. From September (727.3) onwards, the numbers gradually decreased in the following months, with November (371.4) and December (431.7) showing

fluctuations in entries. The total entries of non-residents in 2013 amounted to 6268.9, marking an increase compared to the previous year.

In 2014, the year started with 340.4 entries in January, which remained relatively stable at 306.4 in February. March saw a slight increase to 342.0, but the notable rise came in April with 448.5 entries. The trend continued to climb in May with 535.2 entries, reaching a significant peak in June at 683.5, likely reflecting the peak of the summer tourist season. July remained high at 654.3, indicating the continued popularity of Tunisia as a summer destination. August recorded the highest number of entries in the year at 958.7, which aligns with the summer vacation period. From September (646.0) onwards, the numbers gradually decreased, with fluctuations in the last few months of the year, November (315.4) and December (350.6). The total entries of non-residents in 2014 amounted to 6068.6, experiencing a slight decrease compared to the previous year.

In 2015, 269.1 entries were made in January, followed by a drop to 218.1 in February. The trend increased marginally in March to 315.9, but significantly in April to 333.1 entries. A further rise to 434.2 in May certainly signaled the start of the tourist season as the weather improved. In June (433.0) and July (365.1), entries were comparatively high, reflecting the summer travel season. With 637.3 submissions, August had the most throughout the year. This corresponds to the busiest time for summer vacations. The numbers began to decline after September (321.9), fluctuating in the final two months of the year, November (242.6) and December (308.4). The total entries of non-residents in 2015 amounted to 4201.9, marking a significant decrease compared to the previous year. In 2015, Tunisia experienced a significant and deeply troubling decline in the total entries of non-residents. This decline was primarily attributed to two horrific terrorist attacks that unfolded in the country that year. The first attack took place at the Bardo National Museum in March, where armed assailants targeted tourists, resulting in the tragic loss of 22 lives, including foreigners. Only a few months later, in June, another heart-wrenching attack occurred at a beach resort in Sousse, claiming the lives of 38 tourists. These attacks had a chilling effect on Tunisia's tourism industry, causing an immediate drop in tourist arrivals. Safety concerns were paramount in travelers' minds, leading to widespread cancellations of bookings and travel plans. Tunisia, celebrated for its historical sites, beautiful coastlines, and cultural attractions, saw a sharp reduction in visitor numbers, affecting an industry that is a vital contributor to the nation's economy. In response to these challenges, Tunisia embarked on an extensive effort to enhance security measures, rebuild trust among travelers, and diversify its tourism offerings. The government collaborated closely with international partners to combat terrorism and promote safety.

In 2016, the year commenced with 209.4 entries in January and 199.5 in February. March and April saw stable entries at 201.5 and 237.4, respectively. May marked a significant upswing with 342.5 entries, signifying the start of the tourist season. Tourist numbers remained robust through June (311.4) and reached their peak in July (581.6) and August (832.0) during the summer vacation period. September maintained solid entries at 460.3, while the arrival of cooler weather in October (406.4) led to a slight decline. November (315.5) and December (428.2) exhibited a further decrease, typical

of late autumn travel patterns. The total entries of non-residents in 2016 amounted to 4525.7, indicating a slight increase compared to the previous year.

2017 started with a total of 231.3 entries in January, indicating a moderate influx of tourists during the winter season. February saw an increase to 274.0 entries, possibly due to favorable weather and cultural attractions. The arrival of spring in March brought a significant surge in entries to 374.7, marking the beginning of the tourist season. The summer months, especially July and August, witnessed the highest peaks, with 740.9 and 937.2 entries, respectively. Entries remained solid in September, and as the year transitioned to cooler months, there was a slight decrease in November. The year ended with 529.3 entries in December.

The total of entries of non-residents in 2017 is 5742.6. We can observe a remarkable increase of the entries compared to the previous two years because Tunisia got its stability back.

With 296.0 entries at the beginning of 2018, winter tourism was mild. A little increase to 313.4 entries was recorded in February. March heralded the start of the spring travel season with a significant increase to 451.2 entries. With 528.3 entries, may marked the beginning of the busiest travel season as summer drew near. The highest peaks were recorded in the summer months of July and August, with 869.4 and 931.3 entries, respectively. In September (718.4), entries held steady, and when the year changed seasons, there was a minor fall in November (464.1). Due to holiday travel, the year ended with 677.6 entries in December.

The total of entries of non-residents in 2018 is 6921.2. When compared to the prior year, we can see that the number of entries has significantly increased again.

In 2019, Tunisia's monthly entries of non-residents continued to exhibit a recognizable seasonal pattern. The year began with 387.7 entries in January, signifying a moderate influx of tourists during the winter season. Entries increased slightly in February to 403.5, likely due to pleasant weather and cultural attractions. March marked the commencement of the spring tourist season with a substantial rise to 489.8 entries. As summer approached, may witnessed the start of the peak tourist season with 522.0 entries. June recorded a significant spike with 783.1 entries as tourists flocked to Tunisia's attractions. July and August reached their zenith with 1000.5 and 1068.3 entries, respectively, during the summer vacation period. Entries remained robust in September (833.2), with a gradual decline in the late autumn months. December concluded the year with 737.4 entries, influenced by holiday travel.

The total of entries of non-residents in 2019 is 7984.5. We can see a notable rise of entries when compared to all the previous years. That year, the number of entries of non-residents reached the highest peak.

The monthly entries of non-residents in Tunisia for 2020 reveal a stark and unprecedented decline in tourism. The year started with relatively typical numbers in January (428.7) and February (442.4). However, a significant drop began in March (197.7) when the COVID-19 pandemic started to spread globally.

April (0.1) and May (0.3) recorded almost no entries, reflecting the severe impact of the pandemic and the ensuing travel restrictions and lockdowns. The slight uptick in June (2.1) indicated the cautious reopening of borders.

Throughout the summer months, the numbers remained low as travel uncertainties and health concerns persisted. Even though there was a modest increase in September (49.8) and October (48.1), the figures were a fraction of what they were in previous years.

November (30.7) and December (90.5) continued to show lower numbers compared to pre-pandemic times, as international travel remained constrained.

The total of entries of non-residents in 2020 is 1432. It is lower than all the previous years, it experienced a trough decline.

It's important to note that these numbers reflect not only Tunisia's efforts to rebuild its tourism industry after the challenges of the Arab Spring and security concerns but also the impact of significant global events, especially the COVID-19 pandemic, on international travel and tourism. Countries around the world experienced a sharp decline in tourist arrivals due to the pandemic and the measures taken to contain it. The data illustrates the resilience of Tunisia's tourism sector and its ability to recover after periods of instability and crisis. It's also a testament to the importance of tourism to Tunisia's economy and the challenges it faces in maintaining and growing this vital industry.

Table 1. Entries of non-residents (2000-2020).

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	208.1	246.8	219.3	231.0	271.8	299 .0	287.9	307.5	308.6	314.5	333.1	177.7	310.3	279.1	340.4	269.1	209.4	231.3	296.0	387.7	428.7
2	262.5	301.9	256.2	258.5	313.1	312 .9	301.0	314.4	336.9	344.1	324.6	184.1	255.8	248.4	306.4	218.1	199.5	274.0	313.4	403.5	442.4
3	342.4	401.4	400.8	314.0	370.9	416 .1	387.1	414.7	455.7	432.9	441.0	252.3	371.8	395.9	342.0	315.9	201.5	374.7	451.2	489.8	197.7
4	484.0	552.2	406.9	372.6	456.1	476 .9	565.8	552.4	516.7	562.3	495.0	313.9	468.9	441.3	448.5	333.1	237.4	361.4	470.1	577.9	0.1
5	407.9	461.9	409.1	354.6	478.7	554 .8	540.3	542.2	601.6	594.2	612.1	387.1	499.4	551.3	535.2	434.2	342.5	424.0	528.3	522.0	0.3
6	464.7	538.8	462.8	471.7	552.2	641 .8	636.5	670.2	732.9	718.5	702.8	462.5	596.1	706.5	683.5	433.0	311.4	379.0	590.9	783.1	2.1
7	585.8	660.5	575.4	624.4	736.6	841 .8	866.2	910.3	958.3	986.4	1064.2	648.9	742.5	666.7	654.3	365.1	581.6	740.9	869.4	1000.5	69.9
8	664.2	738.0	715.4	820.1	906.3	948 .8	1025.1	1056.3	1094.4	938.2	810.1	621.4	739.7	888.6	958.7	637.3	832.0	937.2	931.3	1068.3	71.7
9	527.0	581.5	540.1	548.4	641.9	676.4	714.5	706.2	634.7	631.8	690.3	599.6	689.3	727.3	646.0	321.9	460.3	609.5	718.4	833.2	49.8
10	521.8	433.0	490.1	492.0	550.5	520.8	578.0	605.5	649.5	612.5	646.2	494.2	495.0	560.5	488.8	323.1	406.4	500.7	610.5	684.5	48.1
11	324.7	243.1	255.3	267.4	324.6	333.7	333.0	348.6	376.6	360.4	368.4	372.5	385.5	371.4	315.4	242.6	315.5	380.7	464.1	496.5	30.7
12	264.4	228.2	332.1	359.6	395.4	355.5	314.0	333.4	383.9	406.5	415.6	271.1	396.1	431.7	350.6	308.4	428.2	529.3	677.6	737.4	90.5
13	**5057.5**	**5387.3**	**5063.5**	**5114.3**	**5998.1**	**6378.4**	**6549.5**	**6761.9**	**7050.3**	**6902.3**	**6903.4**	**4785.3**	**5950.4**	**6268.9**	**6068.6**	**4201.9**	**4525.7**	**5742.6**	**6921.2**	**7984.5**	**1432.0**

Note: 1-January; 2-February; 3-Mars; 4-April; 5-May; 6-June; 7-July; 8-August; 9-September; 10-October; 11-November; 12-December; 13-Total.

Source: Authors' own elaboration.

Figure 24 conceptually illustrates the fluctuations in Tunisian tourist arrivals over two decades, potentially offering insights into tourism trends, impact on the hospitality industry, and correlation with technological adoption. However, a detailed interpretation requires the actual data to understand specific causes and effects, as well as consideration of external factors influencing tourism.

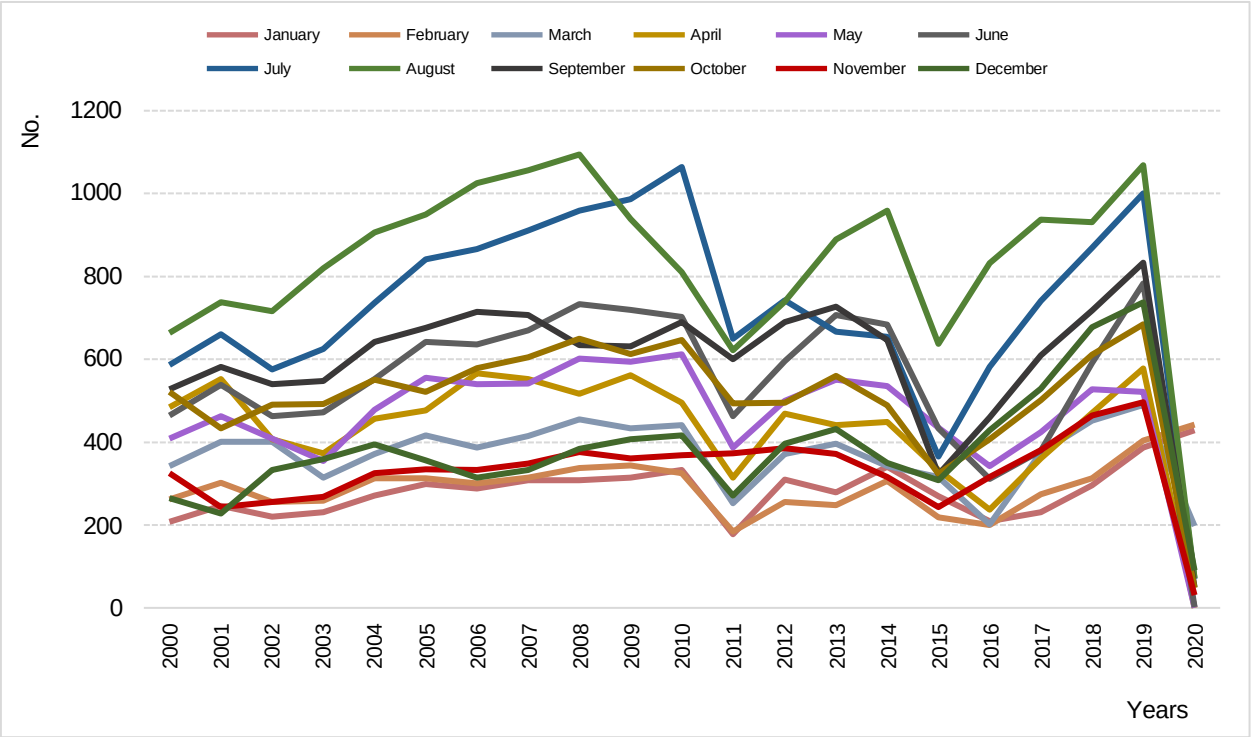

Figure 21. Entries of non-residents per month (2000-2020).

Source: Authors' own elaboration.

3.1.2 Entries of non-residents per year

This section delves into the annual entries of non-residents in Tunisia, providing insights into the fluctuations and trends observed in the tourism sector over the years.

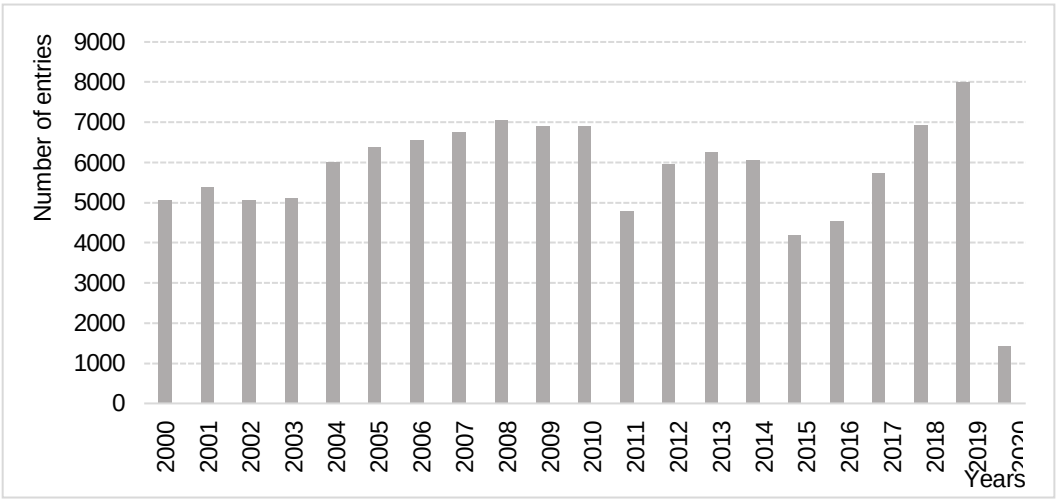

Figure 22. Entries of non-residents per year (2000-2020).

Source: Authors' own elaboration.

The annual entries of non-residents in Tunisia from 2000 to 2020 reflect a dynamic tourism landscape with various trends and significant events:

Steady Growth (2000-2008): The early 2000s witnessed consistent growth in non-resident entries, rising from 5057.5 in 2000 to a peak of 7050.3 in 2008. This growth can be attributed to factors such as improved infrastructure, political stability, and Tunisia's appeal as a tourist destination.

Global Economic Crisis (2009): In 2009, the entries were 6902.3, reflecting relative stability during a period of global economic turmoil. Tunisia's resilience may have been due to its affordability and cultural attractions. However, this period marked the beginning of challenges for the tourism industry.

Post-Revolution Impact (2011): The entries dropped to 4785.3 in 2011, primarily because of the Tunisian Revolution, which disrupted tourism and led to decreased visitor numbers.

Recovery and Growth (2012-2014): Tunisia showed signs of recovery in the following years, with entries increasing to 5950.4 in 2012 and further growth in 2013 and 2014.

Challenges in 2015: The year 2015 posed challenges as two major terrorist attacks targeting foreign tourists occurred, resulting in a sharp decline in entries to 4201.9. Security concerns negatively impacted the tourism sector.

Resurgence in 2019: Notably, 2019 saw a resurgence in entries, reaching 7984.5, which is the highest peak over the course of two decades, suggesting renewed interest in Tunisia as a tourist destination.

COVID-19 Pandemic (2020): In 2020, the global COVID-19 pandemic caused an unprecedented disruption in various sectors, with international tourism being one of the hardest hits. The number of entries plummeted to 1432.0, a stark decline from previous years, as countries worldwide imposed stringent travel restrictions to curb the spread of the virus. Safety concerns and lockdown measures further discouraged travel, leading to a significant downturn in tourism activities. This dramatic reduction highlighted the vulnerability of the tourism industry to global health crises and underscored the far-reaching impact of the pandemic on global mobility and economic stability.

In summary, Tunisia's tourism journey over this period reflects periods of growth, challenges, and recovery. The impact of global events, economic conditions, and security issues on the tourism sector is evident in the data.

3.2 Nights spent by non-residents (2000-2020)

This section discusses the nights spent by non-residents in Tunisia from 2000 to 2020. Analyzing this data can provide valuable insights for the hospitality industry.

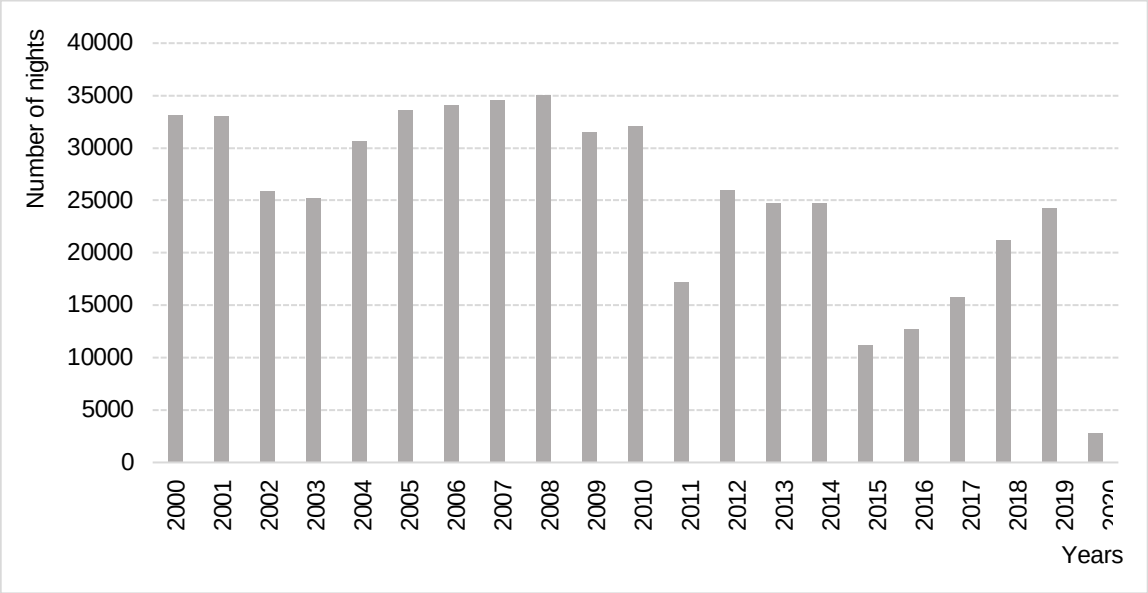

Figure 23. Nights spent by non-residents (2000-2020).

Source: Authors' own elaboration.

Over the course of 20 years, the annual figures indicating the nights spent in Tunisia by non-residents reveal some important patterns and events:

Growth Period (2003–2008): Non-resident nights spent increased steadily in the early 2000s, reaching a peak of 34048.7 nights in 2008. Tunisia's popularity as a travel destination, distinguished by its cultural attractions and affordability, is responsible for this period of growth.

Global Economic Crisis (2009): With a decrease of 31556.9 nights, the effects of the global economic crisis in 2009 are clearly seen in the figures. This cut was made in response to the economic difficulties that many nations at the time were experiencing.

Post-Crisis Recovery (2010): The tourist industry began to show indications of revival in the early 2010s, and the number of nights spent by visitors increased gradually. Only 17207.6 nights were booked in 2011, a considerable decrease due to the Tunisian Revolution in 2011, which was seen in the revolution's negative impact on travel.

Obstacles in 2015: With a dramatic fall to 11170.3 nights, 2015 presented significant obstacles. Two significant terrorist incidents in Bardo meusum and Habib Bourghiba Street that targeted foreign tourists are to blame for this fall, which led to increased security concerns and fewer visitors overall.

Steady Growth and COVID-19 Impact (2016-2020): After 2015, the economy began to slowly recover, however the number of nights spent by non-residents did not return to the pre-2011 levels. The global COVID-19 pandemic in 2020 caused a huge decline to 2817.9 nights, which had a negative influence on international travel and tourism.

Overall, the information illustrates how dynamic the tourism sector has been in Tunisia during the past 20 years, with periods of expansion, difficulty, and recovery. The variations in the number of nights spent

by non-residents show how the tourism industry is impacted by international events, the state of the economy, and security concerns.

3.3 Revenues generated by hotels (2000-2020)

Analysis of customer influx into Tunisian hotels over the past two decades, alongside the corresponding foreign currency revenues and their impact on the country's GDP, sheds light on the dynamic relationship between tourism, economic growth, and hospitality sector development between (2000-2020).

3.3.1 Revenues in foreign currencies

The hospitality industry, due to its global nature, often generates revenues in multiple foreign currencies.

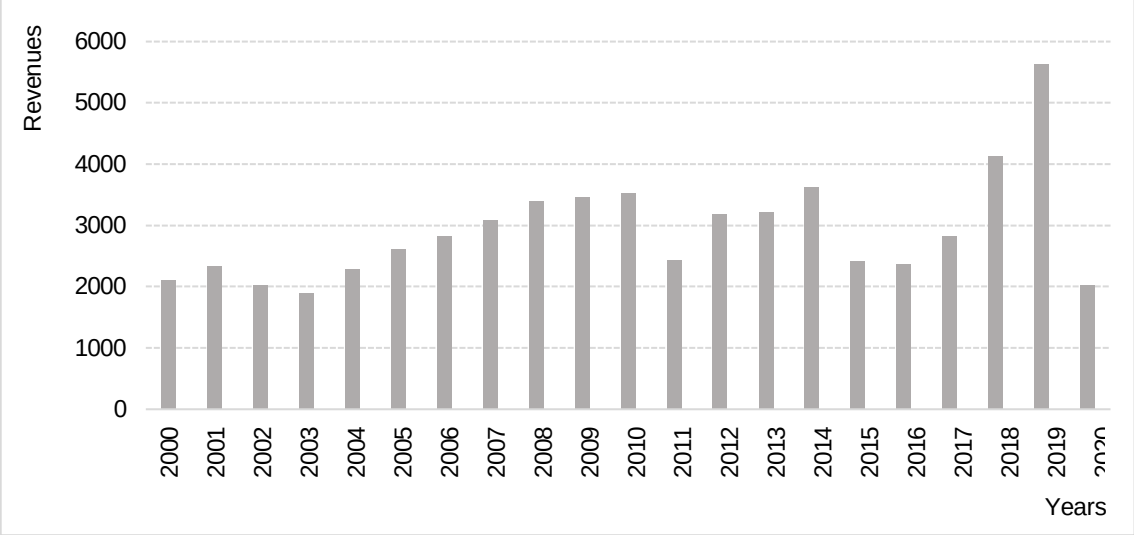

Figure 24. Revenues in foreign currencies in million TND (2000-2020).

Source: Authors' own elaboration.

The annual data on revenues in foreign currencies in Tunisia over a 20-year period reveal several significant trends and events:

Early 2000s Growth (2000-2005): The early 2000s saw consistent decrease in revenues, with figures increasing from 2095.1 billion in 2000 to 2611.0 billion in 2005. This period of growth can be attributed to Tunisia's appeal as a tourist destination, characterized by its cultural attractions and affordability.

Steady Increase and Peak (2003-2008): The years from 2003 to 2008 marked a steady increase in revenues, culminating in a peak of 3390.2 billion in 2008. This growth was likely influenced by effective tourism marketing, infrastructure development, and political stability during this period.

Global Economic Crisis (2009): The impact of the global economic crisis in 2009 is evident in the data, with a minor increase to 3471.9 billion. This reduction reflects the economic challenges faced by many countries worldwide during that period.

Post-Crisis Recovery (2010): The tourism sector showed signs of recovery in the early 2010s, with revenues gradually increasing. However, the Tunisian Revolution in 2011 led to a significant drop in

2011, with revenues falling to 2432.6 billion. This decline was reflective of the disruption caused by the revolution on tourism.

Challenges in 2015: The year 2015 posed significant challenges, with a decline to 2414.7 billion. This decrease can be attributed to two major terrorist attacks targeting foreign tourists, which resulted in heightened security concerns and a decline in visitor numbers.

Recovery and Expansion (2017-2019): Revenues bounced back, surpassing previous peaks in 2018 and 2019, reaching 4141.2 billion and 5628.4 billion, respectively. These years signaled renewed interest in Tunisia as a tourist destination and stronger economic performance.

COVID-19 Pandemic Impact (2020): The year 2020 witnessed a notable drop to 2030.3 billion due to the global COVID-19 pandemic, which severely impacted international travel and tourism.

Overall, the data reflects the dynamic nature of Tunisia's tourism industry and its impact on the country's revenues in foreign currencies over two decades. The influence of global events, economic conditions, and security issues is evident in the fluctuations in revenue figures, with periods of growth and decline often tied to these external factors. The resilience and recovery of Tunisia's tourism sector will depend on a combination of factors, including political stability, safety measures, global economic conditions, and the country's ability to adapt to changing circumstances. Tunisian authorities and stakeholders in the tourism industry may draw insights from these historical trends to navigate future challenges and capitalize on opportunities for growth in the years to come.

3.3.2 Revenues per night

The analysis of revenue per night provides crucial insights into the financial performance and efficiency of hotels, particularly within the context of technological advancements in the hospitality industry.

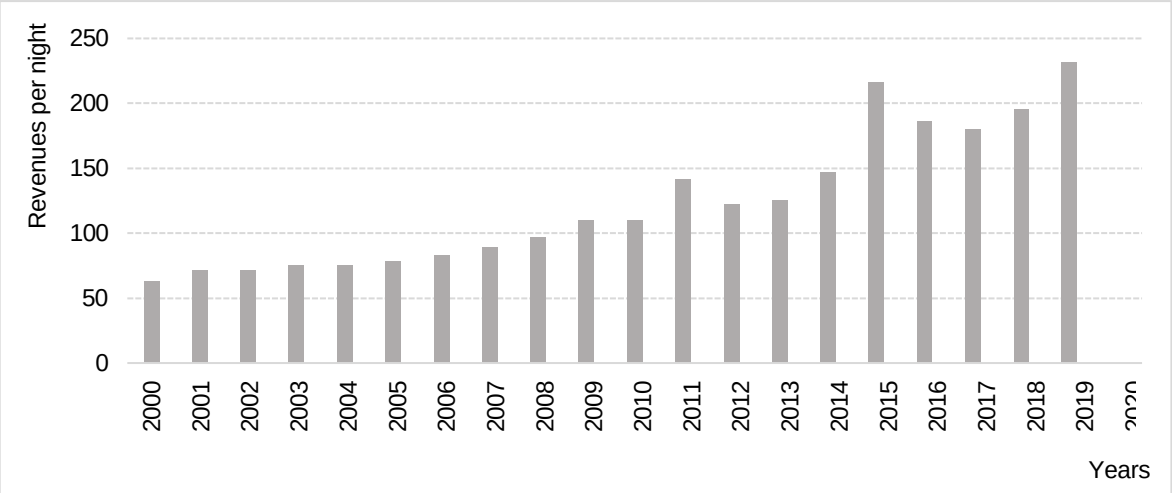

Figure 25. Revenues per night in TND (2000-2020).

Source: Authors' own elaboration.

The information on nightly revenue generated by Tunisian tourist accommodations over a 20-year period sheds light on the sector's economic performance and level of competitiveness. Here is a breakdown of these numbers:

Steady Growth (2000–2009): The revenue per night increased steadily between 2000 and 2009, rising from 63.3 dinars in 2000 to 110.0 dinars in 2009. Due to its rich cultural legacy, reasonable cost, and well-established tourism infrastructure, Tunisia has become more popular with travelers over the past few decades.

Impact of Tunisian Revolution (2011): Revenue per night increased significantly in 2011 to 141.4 dinars. The unrest during the Tunisian Revolution may be to blame for this. It's possible that tourists were willing to pay more for security.

Post-Revolutionary Period (2012–2014): After the revolution, there was some turbulence in the amount of money made each night. The numbers fell in 2012 (122.5 dinars) and 2013 (125.0 dinars), but they rose to 146.3 dinars in 2014. This possibly denotes a period of tourism industry revival and stabilization in Tunisia.

Challenges in 2015: In 2015, revenue per night increased significantly, reaching 216.2 dinars. This might be explained by the decrease in tourists brought on by worries about security following terrorist incidents. If there were fewer visitors, perhaps they paid more on lodging because the security costs got higher.

Steady Performance (2016–2019): From 2016 to 2019, the rates stayed largely the same, ranging from 185.7 dinars to 231.6 dinars a night. This shows that Tunisia continued to draw tourists who were willing to spend more money while they were there, demonstrating the nation's tenacity in the face of difficulties.

In conclusion, the information shows how the tourism sector in Tunisia has changed over time, experiencing ups and downs as well as obstacles. The differences in revenue per night over these years show how global events, security issues, and economic situations have affected travel expenditures.

3.3.3 Revenues per bed

Revenues per bed is a crucial metric in the hospitality industry, providing insights into the financial performance of accommodation establishments. This section analyzes the revenues generated per available bed, offering a deeper understanding of the industry's profitability and efficiency.

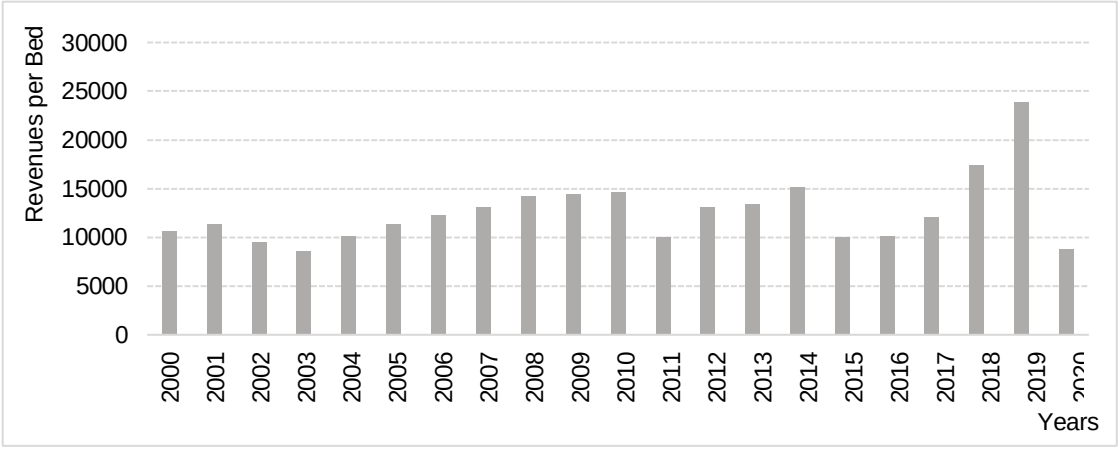

Figure 26. Revenues per bed in TND (2000-2020).

Source: Authors' own elaboration.

The data on revenues per bed generated by touristic establishments in Tunisia over 20 years provides insights into the economic performance and competitiveness of the country's tourism sector. Here's an analysis of these figures:

Steady Growth (2000-2005): From 2000 to 2005, the revenue per bed showed consistent decrease, increasing from 10610.0 dinars in 2000 to 11360.2 dinars in 2005. This period reflects Tunisia's attractiveness to tourists due to its cultural heritage, affordability, and well-established tourism infrastructure.

Continued Growth and Peak (2004-2010): The years from 2004 to 2010 marked continued growth in revenues per bed, reaching a peak of 14472.9 dinars in 2009. This period suggests Tunisia's ability to attract tourists willing to spend more on accommodations.

Post-Crisis Stability (2010-2013): Following the global economic crisis, there was stability in revenues per bed from 2010 to 2013. This stability indicates that Tunisia's tourism sector had rebounded and was attracting visitors at a consistent rate.

Challenges in 2011 and 2015: The years 2011 and 2015 saw significant increase in revenue per bed, dropping to 10046.0 dinars in 2011 and 10003.2 dinars in 2015. These declines were likely influenced by security concerns following the Tunisian Revolution and subsequent terrorist attacks.

Recovery and Expansion (2016-2019): Revenues per bed rebounded strongly in 2016 and 2019, reaching 17428.0 dinars and 23847.6 dinars, respectively. This period signaled renewed interest in Tunisia as a tourist destination and a willingness to spend more on accommodations.

COVID-19 Pandemic (2020): In 2020, there was likely a significant impact on tourism due to the COVID-19 pandemic, as revenue per bed dropped to 8792.9 dinars. Travel restrictions and reduced international tourism likely contributed to this decline.

In summary, the data reflects Tunisia's evolving tourism industry, marked by periods of growth, recovery, and challenges. The impact of global events, security concerns, and economic conditions on tourism spending is evident in the variations in revenue per bed over these years.

Table 2. Tourism indicators (2000-2020).

Variables	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Tourism investments	million	322.5	330.9	353.3	282.3	288.2	246.2	204.6	213.2	253.6	309.3	376.4	208.2	240.1	297.8	241.9	200.2	261.1	447.2	216.3	196.2	294.3
Number of establishments	No.	736.0	755.0	777	790	800	816	826	834	836	856	856	861	846	847	848	862	824	848	868	876	875
Capacity in beds	thousand	197.5	205.6	214.3	222.0	226.2	229.8	231.8	235.7	238.5	239.9	241.5	242.1	242.0	240.2	240.0	241.4	235.0	234.3	237.6	236.0	230.9
Direct employment	thousand	79.0	82.2	85.7	88.8	90.5	91.9	92.7	94.3	95.4	96.0	96.6	…	96.8	96.1	96.0	96.5	94.0	93.7	95.0	94.4	92.4
Entries of non-residents	thousand	5057.5	5387.3	5063.5	5114.3	5998.1	6378.4	6549.5	6761.9	7050.3	6902.3	6903.4	4785.3	5950.4	6268.9	6068.6	4201.9	4525.7	5742.6	6921.2	7984.5	1432.0
Nights spent by non- residents	thousand	33168,5	33005.6	25897.2	25301.3	30664.5	33587.2	34086.1	34545.7	35048.7	31556.9	32136.2	17207.6	25920.5	24787.9	24788.9	11170.3	12779.5	15727.8	21212.5	24304.4	2817.9
Average length of stay (in days)	Days	6.6	6.1	5.1	4.9	5.1	5.3	5.2	5.1	5.0	4.6	4.7	3.6	4.0	4.1	4.1	2.7	2.8	2.7	3.1	5.4	4.4
Relative occupancy rates	%	55.8	55.2	44.0	42.0	48.7	51.5	51.5	51.7	52.7	50.2	50.7	34.3	45.9	46.1	44.9	26.1	30.3	34.3	40.9	44.6	11.1
Revenues in foreign currencies	million	2095.1	2340.0	2021.0	1902.9	2290.0	2611.0	2825.2	3077.3	3390.2	3471.9	3522.5	2432.6	3175.3	3221.4	3625.6	2414.7	2373.4	2831.0	4141.2	5628.4	2030.3
Revenues per night	dinar	63.3	70.9	70.9	75.2	74.7	77.7	82.9	89.1	96.7	110.0	109.8	141.4	122.5	125.0	146.3	216.2	185.7	180.0	195.2	231.6	0
Revenues per bed	dinar	10610.0	11384.0	9429.9	8570.9	10125.9	11360.2	12186.1	13054.5	14211.8	14472.9	14584.2	10046.0	13121.2	13408.6	15101.8	10003.2	10098.8	12080.8	17428.0	23847.6	8792.9

Source: Authors' own elaboration.

In the realm of Tunisia's international hotel industry, the story told by data is as compelling as it is intricate. This section embarked on a journey through two decades of entries, earnings, and economic impact, offering a panoramic view of an industry that has weathered political transformations and global pandemics while adapting to the relentless march of technological progress.

The entries of non-residents examined month by month revealed the industry's capacity to evolve, adapt, and thrive. Peaks and troughs in these figures traced not only the rhythm of the seasons but also the influence of external events, from political revolutions to global health crises. Tunisia's allure as a tourist destination, once disrupted by the Arab Spring in 2011, gradually recovered, only to face another formidable challenge in the form of the COVID-19 pandemic in 2020.

The annual entries of non-residents, viewed in totality, exhibited a remarkable growth trajectory over the years, with the industry making a substantial contribution to the nation's GDP. It is a testament to Tunisia's resilience as a desirable tourist hub and its enduring appeal to visitors from around the world.

Comparative analyses of pivotal years, such as 2011, marked by the Arab Spring, and 2020, overshadowed by the global pandemic, offered profound insights into the industry's adaptability and tenacity. These events, while causing disruptions, failed to extinguish the sector's vitality, showcasing the industry's remarkable ability to rebound from adversity.

Beyond entries, this section scrutinized vital metrics like nights spent by non-residents, foreign currency incomes, revenues per night, and revenues per bed. These metrics underscored the industry's multifaceted economic significance, demonstrating how each visitor contributes not only to Tunisia's cultural tapestry but also to its economic growth.

To summarize, the data presented in this section paints a dynamic portrait of Tunisia's international hotel industry. It's a story of resilience and adaptation, where external shocks serve as opportunities for innovation. As we delve further into this multifaceted industry, our exploration extends to the pivotal role of artificial intelligence, where data-driven insights and AI-powered solutions have the potential to further enhance the guest experience, optimize operations, and drive sustainable growth.

The journey through Tunisia's international hotel industry is far from over, and the next section delves into the exciting intersection of AI and the hospitality sector, offering a glimpse into the future of this ever-evolving industry.

4 Forecasting the entries of non-residents in Tunisia and the revenues in foreign currencies with Artificial Neural Networks

Forecasting the entries of non-residents and the revenue in foreign currencies is crucial for the hotel industry in Tunisia, playing a significant role in financial planning, operational efficiency, and strategic growth. By accurately predicting the number of international visitors, hotels can effectively manage their resources, such as staffing, inventory, and room availability, ensuring optimal service levels and guest satisfaction. This foresight allows hotels to tailor their marketing strategies to attract non-residents during periods of lower occupancy, enhancing revenue stability throughout the year. Moreover, forecasting foreign currency revenues is vital for financial planning and risk management. Fluctuations in exchange rates can significantly impact profitability, and having a clear projection of foreign currency inflows helps hotels in hedging against these risks and making informed decisions about pricing and expenditure. Additionally, understanding the trends and patterns in foreign currency revenue enables hotels to negotiate better terms with suppliers and partners, many of whom may operate in different currencies. On a broader scale, these forecasts contribute to strategic investments, such as property upgrades or new amenities, that cater specifically to the preferences and expectations of international guests. Furthermore, accurate forecasting aids in complying with regulatory requirements and tax planning, as governments often have specific policies regarding foreign earnings. In essence, forecasting non-resident entries and foreign currency revenues empowers the hotel industry to enhance operational efficiency, financial stability, and strategic growth, thereby maintaining a competitive edge in a dynamic global market (Kulendran & King, 2019).

Forecasting in the tourism and hotel industry employs various methods, each with its strengths and tailored applications. Traditional methods include qualitative techniques such as expert judgment, Delphi method, and market surveys, which rely on the insights of experienced professionals to predict future trends. Quantitative methods, on the other hand, involve statistical techniques like time series analysis, econometric models, and regression analysis, leveraging historical data to identify patterns and project future outcomes. These methods are essential for capturing seasonal variations, economic impacts, and long-term trends in tourism demand and revenue generation (Assaf & Josiassen, 2016).

However, the advent of artificial intelligence (AI) has revolutionized forecasting methodologies, bringing unprecedented accuracy and efficiency. AI models, particularly machine learning algorithms, can analyze vast amounts of data from diverse sources, such as social media, booking platforms, and economic indicators, to generate highly accurate forecasts. Techniques like neural networks, support vector machines, and ensemble learning can detect complex patterns and relationships that traditional methods might miss. For instance, neural networks can model nonlinear relationships and learn from the data iteratively, improving their predictions over time as more data becomes available.

AI-driven forecasting offers several advantages. It can process real-time data, allowing for dynamic updates to forecasts as new information emerges. This adaptability is crucial in the fast-paced tourism industry, where trends can shift rapidly due to geopolitical events, natural disasters, or changes in

consumer preferences. Additionally, AI models can incorporate unstructured data, such as customer reviews and social media posts, providing a richer and more nuanced understanding of market sentiment and potential demand shifts (Assaf & Josiassen, 2016).

Furthermore, AI forecasting tools can be integrated with other digital systems used by hotels, such as property management systems and revenue management software, creating a seamless and automated process that enhances operational efficiency. For example, predictive analytics can help hotels optimize pricing strategies by forecasting demand for different room types and adjusting rates dynamically to maximize occupancy and revenue.

In summary, while traditional forecasting methods remain valuable, the incorporation of AI models represents a significant advancement in the field. AI-driven forecasting provides greater accuracy, responsiveness, and depth of insight, enabling the hotel industry to make more informed decisions and maintain a competitive edge in an increasingly complex and dynamic market.

Artificial Neural Networks represent a powerful tool for forecasting in the hotel and tourism industry, offering the ability to handle complex, non-linear relationships and adapt to new data. In this fourth section of my thesis, we will leverage ANNs to forecast the entries of non-residents in Tunisia and the revenues in foreign currencies. By doing so, we aim to provide a robust analytical framework that can support strategic planning and decision-making, ultimately contributing to the sustainable growth and competitiveness of Tunisia's tourism sector.

4.1 Artificial Neural Networks

Artificial Neural Networks (ANNs) have emerged as a powerful tool in the field of forecasting within the hotel and tourism industry, offering the capability to model complex, non-linear relationships and adapt to new data dynamically.

4.1.1 Definition of Artificial Neural Networks

Artificial Neural Networks (ANNs) are a sophisticated class of artificial intelligence algorithms inspired by the structure and functioning of the human brain's network of neurons. These networks are designed to recognize patterns, learn from data, and make predictions, emulating the cognitive processes of the human brain. ANNs consist of multiple layers of interconnected nodes, commonly referred to as "neurons." The architecture of an ANN typically includes an input layer, one or more hidden layers, and an output layer (Schmidhuber, 2015).

The input layer is where the network receives various forms of raw data. Each neuron in this layer represents a feature or attribute of the data, such as pixel values in an image, words in a text, or numerical indicators in a dataset. This data is then passed to the hidden layers, which are the core computational units of the network. Each hidden layer consists of neurons that transform the input data by applying weighted sums and activation functions. These functions introduce non-linearity into the network, enabling it to learn and model complex patterns and relationships within the data (Schmidhuber, 2015).

The connections between neurons are characterized by weights, which determine the strength and influence of the signal passed from one neuron to another. During the training process, these weights are adjusted to minimize the difference between the network's predictions and the actual outcomes. This process, known as backpropagation, involves iteratively updating the weights based on the error gradient, thereby refining the network's ability to make accurate predictions (Krizhevsky, Sutskever & Hinton, 2012).

Finally, the output layer produces the network's prediction or classification based on the processed information from the hidden layers. The number of neurons in the output layer depends on the specific task, such as binary classification, multi-class classification, or regression. Through this multi-layered processing, ANNs can learn from large datasets, adapt to new information, and generalize from training data to make predictions on unseen data, making them powerful tools for various applications in fields ranging from image recognition and natural language processing to financial forecasting and medical diagnosis.

4.1.2 Structure and function of Artificial Neural Networks

Artificial Neural Networks (ANNs) are composed of multiple layers of interconnected neurons, each layer performing specific roles in the data processing sequence. The architecture of an ANN is typically divided into three distinct types of layers: the input layer, hidden layers, and the output layer.

- Input Layer: The input layer is the first layer in an ANN and serves as the point of entry for the initial data. Each neuron in this layer corresponds to a specific feature or attribute of the data being analyzed. For instance, in an image recognition task, each neuron might represent the pixel intensity values of the image. The input layer does not perform any computations but simply distributes the data to the next layer. It acts as the interface between the raw data and the neural network, preparing the data for further processing by the hidden layers (Schmidhuber, 2015).

- Hidden Layers: Hidden layers are the intermediate layers situated between the input layer and the output layer. These layers are where the core computational processes of the ANN take place. Each neuron in a hidden layer receives input from the previous layer, applies a mathematical function (such as a weighted sum followed by an activation function), and then passes the transformed data to the next layer. The primary function of the hidden layers is to extract and learn intricate patterns and features from the input data. The number of hidden layers and the number of neurons within each layer can vary, and more complex tasks generally require deeper networks with more hidden layers. This depth enables the network to model complex, non-linear relationships in the data, enhancing its ability to generalize and make accurate predictions (Kourentzes, Petropoulos & Trapero, 2020).

- Output Layer: The output layer is the final layer of the ANN and is responsible for producing the network's prediction or classification. The structure of the output layer varies depending on the specific task at hand. In a binary classification problem, the output layer typically consists of a single neuron that indicates one of two classes. For multi-class classification problems, the output layer contains multiple neurons, each representing a different class. In regression tasks, the output layer might consist of one or more neurons that output continuous values. The output layer processes the information received

from the last hidden layer and translates it into a form that can be interpreted as the network's final prediction or decision (Schmidhuber, 2015).

- Function of Artificial Neural Networks

The functioning of Artificial Neural Networks (ANNs) involves several key components and processes that enable them to learn from data and make predictions. These components include weights and biases, activation functions, and the training process.

- Weights and Biases: Weights are crucial numerical values assigned to the connections between neurons in adjacent layers. They determine the strength and direction of the influence that one neuron exerts on another. When data passes through the network, each input is multiplied by a corresponding weight, which adjusts the signal strength as it moves from one neuron to the next. Biases are additional parameters added to each neuron's input to further adjust the output independently of the weighted inputs. This allows the neuron to better fit the data by providing each neuron with the capability to shift the activation function. Both weights and biases are not static; they are learned and fine-tuned during the training process to minimize the prediction error.

- Activation Function: After the weighted sum of inputs is calculated for a neuron, an activation function is applied to introduce non-linearity into the model. This non-linearity is crucial because it allows ANNs to learn and represent complex, non-linear relationships in the data, which linear models cannot capture. Without activation functions, the network would essentially be a linear regression model, regardless of the number of layers. Common activation functions include the sigmoid function, which maps input values to a range between 0 and 1, the tanh function, which maps inputs to a range between -1 and 1, and the Rectified Linear Unit, which outputs zero for negative inputs and the input value itself for positive inputs. Each of these functions has specific properties that make them suitable for different types of tasks and architectures.

- Training: The process of training an ANN involves adjusting its weights and biases to minimize the error between its predictions and the actual outcomes. This is typically done using a method called backpropagation, which works in conjunction with optimization algorithms such as gradient descent. During training, the network processes the input data and generates an output, which is then compared to the true output to calculate the error. This error is then propagated backward through the network, from the output layer to the input layer. During this backward pass, the gradients of the error with respect to each weight and bias are computed. These gradients indicate the direction and magnitude of the adjustments needed to minimize the error. The optimization algorithm uses these gradients to update the weights and biases iteratively, gradually reducing the error over time. Through this iterative process, the network effectively "learns" from the data, improving its predictions as it continues to process more data.

4.1.3 Applications of Artificial Neural Networks

Artificial Neural Networks have revolutionized numerous fields by offering advanced solutions for complex problems that were previously difficult to tackle with traditional methods. Their ability to learn

from vast amounts of data, recognize intricate patterns, and make precise predictions has made them indispensable tools across a variety of applications.

- Image and Speech Recognition: One of the most prominent applications of ANNs is in image and speech recognition. In image recognition, ANNs are employed to identify and classify objects within images, enabling functionalities such as facial recognition, medical imaging analysis, and automated vehicle navigation. In speech recognition, ANNs process and interpret human speech, converting spoken words into text or commands. This technology underpins virtual assistants like Siri and Alexa, transcription services, and real-time translation tools (LeCun et al., 2015).

- Natural Language Processing (NLP): ANNs are fundamental in natural language processing, which involves understanding and generating human language. This includes tasks such as sentiment analysis, language translation, text summarization, and chatbots. By analyzing large datasets of text, ANNs can learn to understand context, disambiguate meanings, and generate coherent and contextually appropriate responses, significantly advancing human-computer interaction (Aggarwal, 2023).

- Financial Forecasting: In the financial sector, ANNs are utilized for predicting stock prices, economic indicators, and market trends. By analyzing historical financial data, economic conditions, and even social media sentiment, ANNs can generate forecasts that help investors make informed decisions. Their ability to model complex and non-linear relationships makes them particularly suited for the volatile and multifaceted nature of financial markets (Aggarwal, 2023).

- Medical Diagnosis: ANNs play a crucial role in the field of medical diagnosis. They are used to analyze medical images such as X-rays, MRIs, and CT scans to detect abnormalities and diagnose diseases with high accuracy. Additionally, ANNs can process patient data to predict disease outcomes, recommend treatments, and personalize healthcare plans. This application not only enhances diagnostic accuracy but also aids in early detection and prevention strategies (Gulshan, Narayanaswamy & Webster, 2016).

- Tourism Forecasting: As explored in this section, ANNs are invaluable for forecasting tourist arrivals and revenues in the tourism industry. By analyzing historical tourism data, economic indicators, seasonal patterns, and external factors such as political stability and global events, ANNs can predict future tourism trends. These forecasts enable stakeholders to optimize resource allocation, manage tourist flows, and develop strategic marketing plans, ultimately contributing to the sustainable growth and profitability of the tourism sector.

4.1.4 Advantages and Disadvantages of Artificial Neural Networks

Artificial Neural Networks offer several key advantages that make them highly effective and versatile tools for a wide range of applications. Their unique capabilities allow them to handle complex tasks and large datasets with remarkable efficiency and accuracy.

- Adaptability: One of the primary strengths of ANNs is their adaptability. They can learn and adapt to complex patterns in data, making them suitable for various applications across different domains. This adaptability stems from their ability to adjust weights and biases during the training process, allowing them to fine-tune their performance based on the specific characteristics of the input data. As a result,

ANNs can effectively tackle problems in areas such as image recognition, natural language processing, financial forecasting, and more (Du, 2019).

- Non-linearity: ANNs excel at modeling non-linear relationships, which are prevalent in real-world data. By using activation functions such as sigmoid, tanh, and Rectified Linear Unit (ReLU), ANNs introduce non-linearity into the model. This non-linear transformation enables the network to capture and represent complex dependencies between input variables, which linear models cannot achieve. This capability is crucial for understanding intricate patterns in data and making accurate predictions (Du, 2019).

- Generalization: Once trained, ANNs possess a remarkable ability to generalize from the training data to make accurate predictions on new, unseen data. This generalization capability is vital for ensuring that the model performs well in real-world scenarios, not just on the data it was trained on. Through techniques such as regularization and cross-validation, ANNs can avoid overfitting to the training data, thereby enhancing their predictive accuracy and robustness (Du, 2019).

- Scalability: ANNs are inherently scalable, meaning they can be expanded to handle large datasets and complex problems. This scalability is achieved by increasing the number of neurons in each layer or adding more hidden layers to the network architecture. As the network grows in size, it gains a greater capacity to learn from more data and capture more detailed patterns. This scalability is particularly important for applications involving big data, where the volume, variety, and velocity of data can be immense (Du, 2019).

Despite their many advantages, Artificial Neural Networks (ANNs) come with several notable disadvantages that can pose challenges in their application and implementation. These limitations need to be carefully considered to ensure the effective and appropriate use of ANNs.

- Data Requirements: One of the primary disadvantages of ANNs is their substantial data requirements. Training ANNs effectively necessitates large amounts of data to accurately learn patterns and make reliable predictions. This requirement can be a significant limitation when data is scarce, expensive to obtain, or difficult to collect. In scenarios where only limited data is available, the network may struggle to generalize well, leading to poor performance on unseen data. This data dependency makes it crucial to have robust data collection and preprocessing strategies to ensure the quality and quantity of the training data (LeCun et al., 1998).

- Computationally Intensive: Training deep neural networks, particularly those with many layers and neurons, can be computationally intensive and time-consuming. The process involves numerous calculations and iterations to adjust weights and biases, which require significant computational resources. High-performance hardware, such as GPUs (Graphics Processing Units) and TPUs (Tensor Processing Units), is often necessary to handle these intensive computations efficiently. However, access to such hardware can be costly and may not be feasible for all organizations or researchers, limiting the widespread adoption and experimentation with ANNs.

- Black Box Nature: Another major drawback of ANNs is their "black box" nature, which refers to the lack of transparency in how they make decisions. ANNs often provide little insight into the learned patterns and relationships within the data, making it difficult to interpret and understand their internal

workings. This opacity can be problematic in applications where interpretability and explainability are crucial, such as in medical diagnoses, financial decision-making, and regulatory environments. The inability to explain how a model arrives at its conclusions can undermine trust and hinder the acceptance of ANN-based solutions in critical and sensitive fields (Ribeiro & Guestrin, 2016).

4.1.5 Multilayer Perceptron

Artificial Neural Networks come in a variety of types, each specifically designed to address distinct tasks and data structures. This diversity allows ANNs to be tailored to the unique requirements and complexities of different applications, enhancing their effectiveness and versatility. For instance, some networks are optimized for handling sequential data, while others excel at processing spatial data like images.

In this section we will use MLP to forecast the entries of non-residents in Tunisia and the revenues in foreign currencies.

A Multilayer Perceptron (MLP) is a type of artificial neural network that consists of multiple layers of neurons arranged in a feedforward structure. MLPs are characterized by having an input layer to receive the input data, one or more hidden layers to process the inputs, and an output layer to produce the final prediction or classification. Each neuron in an MLP is connected to every neuron in the adjacent layers, with connections assigned weights that are adjusted during the training process to minimize error and optimize performance (Raschka, Mirjalili, 2019).

The fundamental components of an MLP include:

-Input Layer: This layer consists of neurons representing each feature of the input data. It is the initial point of data entry into the network.

-Hidden Layers: These layers, which can range from one to many, apply a series of transformations to the input data. Each neuron in a hidden layer applies a weighted sum of its inputs followed by an activation function to introduce non-linearity into the model.

-Output Layer: The final layer in the network that provides the output prediction or classification. The number of neurons in this layer depends on the nature of the task (for example, one neuron for binary classification, multiple neurons for multi-class classification).

MLPs are trained using supervised learning techniques, where the network learns from a set of labeled training data. During training, the backpropagation algorithm is commonly used to adjust the weights and biases of the neurons to minimize the error between the predicted outputs and the actual targets. This iterative process continues until the network achieves an acceptable level of accuracy (Aslam, Ahmad & Ahmad, 2020).

The Key Features of MLPs are:

- Feedforward Architecture: Information flows in one direction, from the input layer through the hidden layers to the output layer, with no cycles or loops.

- Non-linear Activation Functions: Functions such as sigmoid, tanh, and ReLU are used to enable the network to learn complex, non-linear patterns.

- Versatility: MLPs can be applied to a wide range of tasks, including classification, regression, and pattern recognition.

MLPs are foundational models in the field of neural networks and serve as the building blocks for more complex architectures used in advanced machine learning applications. Their ability to learn and model non-linear relationships makes them powerful tools for solving various predictive modeling problems.

4.2 Forecasting the entries of non-residents and the revenues in foreign currencies for 2019 in Tunisia with MLP

In this section, we will use Multilayer Perceptron (MLP) models, a type of artificial neural network well-suited for handling complex, non-linear relationships, to forecast tourist entries and revenues in Euros for 2019 in Tunisia. We will utilize monthly data obtained from the Tunisia Bureau of Statistics website. The MLP model will enable us to generate accurate predictions, providing valuable insights for tourism industry stakeholders.

The network architecture for our forecasting model consists of 12 nodes in the input layer, a hidden layer with a variable number of nodes, and a single output node. The 12 input nodes correspond to the 12 months preceding the month the network is predicting. For instance, to predict January 2002, the input layer receives data from January to December 2001. The hidden layer configuration varies across models, with 4, 6, 8, and 10 nodes respectively. Each of these four models will undergo 50 training session. During each session, the model is trained over multiple epochs. In each epoch, the network adjusts the weights of the connections based on performance against a validation set from 2018. The first epoch uses randomly initialized weights, and subsequent epochs adjust these weights to improve accuracy. This process continues until there is no improvement over six consecutive epochs, at which point the training iteration concludes, and the best performing weights are saved. After completing 50 iterations for each model, we select the iteration with the best results and evaluate its performance on the 2019 test set.

4.2.1 Forecasting the entries of tourists in Tunisia (in thousands)

The first graphic (Figure 30) represents the validation data, which utilizes data from the year 2018. The second graphic illustrates the test data, focusing on predicting the entries of tourists for 2019, which is the target year for our predictions. In these graphics, the test loss is recorded as 0.373. This "loss" is calculated using the mean squared error (MSE) method, providing a measure of the prediction accuracy by quantifying the average squared difference between the observed and predicted values.

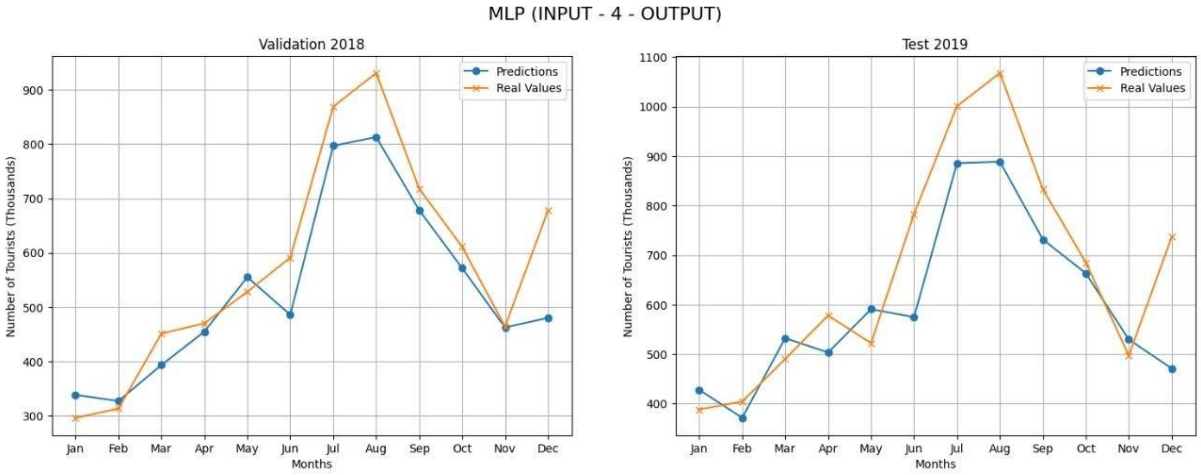

Figure 27. Predictions for 2019-model1,4 noes in the hidden layer (Test Loss: 0.373).

Source: Authors' own elaboration.

The first graphic (Figure 31) illustrates the validation dataset, which utilizes data from the year 2018. The second graphic represents the test dataset, focusing on the year 2019, which is the target year for our predictions. In these graphics, the test loss is recorded as 0.454, calculated using the mean squared error (MSE) method.

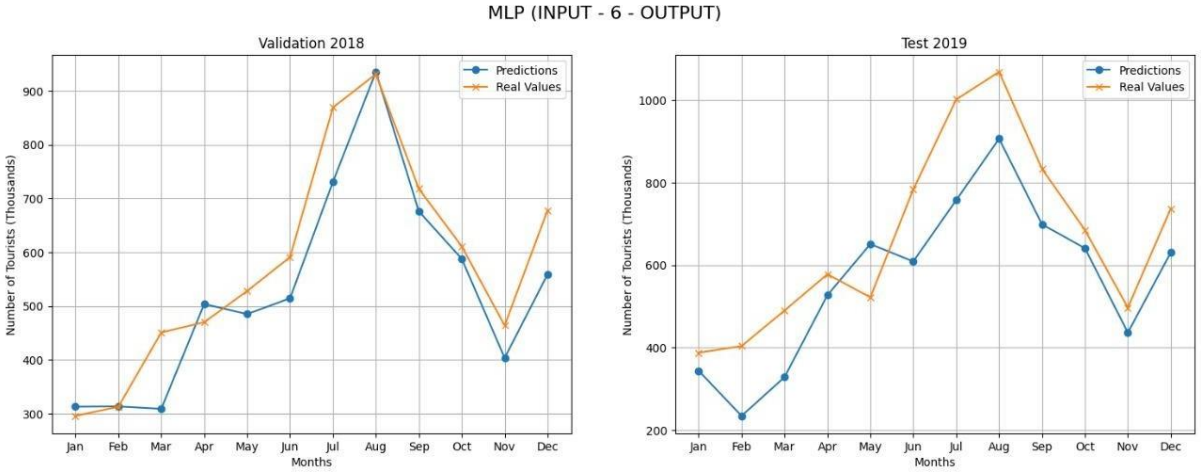

Figure 28. Predictions for 2019-model 2,6 nodes in the hidden layer (Test Loss: 0.454).

Source: Authors' own elaboration.

The first graphic (Figure 32) depicts the validation dataset, using data from the year 2018. The second graphic shows the test dataset, concentrating on predicting the entries of tourists for 2019. In these graphics, the test loss is recorded as 0.304, calculated using the mean squared error (MSE) method.

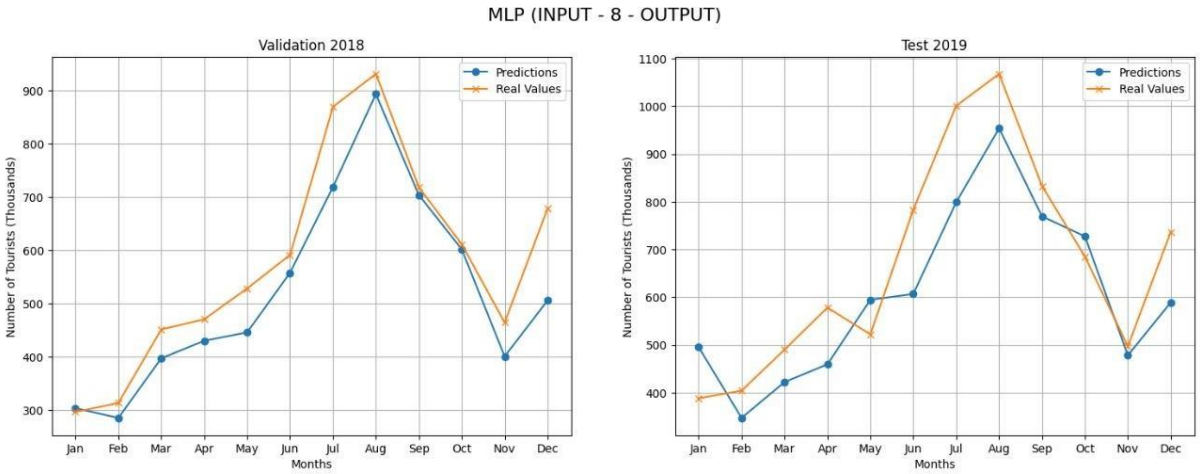

Figure 29. Predictions for 2019-model 3,8 nodes in the hidden layer ((Test Loss: 0.304).

Source: Authors' own elaboration.

The first graphic (Figure 33) depicts the validation dataset, using data from the year 2018. The second graphic represents the test dataset, which focuses on predicting the entries of non-residents for the year 2019. In these graphics, the test loss is indicated as 0.380.

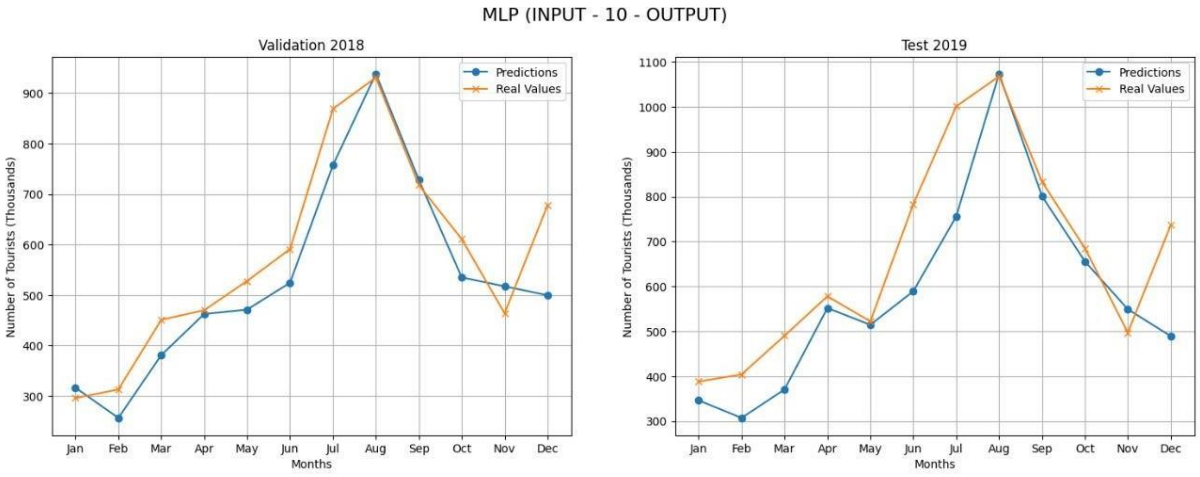

Figure 30. Predictions for 2019-model 4,10 nodes in the hidden layer (Test Loss: 0.380).

Source: Authors' own elaboration.

4.2.2 Forecasting the revenues in foreign currencies in Tunisia (in Euros)

The first graphic (Figure 34) depicts the validation dataset, using data from the year 2018. The second graphic represents the test dataset, focusing on predicting revenues in Euros for the year 2019. In these graphics, the test loss is recorded as 0.092, calculated using the mean squared error (MSE) method.

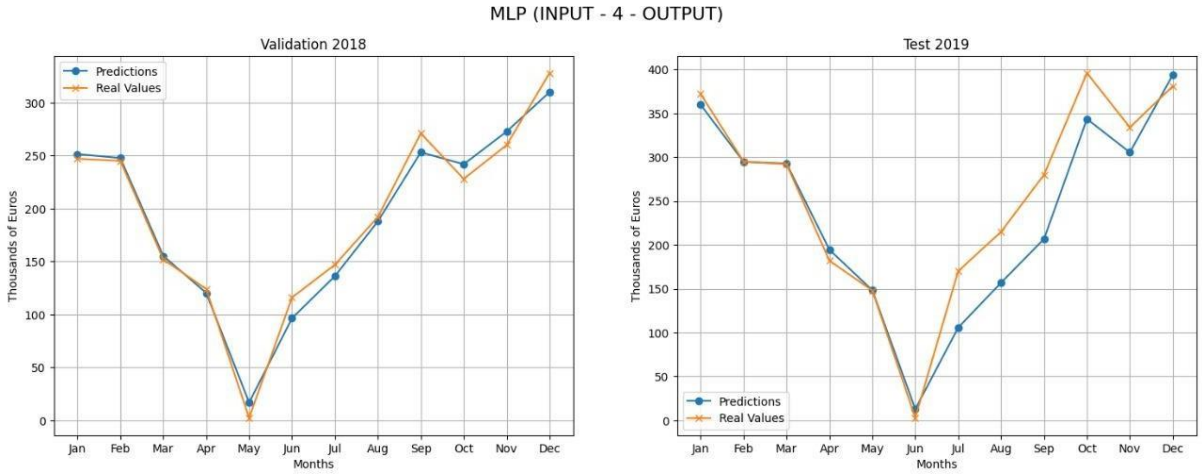

Figure 31. Predictions for 2019 (Test Loss: 0.092).

Source: Authors' own elaboration.

The first graphic (Figure 35) shows the validation dataset, utilizing data from the year 2018. The second graphic represents the test dataset, which focuses on predicting revenues in Euros for the year 2019. In these graphics, the test loss is indicated as 0.108.

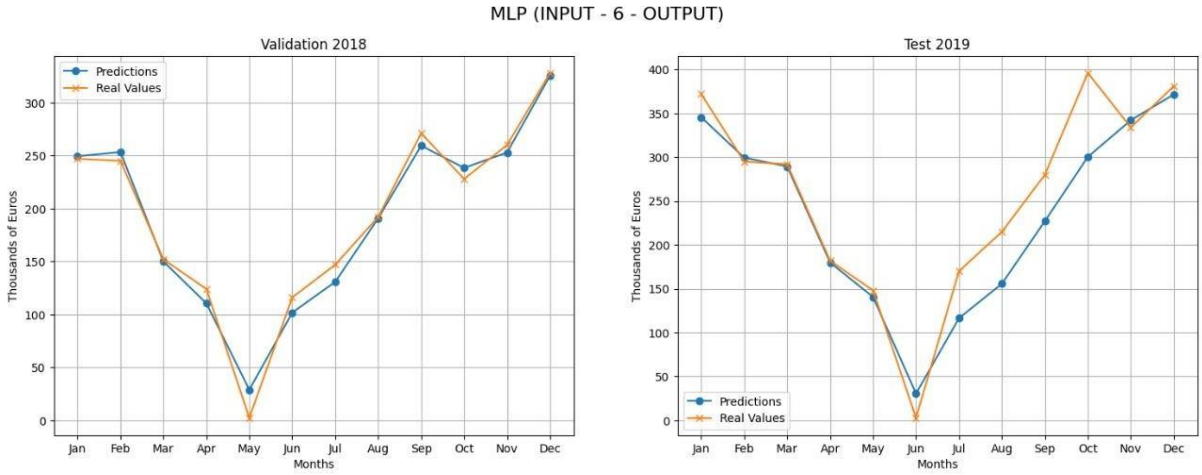

Figure 32. Predictions for 2019 (Test Loss: 0.108).

Source: Authors' own elaboration.

The first graphic (Figure 36) illustrates the validation dataset, which uses data from the year 2018. The second graphic represents the test dataset, where we predict revenues in Euros for the year 2019. In these graphics, the test loss is reported as 0.118.

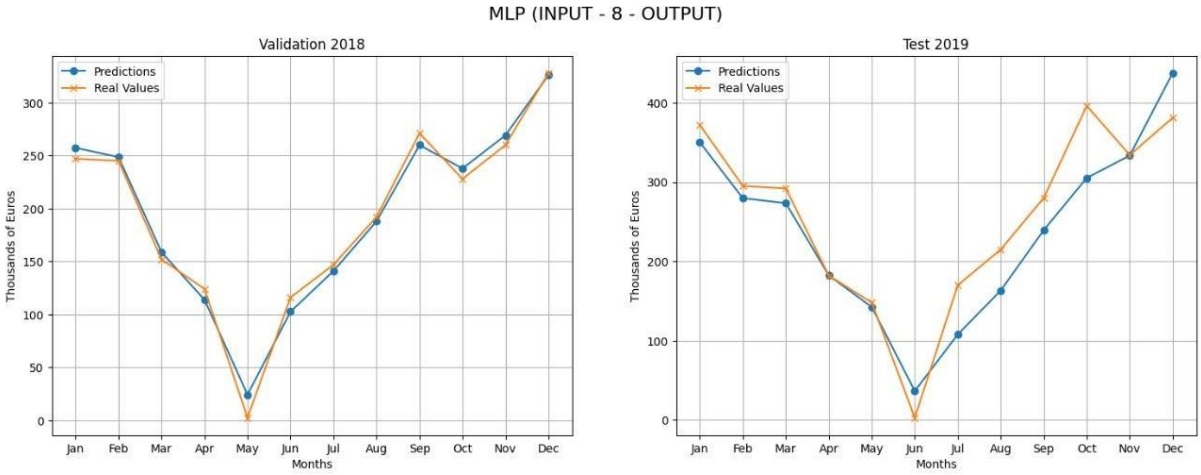

Figure 33. Predictions for 2019 (Test Loss: 0.118).

Source: Authors' own elaboration.

The first graphic (Figure 37) illustrates the validation dataset, utilizing data from the year 2018. The second graphic represents the test dataset, where we predict revenues in Euros for 2019. In these graphics, the test loss is 0.050. It is calculated using the mean squared error (MSE) method like all the previous tests.

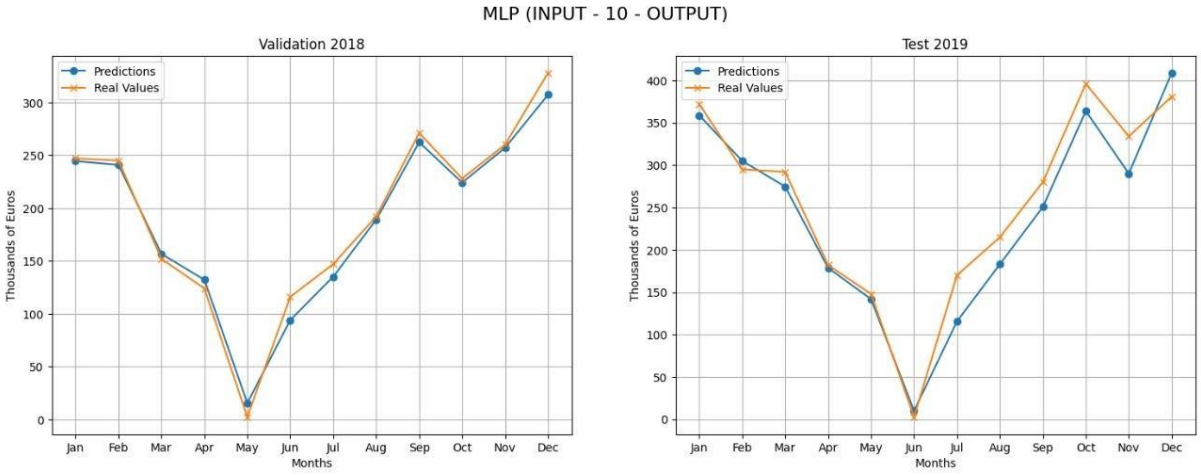

Figure 34. Predictions for 2019 (Test Loss: 0.050).

Source: Authors' own elaboration.

4.3 Main findings

The utilization of Multilayer Perceptron (MLP) models for forecasting tourist entries and revenues in Euros for Tunisia in 2019 has yielded promising results, as evidenced by the low-test losses observed in the various model configurations. The model with 10 nodes in the hidden layer, in particular, exhibited the lowest test loss of 0.050 for revenue forecasting, indicating a high degree of accuracy in predicting this crucial metric. This finding underscores the effectiveness of MLP models in capturing the complex, non-linear relationships inherent in tourism data, making them a valuable tool for decision-makers in the industry.

However, it is important to acknowledge the inherent limitations of forecasting models. While MLPs have demonstrated their predictive capabilities, they are not infallible. External factors, such as unforeseen geopolitical events, natural disasters, or shifts in global economic conditions, can significantly impact tourism trends and render even the most accurate forecasts inaccurate. Therefore, it is crucial to interpret these forecasts with caution and consider them as valuable tools for informing decision-making rather than definitive predictions of the future.

Furthermore, the model's reliance on historical data may not fully capture emerging trends or sudden shifts in tourist behavior. For instance, the COVID-19 pandemic, which drastically impacted global tourism in 2020, was not accounted for in the model's training data. This highlights the importance of continuously updating and refining forecasting models to incorporate new information and adapt to evolving circumstances.

Despite these limitations, the successful application of MLP models in this context opens up exciting possibilities for future research and development. Exploring alternative neural network architectures, such as Recurrent Neural Networks (RNNs) or Long Short-Term Memory (LSTM) networks, which are specifically designed for sequential data, could potentially enhance the accuracy and robustness of tourism forecasting models. Additionally, incorporating external data sources, such as social media sentiment analysis or online search trends, could provide valuable insights into emerging tourist preferences and behaviors, further refining the predictive capabilities of these models.

To summarize, the use of MLP models for forecasting tourist entries and revenues in Tunisia has proven to be a promising approach. While acknowledging the limitations of forecasting models and the need for continuous refinement, the results obtained in this study demonstrate the potential of AI-driven forecasting to empower stakeholders in the tourism industry with valuable insights for strategic planning and decision-making. By embracing these advanced techniques and adapting to the ever-changing landscape of tourism, Tunisia can position itself at the forefront of innovation and ensure the sustainable growth and prosperity of its tourism sector.

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Conclusion, limitations and future suggestions

In conclusion, this thesis represents a comprehensive and detailed journey through the transformative landscape of artificial intelligence (AI) within the context of the Tunisian international hotel industry. Throughout its four sections, it has meticulously examined AI from both a global and specific perspective, unraveling its profound implications for the hospitality sector.

Section 1 laid the crucial foundations by immersing us in the very essence of AI. It embarked on a historical voyage, tracing AI's evolution from a conceptual idea to its contemporary manifestation as a defining force in the digital age. Within this exploration, we sought not only to clarify the multifaceted nature of AI but also to underscore its overarching impact on society, transcending geographical boundaries.

In Section 2, our focus shifted towards the practical applications of AI within the hotel industry. By weaving together academic research and real-world insights, we unveiled the myriad ways in which AI is revolutionizing the guest experience, streamlining hotel operations, and bolstering sustainability efforts. This section illuminated the pivotal role AI plays in the relentless pursuit of attracting and retaining customers, a cornerstone of competitiveness in the hospitality sector.

Section 3 marked a deep dive into the empirical analysis of the Tunisian international hotel industry over the past two decades. Here, we scrutinized data related to customer entries, foreign currency incomes, and the GDP generated by these establishments. By juxtaposing data from various years, we unearthed trends and fluctuations influenced by economic conditions, political events, and global crises, highlighting the resilience and adaptability of the industry.

Section 4 introduced the artificial neural networks and their application, specifically Multilayer Perceptron (MLP) models, for forecasting tourist entries and revenues in Euros for Tunisia. We demonstrated the robustness and accuracy of MLP models in predicting these metrics for the year 2019. By leveraging historical data and advanced neural network architectures, we achieved predictions closely aligned with actual values, underscoring the potential of MLP models as reliable forecasting tools for future trends in the tourism sector.

Across these sections, a resounding message emerged: AI is not a fleeting trend but a dynamic force of transformation. Its integration into the Tunisian international hotel industry holds the potential to redefine its very fabric, fostering enhanced competitiveness, operational efficiency, and customer- centricity. Importantly, we recognized that the impact of AI transcends borders, positioning Tunisia as a potential leader in the innovative application of AI within the global hospitality landscape.

As we reflect on this extensive journey, it becomes evident that the world of AI is in perpetual motion. Successful AI adoption in Tunisia's international hotel sector hinges on adaptability, continuous innovation, and a forward-thinking mindset. AI's immense potential can only be realized through the concerted efforts of industry stakeholders, who must be willing to embrace change and invest in cutting-edge technologies.

In conclusion, this thesis serves as a clarion call to the transformative power of artificial intelligence within Tunisia's international hotel industry. It underscores the dynamic interplay between technology and hospitality, offering a compelling vision of Tunisia's potential to stand as a vanguard of AI-driven innovation on the global tourism stage. As we conclude this enlightening odyssey, we do so with the conviction that AI will not merely augment the industry but redefine it, heralding a new era of unparalleled excellence in the realm of hospitality.

The thesis, while comprehensive, has limitations due to its focus on the Tunisian international hotel industry, potentially limiting the generalizability of findings to other regions or sectors. The data primarily covers the period up to 2020, missing the most recent developments in AI and their impact on the industry. Additionally, the study relies heavily on secondary data, which may have inherent biases or limitations. Future research could expand the scope to include other countries or sectors, incorporate more recent data, and utilize primary research methods like surveys or interviews to gain deeper insights into the perceptions and experiences of stakeholders in the AI-powered hospitality landscape. Furthermore, exploring the ethical implications of AI adoption in more detail, such as job displacement and privacy concerns, would be a valuable addition to the existing research.

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