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Dr.HADDADI MOHAMED

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Preface

ADM'2024, the First International on Artificial Intelligence in Digital Marketing and Management was held in Boumerdes University, Algeria, on Decemeber 3rd & 4th, 2024, at the faculty of economic, commercial and management sciences.

The 2024 International Conference on Artificial Intelligence in Digital Marketing and Management (ADM'24) is organized by the the faculty of economic, commercial and management sciences. The goal of this conference is to increase academic knowledge on Artificial Intelligence (AI), Digital Marketing (DM), and Management. In fact, this was not the only goal. Therefore, never before has an international conference held only in English with a percentage of 100% in the fields of AI, DM and Management taking place at the faculty of economic, commercial and management sciences, Boumerdes University, Algeria. Moreover, we are going towards digitalization and globalization while using this language of science and technology.

In this context, we would like to thank the Dean of our Faculty and the president of Boumerdes University for hosting our ADM'24 Conference. Distinguish thanks are due to those for their excellent help directly or indirectly.

The interest of this conference is clear. The conference has attracted approximately 30 papers from inside and outside. We have accepted 22 oral presentations (Remotely or In-person). The great majority are Phd-students. We hear two keynote speakers. The first is from USA, Business school, with the title: Artificial Intelligence, management and security, whereas the second one is from Artificial Intelligence school, Sidi Abdellah, Algeria. These proceedings contain the revised versions of the papers that took the comments of the reviewers into consideration. The papers were submitted to two reviewers at least in anonymous format. Only the Scientific Committee members were used as reviewers. The authors have to take all the responsibility about the contents of their last papers. All the revised papers were examined for plagiarism (<30%) using Artificial Intelligence tools and applications.

The best paper belongs to two authors, the first is **Dr. Messaoud Bendiaf from** Department of Computer Science, University Mohamed El Bachir El Ibrahimi, Bordj Bou Arreridj, Algeria, **whereas the second is Dr.Souheyla Ammiche** from Department of Letters and Foreign Languages, University Mohamed El Bachir El Ibrahimi, Bordj Bou Arreridj, Algeria, with the following title: "**Sentiment analysis of tweets regarding chatgpt: implications for digital marketing**" which will be published in indexed databases like Scopus on condition to be extended with a portion of 40%.

We would also like to congratulate you all on a very successful conference so that the technical staff is as follows: **Dr.Haddadi Mohamed** as a **general chair** of the First International Conference on Artificial Intelligence in Digital Marketing and Management, **Dr.Bahnes Nacera** as a scientific committee chair, and **Dr.Masdoui** as an organizing committee chair, without forgetting organizing committee members and scientific committee members for their help and their patience.

Therefore, we are delighted to thank all the participants for their acceptable work and for their understanding with us to take into consideration the comments of the reviewers and submitting their camera-ready papers on time.

Finally, ADM'24 will help us in the guidance in how to create and manage Digital companies and how to secure its Big Data.

ADM'24 General Chair

Dr.Haddadi Mohamed

Papers

Content

The impact of online customer experience: a case study amazon's rufus chatbot

HELLABI Zoubeyda[1], ARKOUB Ouali[2]
[1] *Higher School of Management (ESMT), Tlemcen , Algeria (zhellabi@gamil.com)*
[2] *University of Boumerdes, Boumerdes, Algeria, (o.arkoub@univ-boumerdes.dz)*

ABSTRACT

The growing adoption of chatbots has revolutionized customer engagement across industries. This paper examines the role of artificial intelligence in shaping online customer experiences, focusing on Amazon's recently launched AI-powered chatbot, Rufus. We explore how Rufus enhances the e-commerce journey by providing personalized assistance, product recommendations, and streamlined information access. Through an analysis of Rufus's capabilities and its integration into Amazon's platform, we demonstrate how AI-driven chatbots are transforming the online retail landscape. Our findings suggest that Rufus represents a significant advancement in creating more informed, efficient, and satisfying shopping experiences, potentially setting new standards for customer interaction in e-commerce.

KEYWORDS: Artificial Intelligence, Chatbots, Customer Experience, Amazon, Rufus, Online Shopping.

1 INTRODUCTION

The e-commerce landscape is rapidly evolving, driven by advancements in artificial intelligence and the growing demand for personalized, efficient shopping experiences. As online retail continues to dominate consumer behavior, with platforms like Amazon leading the charge, the integration of AI-powered tools has become crucial in enhancing customer interactions and driving sales. Amazon, with its vast user base of over 310 million active users globally and daily sales exceeding 1.4 billion, has consistently been at the forefront of e- commerce innovation. The company's latest advancement, Rufus, an AI-powered chatbot, represents a significant leap forward in how customers interact with online retail platforms.

This paper aims to explore the impact of Rufus on the online customer experience, examining its capabilities, implementation, and potential implications for the future of e-commerce. By analyzing Rufus's role in product discovery, decision-making, and overall shopping journey, we seek to understand how AI-driven chatbots are reshaping consumer expectations and behaviors in the digital marketplace.

2 ONLINE CUSTOMER EXPERIENCE

Online Customer Experience (OCE) has been studied from both cognitive and affective perspectives. The cognitive approach, pioneered by Hoffman and Novak (1996) [1], draws on the concept of "flow" and emphasizes the interaction between user skill and challenge levels during online navigation. This model was further developed to distinguish between goal-directed and experiential web usage behaviors. The affective dimension, introduced by Rose et al. [2], complements the cognitive aspect by considering emotional responses to online stimuli. OCE is now understood as a multifaceted construct encompassing sensory, emotional, cognitive, behavioral, and relational components, with recent research by Bleier et al [3] also highlighting the importance of social and sensory appeal. The evolution of OCE models reflects the growing complexity of online interactions and the need for a holistic approach to understanding and enhancing customer experiences in digital environments.

3 VIRTUAL ASSISTANTS, CHATBOTS, AND ROBOTS

Virtual assistants are AI-powered computer programs that understand user queries and complete tasks (e.g., Siri, Cortana, Alexa). AI enhances product and service intelligence by performing cognitive functions like learning, problem-solving, and decision-making [4]. AI algorithms can now outperform humans in specific tasks, from disease diagnosis to legal advice [5]. They can even detect emotions in facial expressions and voice tones [6].

Chatbots, a type of virtual assistant, use natural language processing to converse with users via audio or text, often in customer service contexts. Robots are physically embodied AI machines that can autonomously sense, manipulate their environment, and perform tasks. The market for social robots is growing rapidly, particularly in retail, hotels, and service contexts (Business Wire, 2017). In this framework, AI-powered technologies can be classified into four types as shown in Table 1.

Table 01: A new typology/classification of AI-powered new technologies. **Source:** Hoyer, W. D., et al, (2020 [7])

Task	**Behavioral**	**Cognitive**
Repetitive	Simple Robot (e.g., Roomba)	Virtual Assistant, Chatbot(e.g., Siri, Alexa)
Nonrepetitive	Smart Robot (e.g., Vector, Cozmo)	Creative Assistant (e.g., Musenet)

AI-powered technologies can be classified into

four types based on task type (repetitive vs. nonrepetitive) and activity type (behavioral vs. cognitive).

4 AI'S EVOLUTION IN CUSTOMER EXPERIENCE

AI-enabled services play crucial roles in different phases of customer interactions [7] . In the pre-transaction phase, they select relevant information, customize choices, and advise customers. Online retailers use "recommendation agents" for product selection, based on browsing history and collaborative filtering [8]. *During transactions*, AI services can negotiate and enable dynamic pricing. For example, mobility apps like Lyft use real-time data to provide transparent, demand-based pricing. *Post-transaction,* virtual assistants provide feedback and recommend additional consumption. In healthcare, they can offer personalized fitness and nutrition advice based on data from smart devices.

The impact of embodied AI (robots) on customer experience is likely to increase. Mende et al [9] found that interacting with robots can increase consumer discomfort and affect consumption behavior. AI-powered technologies offer cognitive value by helping customers make better decisions. They may even predict customer preferences, as seen in Amazon's "anticipatory shipping" initiative [10].

Virtual assistants and robots could provide sensory/emotional value by becoming human-like companions. However, the "uncanny valley" theory suggests that too-human-like robots might repel consumers [11]. As AI develops further, it has the potential to increase cognitive, sensory/emotional, and social values. However, as we approach "technological singularity" [1 2] , there are concerns about AI outpacing humans and potentially replacing jobs.

5 CHATBOTS AND THEIR IMPACT ON CUSTOMER EXPERIENCE

Approaching customers at the right time with a personal touch is essential for enhancing the customer experience. Chatbots offer an accessible means for companies to achieve this by providing continuous and personalized customer interaction [13]. Figure 01 outlines how chatbot quality influences customer experience through three main dimensions: service quality, system quality, and information quality [14]. Service quality, encompassing assurance, responsiveness, and empathy, plays a crucial role in shaping customer satisfaction, trust, and loyalty. Assurance refers to a chatbot's professional problem-solving skills, responsiveness to the speed of service delivery, and empathy for understanding customer needs. System quality, which includes response time, usability, system ensures quick responses, ease of use, and adaptability to changing developments. Information quality, involving accuracy, relevance, and value, ensures that customers receive the right information at the right time [15].

Chatbots enable real-time responses, reducing the risk of losing customers due to unanswered queries [1 6] . Despite concerns about data privacy in the digital age, these concerns often diminish when customers are offered rewards or incentives. Gartner highlights that chatbots can manage customer progress more efficiently than humans by utilizing decision trees, which improves the customer experience through quick service and helpful interactions [17]. When chatbots exceed customer expectations, satisfaction can lead to increased customer loyalty.

Customer experience (Chatbot)		
Service quality	**System quality**	**Information *quality***
Assurance Empathy Responsiveness	**Accurate** **Relevant Valuable**	**Usability** **Reliability** **Availability** **Adaptability**

Figure 1. Customer experience and its dimensions by chatbots. Source: Jenneboer, L., et al., (2022).

6 CASE STUDY: CONSUMER EXPERIENCE WITH AMAZON'S RUFUS CHATBOT

Amazon is the first name that springs to mind when discussing online shopping, and with good reason. As of 2024, the platform boasts over 310 million active users globally, making it one of the most convenient and leading ecommerce platforms in the world. This massive user base has drawn in over 9.7 million sellers, with more than 2 million actively selling on the platform. Amazon's dominance is further underscored by its daily sales of $1.4 billion, driven by popular features such as fast and free shipping, an extensive product selection, and the growing membership of Amazon Prime, which now has over 200 million members worldwide. Amazon has solidified its position as a trusted source for product research, with 51% of users turning to the platform to explore products and read reviews before making purchasing decisions (Table 2).

Table 02: Online platforms ranked by user percentage for product search and shopping. (Source: amzscout.net)

Platform	Percentage of Users
Amazon	51%
Search engines	39%
Walmart.com	34%
YouTube	23%
Facebook	21%
Instagram	17%
TikTok	16 %

This makes Amazon the top destination for product searches, surpassing traditional search engines and other ecommerce platforms. Customers use Amazon more than any other search engine to look up products before purchasing them online.reliability, availability, and adaptability, assesses the technical performance of

chatbots. A well-designed, Amazon has been using AI expansively for 25+ years to improve customer experiences. The personalized recommendations customers get when they shop Amazon's store, the pick paths in its fulfillment centers, its drone deliveries, the conversational capabilities of Alexa, and its checkout-free Amazon Go stores are just a few examples of experiences fueled by AI. Generative AI is going to change virtually all customer experiences as we know them.

6.1 Rufus's Chatbot

Amazon has announced that **Rufus**, its latest AI-powered chatbot, is now available to all customers in the U.S. Rufus has already handled tens of millions of questions, aiming to enhance the shopping experience by integrating search and purchase into a single platform.
Rufus, Amazon's generative AI-powered chatbot, is designed to enhance the shopping experience by providing personalized assistance throughout the customer journey. From answering specific product queries to offering tailored recommendations and tracking orders, Rufus simplifies the shopping process by leveraging Amazon's extensive product catalog and real-time data. Below is an overview of Rufus's key capabilities, complete with examples of how it assists customers in various ways.

6.2 Rufus's caapabilities

Rufus, Amazon's generative AI-powered chatbot, is designed to enhance the shopping experience by providing personalized assistance throughout the customer journey. From answering specific product queries to offering tailored recommendations and tracking orders, Rufus simplifies the shopping process by leveraging Amazon's extensive product catalog and real-time data. Below is an overview of Rufus's key capabilities, complete with examples of how it assists customers in various ways. Table 03 summarizes the various functions Rufus provides to enhance customer interaction with the Amazon platform. Rufus, designed as a virtual shopping assistant within the Amazon Shopping app, aims to streamline the customer experience by providing real-time answers to a wide range of product-related questions. By leveraging extensive customer data, feedback, and generative AI technology, Amazon seeks to offer a comprehensive end-to-end shopping journey with Rufus. This AI-powered assistant not only helps customers save time and make more informed purchase decisions but also supports users throughout their entire shopping process, effectively providing a personalized shopping companion available whenever customers interact with Amazon's store.

Table 03. Rufus's capabilities

Capability	Description	Example
Understanding Product Details	Rufus answers specific product questions based on product listings, reviews, and Q&As. Customers can inquire about product features or details before purchasing.	Customers ask, "Is this coffee maker easy to clean?" or "Is this mascara a clean beauty product?" Rufus provides relevant details based on reviews and product descriptions.
Product Recommendations	Offers personalized suggestions by considering product features, location, and user preferences, enhancing the decision-making process.	A customer asked about pool umbrellas for Florida, and Rufus recommended options based on weather conditions. Other examples include queries like "What are the best wireless outdoor speakers?"
Comparing Products	Rufus compares product features, helping customers understand differences between similar items, allowing them to make more informed decisions.	Customers ask, "What's the difference between gas and wood-fired pizza ovens?" or "Compare OLED and QLED TVs." Rufus offers detailed comparisons to assist with decisions.
Staying Updated on Trends	Keeps customers informed on the latest product trends, ensuring they have access to the newest and most relevant products in the market.	Customers ask, "What's the most advanced Fire tablet for kids?" or "What are the latest denim trends?" Rufus provides up-to-date information.
Order Management	Provides easy access to current and past order tracking, simplifying the process of managing online purchases.	Customers inquire, "Where is my order?" or "When was the last time I ordered sunscreen?" Rufus helps track and access order history.
Answering Non-Shopping Questions	Beyond shopping, Rufus answers a variety of general questions that help customers with planning and other non-shopping-related inquiries.	Customers may ask, "What do I need to make a soufflé?" or "What do I need for a summer party?" Rufus provides helpful suggestions outside of direct product queries.
Getting Started	Customers access Rufus via the Amazon Shopping app or desktop. The chatbot is integrated into the platform for a seamless shopping experience.	Users can start by tapping the Rufus icon in the Amazon app or on their desktop, allowing for easy access to assistance whenever needed.

7 CONCLUSION

The integration of AI-powered chatbots like Rufus into the e-commerce landscape marks a significant advancement in customer service. Rufus's ability to provide real-time support, personalized recommendations, and efficient order management has proven to be a valuable asset to Amazon, enhancing the overall consumer experience. This research highlights that chatbots can drive higher customer satisfaction and loyalty by addressing specific needs and offering seamless interactions. As AI continues to evolve, its role in e-commerce will likely expand, presenting new opportunities for businesses to optimize their customer service strategies.

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The Role of Artificial Intelligence in Knowledge Management: A Qualitative Analysis of Interviews Next to Two Tunisian Companies

Rim Maâlej[1], Habib Affes[2]
[1] *A Doctor in Management at the Faculty of Economics and Management of Sfax, Tunisia (maalej.rim@gmail.com)*
[2] *A Professor of Higher Education at the Faculty of Economics and Management of Sfax, Tunisia (habib.affes@yahoo.fr)*

ABSTRACT

In fact, in this era, artificial intelligence (AI) plays a crucial role in the transformation of businesses. Therefore, this research paper deals with the role of AI in the knowledge management (KM). For this reason, the aim of this article is to provide an answer to the following question; "What is the role of artificial intelligence in the knowledge management?" ". Therefore, to answer this question, a qualitative analysis was conducted in two Tunisian companies, including "SOPAL" and "SOTIM" to study the integration of AI and its role in business strategy and KM. The results of this study showed very clearly that the interviewees agreed that AI represents a good business opportunity for companies. Since it is considered as a pillar of KM, which discusses its role in acquiring and organizing knowledge, collaboration, sharing knowledge and strengthening organizational learning.

KEYWORDS: Artificial intelligence, knowledge management, qualitative analysis, Tunisian companies.

1 INTRODUCTION

Nowadays, the development and strong integration of AI in companies might raise major organizational challenges, particularly in the field of the KM. In fact, in a rapidly evolving digital world, AI emerged as an essential aspect of modern business strategy, as it combines artificial intelligence and KM, while exploiting the power of AI to streamline and optimize the processing of information within companies .Therefore, KM has become the cornerstone of success and sustainability. Indeed, [1] define AI. as "the capacity of a machine to learn from experience, get adapted to new inputs, and perform tasks similar to the humans'. Moreover, [2] stated that AI is considered as "the innovation with the greatest disruptive potential"

Therefore, in an environment characterized by high competitiveness where decision-making is crucial and where the resources are limited, many researchers, notably [3]. It have been interested in the integration of AI, particularly in large companies. In this vein, [4] stated that several AI tools have been implemented in the decision-making process, noting that digital transformation requires a change in the business strategy. Notwithstanding However, despite the importance given attached to AI, AI, there is still a gap in theoretical and empirical results on how it can create value for businesses [1- 4]. This research aims to explore, analyze and understand the notion of AI, its integration into the practical life of Tunisian companies and to study its role within KM. Indeed, the two notions now tend in mutual harmony, thus providing new perspectives and leading to new problems for research.

As a result, several technologies have made it possible to capitalize on the knowledge of resources to build a solid and consistent knowledge base. In this context, very good results in the consolidation of knowledge generated by the different online learning actors to capitalize on their knowledge and create a heritage adapted to different profiles, while ensuring effective, social and collaborative following the integration of AI. The objective of this research is to study the use of AI in companies to help them maintain their competitive position in the present and near future. Which leads to being more creative and solving new problems effectively. In another way it is to study the role of AI in KM and therefore in the success of the company. This subject is becoming interesting for researchers, managers, employees and especially businesses on how the integration of AI is manifested in Tunisian companies and what role it plays in the KM.

First, we will briefly give the history of AI and define it. Then, we will present the concept of the KM after that, we will study the role of, AI in the KM. Secondly, we will present the literature review, finally, present, and analyze the selected responses.

2 LITERATURE REVIEW

2.1 Artificial intelligence

2.1.1 Historical

AI is one of the most disruptive topics affecting businesses. Several technologies have been evolved, notably chatbots. However, the origin of the chatbot undoubtedly dates back to the conception of intelligent machines sparked by Alan Turing in the 1950s. The evolution of AI facilitates the involvement of super intelligent super computers like IBM Waston and

subsequently the foundation chatbots. It finds its importance in companies considering it as a lever of competitiveness.

2.1.2 Definitions

AI can be defined as "the automation of activities associated with human reasoning, such as decision-making, problem solving, learning…" [5]. Again, it is seen as the "discipline studying the possibility of having computers perform tasks for which humans are today better than machines" certainly as "the study of mechanisms allowing an agent to perceive, reason, and act" [6]. Adding further, [7] states that "AI is not an easy thing" and that it is even "illusory to seek a clear definition". Yann Le Cun defined AI as "the set of techniques that imitate human intelligence and allow machines to reproduce functions that are attributed to humans: seeing, moving, sorting and prioritizing information, understanding a language, make a decision…".

Indeed, using techniques, such as sentiment analysis, named entity recognition and text summarization, NLP systems can extract actionable insights from unstructured text data, facilitate human-machine communication and enable tasks such as chatbots, virtual assistants and automated document analysis. However, chatbots have several advantages for businesses and customers.

Firstly, they increase efficiency and allow businesses to achieve economies of scale while providing convenient and additional services to their customers. They allow businesses to solve several customer problems. Secondly, chatbots constitute factors of differentiation and distinction compared to others and allow companies to evolve, stand out and always be dynamic.

2.2 Knowledge management

Nowadays, as companies face a constantly changing environment, KM constitutes the lever of organizational performance and therefore the ability to adapt has become essential. KM, for its part, is a discipline focusing on the systematic management of knowledge assets within organizations to facilitate better decision-making, foster innovation, etc. It encompasses a range of practices, processes and technologies aimed at capturing, codifying, organizing, storing, retrieving and sharing knowledge across organizational boundaries.

Additionally, KM organizes the company's knowledge, making it accessible and actionable for everyone within the organization. With a good KM system, any type of business can say goodbye to lost or isolated information. A company that fosters a culture of knowledge sharing is one that creates an adaptable, aligned, engaged, resilient and highly effective team.

In fact, companies are therefore faced with the search for typical KM approaches, which are most commonly indicated under the name of KM or "KM" [8].

2.3 The role of artificial intelligence in knowledge management

AI and KM have become inseparable partners in driving change within modern businesses. With more than three decades in this dynamic, field, they have had the privilege of pioneering the evolution of AI-based KM solutions and their results on organizational effectiveness, innovation and decision-making. In this research, we delve deeper into the relationship between AI and KM, shedding light on how pioneering companies are leveraging this synergy to open new frontiers in knowledge discovery and collaboration. KM often involves classifying and organizing large sets of data, documents and information. AI can automate this tiring process by using machine-learning algorithms to sort, arrange and organize data based on predefined rules.

AI plays a vital role in creating knowledge to subsequently improve decision-making [9].The integration of AI leads to better efficiency in generating knowledge related to the external market, where AI models use Big Data to collect market intelligence data, monitor the activities of other competitors, track the product launches, and react to legislative changes or the arrival of new competitors on the market [9].

As a result, AI is at the forefront of technological innovation, encompassing a wide range of methodologies and technologies aimed at replicating and augmenting human intelligence in machines. At its core, AI seeks to equip systems with the ability to perceive reason, learn and interact intelligently with their environment. In the field of AI, key technologies, such as machine learning, natural language processing, computer vision and robotics enable systems to analyze vast volumes of data, identify patterns, make predictions and perform tasks traditionally requiring human cognition. KM represents the foundation of AI. This is explained by better integration of AI, which is based on effective management of knowledge, content and data. It also plays an important role in leading change teams to create an environment conducive to the optimal exploitation of AI.

3 RESEARCH METHODOLOGY

In order to carry out our investigation concerning AI and KM, we adopted a qualitative approach using a semi-structured interview guide. The latter is considered"a technique intended to collect, with a view to their analysis, discursive data reflecting in particular the consciousness or unconsciousness of mental universe of individuals" [8]. Therefore, we need to know information about the importance of AI, KM and the role of AI in KM. The following table summarizes the questions of interview.

In this context, [11] stipulate that "in a qualitative research, researchers are concerned with the mechanisms or phenomena that are still little studied through investigations of a more exploratory nature, with a strong emphasis on description, a focus on understanding the phenomena and the development of theories aimed at understanding the data collected in the most complete

way possible. This approach is based on an exploratory logic which consists of “discovering or deepening a structure or functioning to serve two major objectives: the search for explanation (and prediction) and the search for understanding” [12].

Table 1. Interview guide

Preamble: "We thank you for your cooperation in this interview. Our research is part of an academic framework. We would like you to tell me first about your role within the company, then about your opinion on AI within the skills in Tunisian companies... We have planned an interview guide; we will ask you a few questions if certain points are not covered. Do not hesitate to tell me anything that comes to mind."	
Theme	**Questions**
AI	1- What AI technology is used in your company?
	2- In your opinion, how do you see AI in your company?
	3- In your opinion, why did your company integrate AI?
	4- Following the integration of AI, what is the role of AI in knowledge management?
KM	1- What are the factors that drive your company to use a KM approach?

In this context, [11] stipulate that “in a qualitative research, researchers are concerned with the mechanisms or phenomena that are still little studied through investigations of a more exploratory nature, with a strong emphasis on description, a focus on understanding the phenomena and the development of theories aimed at understanding the data collected in the most complete way possible. This approach is based on an exploratory logic which consists of “discovering or deepening a structure or functioning to serve two major objectives: the search for explanation (and prediction) and the search for understanding” [12].

In this research, AI is a concept little studied in the Tunisian context both theoretically and empirically, it suffers from a lack of conceptualization and an absence of theoretical models.

Our objective is to explore and understand the role of AI in KM based on a qualitative analysis. Thus, this research was carried out in the two companies “SOPAL” and “SOTIM” to have more relevant and reliable information and better communication.

In terms of selecting the sample for this study, the question of the number of interviews to be retained is a problem that remains quite complicated. In order to find a solution to the problem of sample size, the literature highlights two principles, notably replication [13] and saturation [14]. According to the latter, the adequate size of a sample is that which ensures theoretical saturation.

However, when the researcher stops at a certain number of interviews in which he does not find additional information to enrich the theory, from where the researcher sees phenomena already noticed, at this level saturation is achieved. According to [6], the appropriate sample size is that which arises from the logic of replication according to the degree of certainty.

When no new output appears after an analysis of the data to validate the theory, at this level, replication is carried out. Then, the researcher must add research interviews and carry out successive replications to reach saturation. Based on these two cases, the researcher must make his own approximation as to theoretical saturation or replication.

As part of this study, we followed the support who advised involving a number of interviews between four and ten to conduct rigorous research and validate a theory. To do this, we have planned ten face-to-face interviews. This allowed us to reach the number of people essential for this survey, which lasts two successive days for each company. It was actually more interesting to do interviews of varying length, in order to collect a greater number of responses on the same subjects and have a little freedom to express one's opinion. Thus, we chose managers and employees who are heterogeneous (taking into account women and men occupying very different functions).

4 PRESENTATION AND ANALYSIS OF THE SELECTED RESPONSES

4.1 Presentation of the selected cases

The following table summarizes the characteristics of each interviewed employee.

The choice of the first company SOPAL, which was created in 1981, is nationally very famous and benefited from a great use of AI. Currently, it has become a leader in Tunisia in the manufacture and distribution of products in the sectors of sanitary equipment, and water and gas connection. Its growth has been driven by a continuous improvement in the quality and permanent innovation of products, at the service of the consumer. In addition, it benefited from a total integration of its process. Besides, its technical design office is characterized by better equipment, the most efficient in design and development.

Table 2. Presentation of the cases of SOTIM and SOPAL Companies

	SOTIM Company				
	Career	Age	Sex	Function	Duration of time
Frame 1 : Mrs Fadwa	5 years	36	Female	Quality and production management manager	45mn
Frame 2 : Mr Salmen	4 years	44	Male	Sales Director	30mn
Frame 3 : Mr Slim	8 years	46	Male	HR Director	1h :30mn
Frame 4 : Mr Yassine	18 years	40	Male	Production Director	30mn
SOPAL Company					
Frame 1 : Mr Nizar	12 years	55	Male	Laboratory Manager Product Quality and Metrology	30mn
Frame 2 : Mr Said	2 and a half years	25	Male	HR development	1 hour
Employee 1 : Mrs Fatma	6 years	32	Female	Sales assistant: exhibition of customer displays	30mn
Employee 2 : Mrs Héla	2years	33	Female	Sales assistant: delivery	30mn

4.2 Analysis of the retained responses

Therefore, throughout the development of the interview guide, we have chosen to ask open-ended questions in order to give relatively broad freedom of expression to the employees we are going to interview. This interview guide focuses on the concept of AI and its role in the knowledge management. The purpose of this part is to understand the structure of the interview guide and the expected answers through each asked question. Then, to study the content of the interview guide in a clearer and more precise way, we presented it in the form of a table (see Appendix).

4.1.1 Case of the SOTIM Company

Mrs. Fadwa: sees that AI in their company is a good technique. She states, "We are following this technology in our production function, for example the templates which are the basis of manual cutting have been replaced by automatic shaping machines programmed by innovative software. This gives us speed, less waste, time saving and a lot of and also the employee becomes mobilized, dynamic and attentive". Thus, every two years, the maintenance and the industrial managers visit the large international fair of "Spring Mattress" in Germany to have an idea on the innovation of software, new machines, production techniques and fabrics. We are always -in a situation of a continuous technological monitoring by maintaining the leader's position in this field on the Tunisian market at the level of development of this product. Therefore, the development of AI represents a key success factor for the company. Internationally, SOTIM exported a lot to the Libyan market, but after the 2011 revolution and given the circumstances of the war, it made a break and was forced to sell only in the local market.

As for the AI and the KM, they have become inseparable partners to drive transformative change within our company. However, the use case of AI for KM, before exploring KM is essential to implement AI in our company.

Mr Salmen: In this context, AI has become an important and extraordinary technique, which leads us to make predictions to buy new softwares by 2021. In fact, Mr Salmen stated that AI has benefits, such as speed, the possibility to promote work and facilitate tasks, for example, the use of GPRS for trucks. Besides these advantages, it also has limitations, he predicts that, "in the years to come when it is well pushed, it can replace me completely". The use of multiple data sources gives decision-makers the power to use AI for predictive analysis, promoting more informed choices based on data. AI makes it possible to store a large number of contents while determining new more personalized archiving criteria, keeping only the most appropriate contents. AI facilitates the development of knowledge management by offering various tools for acquiring, codifying and analyzing, sharing and using knowledge, leading to efficiency.

Mr Slim: The platform has become useful in recent years and especially during the lockdown period, such as paying employees remotely, making transfers better than filling out checks and contacting the manager to sign and declare them. This platform has allowed us to save time in terms of travel, speed, easy to handle, no risk of error. This makes our task easier and the rapid circulation of information with the employment office. Thanks, for the moment, to the platform, we place the order, such as purchasing tickets and vouchers that are prepared by the SODEXO Company. AI aims to make knowledge more accessible and more exploitable.

Mr. Yassine: He is satisfied with these softwares in their current state. In this case, there is no renewal at the level of this technique and when the opportunity arises, he does not hesitate to do so because this technology allows us to save time and especially speed at the level of production. However, it is impossible to replace the

employee with intelligence and his answer is equivalent to Mrs. Fadwa's, we are not at the level of automation. The success of AI in our country, generally and specifically in our society, is linked to two essential points, which are the connection which must be strong and the acceptance of several users at the same time. Consequently, AI helps KM to generate a competitive advantage and faster decision-making. "I am pleased to work with this technology that adapts to the times generally and more particularly to our company SOPAL which always requires an improvement of the products. Similarly, AI offers expert systems capable of ensuring the induction of tacit knowledge. The latter ensures the design of a flow of knowledge from constituent elements of applications that allow successful communication between all the stakeholders of our company.

4.1.2 Case of the company SOPAL

HR Manager: Mr. Said He perceives that AI mainly concerns robotisation, materials, etc. At the level of my HR position, "we are interested in the digitalization of processes at the level of internal communication which makes the task easier during the confinement period (COVID 19) and we protect the information in real time as we go. In the event of a salary payment that must be divided, for example, into two groups following two successive periods to avoid congestion. All this through very fluid communication. «In fact, AI systems optimize and improve decision-making processes based on decisive data with efficient access to knowledge and information. Following the use of AI, we can achieve better quality information and data as well as better security for intellectual property. By becoming a key resource for companies, knowledge will indeed lead them to change their organizational methods. Knowledge in business is often inseparable from the individual.

Sales assistant: Mrs. Fatma and Mrs. Héla: These two employees work as a team in the same office. They see that AI makes the task easier through lighter access such as the SEGE software, which becomes integrated into the web. The latter becomes easier to handle (absence of the server) and more relevant in the presence of the new microfibers. In such ways, there is no connection break in the event of placing orders and in the event of changing files. "During the COVID and confinement period, we benefit from working remotely, everyone has their tasks". AI is a good thing since it saves time but it does not replace people especially in offices (especially in our sales department thanks to communication with customers).

The sales department is the first department affected in the company since there is direct contact with customers, such as in the event of a breakdown, we must give the exact date of repair. As for the KM, it is refocusing on the management of interactions and relationships around knowledge (social networks). This evolution leads to considering knowledge not as a resource to be optimized but rather a resource mobilized throughout the company's activity.

4.3 Discussion of results

At this level, we discuss our research work accompanied by other research found by some researchers. This survey is in the same direction as the research of Eurobarometer cited by [3] which notes that AI does not steal and replace the tasks of employees with robots and machines, especially the most qualified and the fear of losing work considered as an exaggeration. However, if there is a replacement, only for routine tasks. In addition, the integration of this new technology requires a job characterized by the employee's autonomy, teamwork, cooperation, horizontal communication, etc., not forgetting to always follow training to strengthen human skills.

Training encourages continuous learning through experience. This research also merges with the work of [16], which states that the development of AI is generally perceived positively. Also, Levy and Murnane emphasize that AI offers better productivity and the possibility of being competitive compared to other companies. It leads to a strengthening of good working relationships such as cross-functional communication, the ability to manage a group or a project, cooperation, active listening. AI will then become complementary with employees [15]. To conclude, in this survey we note that there is a confusion between AI and digital intelligence in the responses of the respondents especially the human resources managers of the two companies SOPAL and SOTIM. Note that this new notion "AI" is applied mainly in the production function. The latter is considered as a determining and motivating factor for the interviewees.

5 CONCLUSION

Artificial Intelligence and Knowledge Management form a crucial alliance. AI offers new work optimization potentials that KM can rely on to facilitate knowledge sharing. KM offers the company and the essential structures for implementing AI projects. They maximize decision-making and information management, becoming a vital driver of business sustainability. The rise of AI capabilities and promising functionalities to achieve certain objectives may require forms of division of laboratory between workers and the various intelligent machines that we have witnessed in companies in the past. These new roles require a new set of skills and competencies for humans and a new design for intelligent machines, while Humans must watch their perceptions, skills, and work practices to be able to leverage their artificial partners for KM, while avoiding automation pitfalls, such as cognitive complacency or algorithm aversion. Such preparations by organizations help put into practice the unique capabilities of AI in KM, which are only utilized and realized through an effective symbiotic partnership between knowledge, workers and intelligent systems.

This research shows very well that the interviewees see that AI is a good opportunity and a business opportunity for the company. An evolving technology always remains a key factor of success. It

allows companies to save more time and strengthen their competitive position. By improving the quality of life and satisfaction of the employees in their work, AI will allow them to be more productive and more scalable. Our results explain that AI is applied in all areas: in robotics (artificial vision, mechanics, expert systems, etc.), in customer's relations, in the field of human resources to create consulting solutions, to analyze trends, to analyse and the image of the company in the media and social networks, etc. However, this research is not without limitations. AI leads to a fear for some interviewees of being over taken by their own creations, which subsequently leads to the fear of losing their jobs in the future. The second limitation is the sample size (two companies and 8 interviewees). Therefore, we suggest extending beyond two companies. The third limitation is that some interviewees give off-topic and out-of-scope information, which requires patience with them until the expected answers are obtained.

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The Role of Artificial Intelligence in Accounting for Startups: A Case Study of Moufid Business Intelligence

Belkadi Tahar Lamine [1], Belkadi Belkacem[2],
[1] *University of M'hamed Bougara, Boumerdes, Algeria (t.belkadi@univ-boumerdes.dz)*
[2] *University of M'hamed Bougara, Boumerdes, Algeria (b.belkacem@univ-boumerdes.dz)*

ABSTRACT

Artificial Intelligence (AI) is rapidly transforming the field of accounting, especially for startups that seek streamlined, efficient, and accurate financial processes. This paper explores the integration of AI in the accounting processes of Moufid Business Intelligence, a startup focused on delivering advanced financial solutions to businesses. By leveraging machine learning, natural language processing, and automation, AI offers unique advantages to startups by reducing manual work, improving accuracy, and offering insights that traditional accounting practices cannot easily provide. Through a case study on Moufid, this article demonstrates how AI-based systems can enhance financial reporting, forecasting, fraud detection, and compliance, ultimately enabling startups to make data-driven decisions and maintain agility in an increasingly complex business environment.

KEYWORDS: Startup- accountant- Audit- artificial intelligence.

1 INTRODUCTION

The rapid development of AI technology has spurred innovative applications across various sectors, with the accounting profession being no exception. For startups like Moufid Business Intelligence, which operates at the intersection of financial services and advanced technology, AI presents opportunities to enhance operational efficiency and improve data management. The ability to analyze and process vast amounts of data quickly and accurately is crucial for startups that face unique financial challenges, such as limited budgets, rapid growth, and evolving regulatory requirements. This paper examines how AI tools are being applied within the Moufid Business Intelligence startup to optimize accounting workflows and support strategic decision-making.

2 LITERATURE REVIEW

AI applications in accounting have grown extensively, encompassing tasks such as data entry, auditing, fraud detection, and tax preparation. can significantly studies reveal that machine learning algorithms and AI-driven platforms can significantly reduce the time and cost associated with financial operations [2], [3]. AI technologies such as Robotic Process Automation (RPA) and Natural Language Processing (NLP) facilitate real-time data entry and analysis [1] leading to improved accuracy in accounting records. Recent research has also highlighted the potential of predictive analytics to support financial forecasting, budgeting, and resource allocation. However, while large corporations have widely adopted AI, its application in startups remains less documented, marking a gap that this study aims to address.of headings and subheadings should follow this example. No spaces should be placed between paragraphs.

3 METHODOLOGY

The case study method was employed to explore the role of AI in the accounting processes of Moufid Business Intelligence. Data were collected through interviews with the company's accounting and technology teams, as well as a review of internal reports and system performance metrics. This qualitative approach provides a detailed understanding of how AI technologies are implemented in the startup's accounting functions and evaluates the effectiveness and challenges of these applications. Tables and Figures

3.1 The Evolution of Accounting with AI

Traditional accounting practices often involve manual data entry, repetitive tasks, and time-consuming analysis. AI, however, has the potential to automate these mundane activities, allowing accountants to focus on higher-value strategic tasks. Moufid Business Intelligence, for instance, employs AI-powered algorithms to automate data extraction, classification, and reconciliation. This not only saves time but also significantly reduces the risk of human error.

Moreover, AI-driven analytics tools can uncover hidden patterns and trends within vast datasets. By analyzing historical financial data and external market factors, accountants can gain a deeper understanding of their organization's performance and make informed predictions about future trends. Moufid Business Intelligence utilizes machine learning to identify anomalies, forecast revenue, and optimize resource allocation.

3.1.1 Challenges and Opportunities

The integration of AI into accounting practices also presents certain challenges. One significant concern is the potential for job displacement. However, as AI automates

routine tasks, it creates opportunities for accountants to develop new skills and take on more strategic roles. Moufid Business Intelligence addresses this by providing training and support to help accountants adapt to the changing landscape.

Another challenge is the need for robust data security and privacy measures. AI systems rely on large amounts of sensitive financial data, and it is crucial to protect this information from unauthorized access and cyberattacks. Moufid Business Intelligence prioritizes data security and implements stringent measures to safeguard client information.

4 CASE STUDY: MOUFID BUSINESS INTELLIGENCE

Moufid Business Intelligence is a startup focused on providing advanced data-driven insights and financial services to businesses. By leveraging AI in its operations, Moufid aims to offer accurate, real-time financial insights to its clients, primarily small- to medium-sized businesses. The following sections outline the AI-driven tools and processes that Moufid uses for core accounting functions.

4.1 AI-Powered Financial Reporting and Analysis

One of the key applications of AI in Moufid's accounting system is automated financial reporting. The AI tool processes financial data in real-time, categorizes expenses, and prepares statements without manual intervention. Machine learning algorithms analyze historical data to detect patterns, allowing for quick and accurate monthly, quarterly, and annual reporting. This not only saves time but also reduces errors that might occur in manual data entry, providing clients with reliable data for their strategic decision-making.

4.2 Predictive Analytics for Cash Flow Management

Cash flow is a critical aspect of financial management for startups, where unpredictable expenses or cash shortages can significantly impact operations. Moufid's AI system uses predictive analytics to forecast cash flow based on historical spending, seasonal trends, and market data. This enables more informed budgeting and helps the company anticipate potential financial constraints.

4.3 Fraud Detection and Compliance

Moufid's AI-driven fraud detection tool uses anomaly detection to identify irregularities in transaction data, providing an additional layer of security for both the startup and its clients. Machine learning models are trained on historical transaction data to detect unusual patterns, reducing the risk of fraud and ensuring compliance with financial regulations. By automating compliance checks, the system also helps maintain transparency and regulatory adherence, which are crucial for early-stage companies.

5 Results

The integration of AI in Moufid Business Intelligence's accounting processes has led to significant improvements in efficiency and accuracy. The automated reporting system has reduced the time needed for monthly financial closures by 40%, freeing up the accounting team to focus on strategic tasks. Predictive analytics has provided valuable insights into cash flow management, enabling better budget planning and minimizing the likelihood of unexpected cash shortages. Furthermore, the AI-based fraud detection system has proven effective in identifying irregularities, enhancing overall financial security.

6 Challenges and Limitations

Despite its benefits, AI implementation in accounting poses challenges for startups like Moufid. Data quality remains a primary concern, as AI algorithms depend on high-quality, structured data for accurate analysis. Additionally, while AI tools can automate many routine tasks, skilled professionals are still required to interpret complex results, particularly in areas like compliance and strategic financial planning. There is also the challenge of balancing the costs of AI tools with the limited financial resources typical of startups.

6.1 Challenges of Implementing AI in a Startup Environment

While the advantages of AI in accounting are clear, implementation challenges can be significant, particularly for startups. One major issue is the financial cost associated with acquiring AI technology and talent. For many startups, investing in AI requires a substantial upfront cost for software, infrastructure, and skilled personnel. Additionally, integrating AI with existing accounting systems can be technically challenging, especially for startups that lack the resources of larger companies. There is also a steep learning curve associated with using AI tools effectively. Accounting teams need to be trained not only to use these tools but also to interpret the data accurately and apply it in decision-making contexts.

Further, AI models rely on data quality and completeness to be effective; missing or inaccurate data can skew results, leading to suboptimal financial decisions. Another concern for startups is data privacy and security. Since AI systems require vast amounts of data, startups like Moufid must ensure that client and internal data is stored securely and handled in compliance with privacy regulations. This need for robust data governance can add complexity to AI adoption, especially in industries with strict regulatory requirements.

6.2 Future Directions and Opportunities for AI in Accounting

The future of AI in accounting for startups like Moufid Business Intelligence looks promising, with emerging technologies offering even more sophisticated tools for data analysis, reporting, and strategic planning. One area of potential growth is the use of AI in environmental, social, and governance (ESG) reporting. With increased regulatory focus on sustainable business practices, AI can help track and report on ESG metrics, which are becoming increasingly important to investors and stakeholders. AI technologies, such as advanced NLP and computer vision, could also enable startups to automate document management and contract analysis, reducing legal and administrative costs. For example, NLP models can be used to extract key information from contracts, invoices, and financial documents, saving time and minimizing errors in data entry. Additionally, as blockchain technology becomes more integrated with AI, startups may see improvements in transaction security and transparency, particularly in verifying financial records and reducing fraud.

Another promising direction is the incorporation of cognitive AI, which combines machine learning with deep learning to mimic human decision-making. In an accounting context, cognitive AI could enable startups to predict market trends and adapt strategies based on real-time analysis, which would further strengthen their competitive position.

7. CONCLUSION

The case study of Moufid Business Intelligence demonstrates that AI can significantly enhance accounting efficiency and accuracy for startups. By automating repetitive tasks, predicting cash flow, and detecting fraud, AI allows startup accountants to focus on high-value activities that drive strategic growth. However, challenges related to data quality and interpretation remain, underscoring the need for a balanced approach that combines AI with human expertise. Future research could expand on this study by examining AI integration across various startup sectors and analyzing the long-term impact of AI on financial sustainability and growth.

The integration of AI into accounting practices offers a transformative opportunity for startups like Moufid Business Intelligence. Through automation, real-time analysis, predictive analytics, and fraud detection, AI can significantly enhance operational efficiency, reduce manual workload, and enable startups to make more informed, data-driven decisions. While challenges such as cost, data quality, and security must be addressed, the benefits of AI far outweigh these obstacles, particularly for startups striving to maximize their resources.

Moufid's experience with AI shows that, when implemented effectively, AI can provide a competitive advantage by enabling agile financial management and personalized client services. As AI technology continues to evolve, it will likely become an indispensable tool for startups seeking to thrive in an increasingly data-driven economy. This case study suggests that for startups, adopting AI in accounting not only streamlines operations but also opens new possibilities for strategic growth and resilience in a complex business landscape

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Sentiment analysis of tweets regarding chatgpt: implications for digital marketing

Messaoud Bendiaf[1], Souheyla Ammiche[2]
[1] *Department of Computer Science, University Mohamed El Bachir El Ibrahimi, Bordj Bou Arreridj, Algeria (messaoud.bendiaf@univ-bba.dz)*
[2] *Department of Letters and Foreign Languages, University Mohamed El Bachir El Ibrahimi, Bordj Bou Arreridj, Algeria (souheyla.ammiche@univ-bba.dz)*

ABSTRACT

Sentiment analysis has become a valuable tool in understanding public opinion across various fields, especially in the context of social media. This paper focuses on the sentiment analysis of tweets related to ChatGPT, an advanced AI language model, by utilizing supervised machine learning algorithms. The dataset of Twitter comments was classified into positive, neutral, and negative categories using SVM, Naive Bayes, and KNN classifiers. The study revealed that SVM outperforms the other classifiers in terms of accuracy and precision. This paper discusses the implications of these results for AI-driven digital marketing strategies.

KEYWORDS: Natural Language Processing, Sentiment Analysis, ChatGPT, Twitter, Digital Marketing, Opinion Mining

1 INTRODUCTION

Recent years marked a pivotal moment in the development of artificial intelligence, with OpenAI's ChatGPT [1] making a groundbreaking debut and quickly capturing global attention. It's now rare to find someone who hasn't either tried it firsthand or heard about its impressive capabilities. From generating content and analyzing data to assisting with coding, creative projects, homework, and marketing, ChatGPT's range of applications appears boundless.

With the rise of Web 2.0, online platforms such as Twitter (actually known as X platform) have become significant spaces where users express their opinions about various topics, including products and services. For companies and marketers, understanding these sentiments is essential for shaping digital marketing strategies and improving customer engagement. In particular, analyzing public sentiment on ChatGPT, a widely discussed AI tool, provides insights into consumer attitudes towards artificial intelligence technologies.

ChatGPT itself has become a powerful tool for digital marketing. As an advanced AI product, it enables brands to automate customer interactions, generate personalized content, and enhance customer service through conversational marketing. ChatGPT can respond to customer inquiries, recommend products, and even engage users in personalized conversations, making it an asset in fostering stronger customer relationships. Moreover, its ability to analyze large volumes of data can help companies gain deeper insights into customer needs and preferences, allowing them to tailor their marketing campaigns more effectively (see Figure 1). By integrating ChatGPT into digital marketing strategies, businesses can improve customer satisfaction, optimize lead generation, and enhance overall engagement across digital channels. As a product, ChatGPT not only influences the AI landscape but also plays a pivotal role in reshaping how companies approach customer interaction and brand promotion in the digital age.

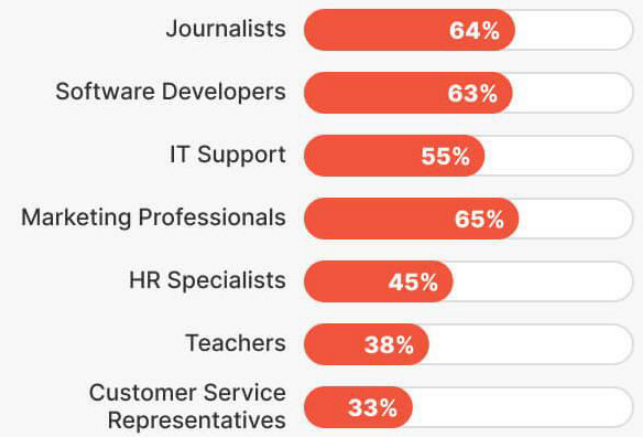

Figure 1. Top 7 jobs using Chatgpt [2]

The remainder of the paper is structured as follows: **Section 2 (Background)** provides an overview of sentiment analysis and its relevance to AI and digital marketing. **Section 3 (Methods)** details the data preprocessing steps, machine learning classifiers, and evaluation metrics used. **Section 4 (Results)** presents the classifier performance in terms of accuracy, precision, recall, and F1-score. **Section 5 (Discussion)** analyzes the results, highlighting the practical implications for digital marketing. Finally, **Section 6 (Conclusions and Future Work)** summarizes key findings and suggests future research directions.

5 BACKGROUND

5.1 Sentiment Analysis

Sentiment analysis, also known as opinion mining, is a Natural Language Processing (NLP) technique used to identify the emotional tone within a body of text. It is

widely employed by organizations to analyze and categorize opinions about products, services, or ideas. Sentiment analysis leverages data mining, machine learning (ML), artificial intelligence (AI), and computational linguistics to evaluate text and determine whether it conveys positive, negative, or neutral sentiments [3].

These systems provide organizations with valuable insights into real-time customer sentiment, customer experiences, and brand perception. They typically utilize text analytics to assess content from online sources like emails, blog posts, reviews, support tickets, news articles, surveys, web chats, tweets, and forums. Algorithms power these systems, employing rule-based, automated, or hybrid methods to evaluate whether a customer's words are positive, negative, or neutral.

Additionally, sentiment analysis can extract the polarity or degree of positivity and negativity, along with identifying the subject and opinion holder in the text. This technique can be applied to different levels of text, from entire documents to paragraphs, sentences, or even subsentences.

5.2 ChatGPT Overview

ChatGPT [4] is an advanced AI chatbot developed by OpenAI, launched in November 2022. It is based on the Generative Pre-trained Transformer (GPT) architecture, specifically utilizing the GPT-3.5 model initially and later updated to GPT-4. This powerful language model is designed to generate human-like text and engage in natural conversations, making it suitable for a variety of applications.

ChatGPT represents a significant advancement in conversational AI technology, offering a wide range of applications across various fields. Its ability to generate coherent text and engage in meaningful dialogue positions it as a valuable tool for both personal and professional use. As AI continues to evolve, tools like ChatGPT will play an increasingly important role in how we interact with technology.

5.3 AI in marketing

AI has revolutionized nearly every aspect of digital marketing, from automation to social media strategies. While AI technologies have been integrated into marketing for over a decade, the rise of advanced Natural Language Processing (NLP) [5] tools like ChatGPT has brought renewed attention to AI's capabilities. AI-driven marketing tools leverage machine learning [6] to handle repetitive tasks, such as generating content for blogs or social media, by analyzing vast amounts of data. Incorporating AI into marketing strategies enhances customer engagement by delivering personalized, relevant content, ultimately improving conversion rates and customer satisfaction.

6 METHODS

6.1 Data collection

The dataset used for this study was sourced from Kaggle, titled "ChatGPT Tweets First Month of Launch" [7]. It contains tweets posted about ChatGPT during its first month, covering the period from November 30, 2022, to December 31, 2022. This dataset (Figure 2) provides a snapshot of public sentiment and engagement with ChatGPT during its early stages, capturing people's opinions and questions regarding the tool.

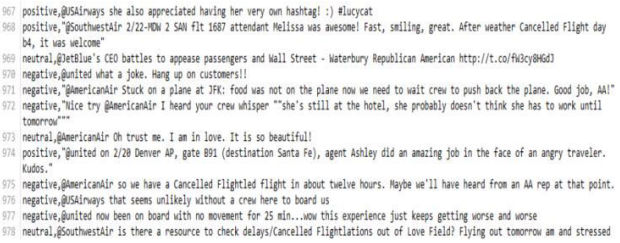

Figure 2. Preview of our dataset

To streamline the dataset for analysis, we retained only the essential columns: **id**, **tweets**, and **labels**. This ensures that we focus on the core elements required for sentiment classification, where "id" uniquely identifies each tweet, "tweet" contains the text data, and "labels" indicate the sentiment categories (positive, negative, neutral). The dataset comprises a total of 23,844 tweets, categorized into three sentiment classes:

- Positive: 3,870 tweets,
- Negative: 14,908 tweets,
- Neutral: 5,066 tweets.

By analyzing these tweets, we gain valuable insights into how users perceived ChatGPT immediately after its launch, making it an ideal source for sentiment analysis and understanding the public's reaction to this groundbreaking AI technology.

Table 1. Performance comparison of our classifiers

Classifiers	Accuracy	Positive			Negative			Neutral		
		Precision	Recall	F1-score	Precision	Recall	F1-score	Precision	Recall	F1-score
KNN	0.85	0.72	0.88	0.79	0.97	0.85	0.90	0.71	0.84	0.77
SVM	**0.86**	0.85	0.75	0.79	0.87	0.95	0.91	0.79	0.66	0.72
NB	0.74	0.59	0.61	0.60	0.83	0.85	0.84	0.60	0.53	0.56

6.2 Data Preprocessing

Preprocessing is a crucial step in preparing textual data for sentiment analysis, as it ensures that the data is clean and standardized for use in machine learning models. In this section, we detail the various preprocessing steps applied to the dataset of tweets about ChatGPT, including converting text to lowercase, data cleaning, tokenization, and lemmatization.

3.2.1 Convert Text to Lowercase

The first step in preprocessing is to convert all text data into lowercase. This ensures uniformity in the dataset, as capitalized and non-capitalized words will be treated the same. For example, "ChatGPT" and "chatgpt" are considered the same word after conversion. This step is simple yet critical because case differences can introduce unnecessary variations that confuse the model. This was implemented using the `lower()` function in Python.

3.2.2 Data Cleaning

Data cleaning focuses on removing unwanted elements from the text, such as hashtags, stop words, special characters, URLs, and usernames. Each of these elements can introduce noise into the dataset, leading to inaccurate sentiment predictions if not handled properly. To perform data cleaning, we employed the "re" library in Python, which allows for the use of regular expressions to efficiently remove these unwanted elements.

- *Removal of Stop Words :* Stop words are common words such as "and," "is", or "the" that do not add significant meaning to the text and can be safely removed. By eliminating these words, we reduce the size of the text data and enhance the model's ability to focus on more meaningful words. For this, we used Python's NLTK library to filter out stop words.
- *Removal of Special Characters:* Special characters such as #, @, %, ! are common in tweets but add little value for sentiment classification. We used regular expressions to strip these characters from the text. This step ensures that the dataset contains only alphabetic characters, making the text more structured and easier to analyze.
- *Removal of Non-Alphabetic Characters:* This step involves removing any non-alphabetic characters, such as numbers, links (URLs), and emoticons, which are irrelevant to sentiment analysis.

For example, URLs and mentions of usernames (e.g., @user123) were removed using regular expressions, leaving behind only words relevant to the analysis.

	Sentiment	Tweet
0	negative	chatgpt rate
1	negative	microsoft 365 copilot chatgpt ai war may end n...
2	positive	bing fab better chat gpt research work
3	positive	use gpt4 image shows world changed forever
4	positive	im you always fascinating explore potential op...

Figure 3. Preview of our dataset after preprocessing.

Figure 3 shows a preview of the dataset after completing all of these preprocessing steps, illustrating the cleaned and standardized text that will be used for sentiment classification.

3.2.3 Tokenization

Tokenization is the process of splitting text into smaller units called tokens, which could be individual words, phrases, or characters. In this study, we performed word-level tokenization, breaking down each tweet into individual words. Tokenization is a critical step for Natural Language Processing (NLP) because it allows the model to work with distinct words or tokens rather than entire sentences or blocks of text. The tokenization process was handled using Python's *nltk.tokenize* library, which splits the text efficiently based on spaces, punctuation, and other delimiters.

3.2.4 Lemmatization

The final step in text preprocessing is lemmatization, which involves reducing words to their base or root form, known as a lemma. For example, the words "running" and "ran" are both converted to the base form "run." Unlike stemming, which simply cuts off word endings, lemmatization considers the context and ensures that the base form is linguistically accurate. We used Python's NLTK *WordNetLemmatizer* to perform lemmatization. This step helps reduce the variability in the text by grouping different forms of a word into a single representation, which enhances the model's ability to generalize during training.

7 RESULTS

Our dataset was split into two parts for model evaluation: **60%** of the data was used for training the classifiers, while the remaining **40%** was set aside for testing. This division allowed us to train the models effectively on the larger portion of the data and then assess their performance using metrics such as accuracy, precision, recall, and F1-score on the test set, providing a robust evaluation of each classifier's capabilities.

In this study, three machine learning classifiers—K-Nearest Neighbors (KNN), Support Vector Machine (SVM), and Naive Bayes (NB)—were evaluated on their ability to classify tweets regarding ChatGPT into three sentiment categories: positive, negative, and neutral. The performance metrics evaluated include accuracy, precision, recall, and F1-score for each sentiment class.

As shown in Table 1, The KNN classifier performed strongly in classifying negative sentiments, achieving a high precision of 0.97 and a balanced F1-score of 0.90. The model performed moderately well in classifying positive and neutral sentiments, with F1-scores of 0.79 and 0.77, respectively. This shows that KNN is particularly good at detecting negative tweets, although it has a tendency to misclassify positive tweets as other categories.

The SVM classifier achieved the highest overall accuracy of 0.86 across all sentiment classes. It performed well in the negative class, with a high F1-score of 0.91, indicating strong recall (0.95) and balanced precision (0.87). In the positive class, SVM also achieved a competitive precision of 0.85, although the recall was slightly lower at 0.75. However, the classifier struggled more with neutral tweets, where the F1-score was 0.72, showing it had some difficulty differentiating neutral sentiments from positive and negative categories.

Naive Bayes performed the worst among the three classifiers, with an accuracy of 0.74. Its performance was strongest in the negative class, where it had a decent F1-score of 0.84. However, it struggled with positive and neutral tweets, achieving an F1-score of 0.60 and 0.56, respectively. This suggests that Naive Bayes is less effective in distinguishing the nuances between positive and neutral sentiments, likely due to its reliance on probability distributions which may not capture complex patterns in the text.

8 DISCUSSION

The performance of the three classifiers—KNN, SVM, and Naive Bayes—demonstrates important distinctions in their ability to classify sentiments expressed in tweets regarding ChatGPT. Among the classifiers, SVM demonstrated the highest overall accuracy at 0.86, outperforming both KNN and Naive Bayes. This result is consistent with prior studies, as SVM is known for handling high-dimensional data well, making it particularly suitable for text classification tasks such as sentiment analysis. The strength of SVM lies in its ability to achieve a high balance between precision and recall across the positive and negative sentiment classes, as reflected in its strong F1-scores. However, the SVM struggled slightly with the neutral class, indicating that there may be some overlap between neutral sentiments and the other two categories.

The KNN classifier also performed well, particularly in classifying negative sentiments, where it achieved the highest precision of 0.97. This suggests that KNN is effective in recognizing clear-cut negative statements, though it seems to struggle with classifying tweets that are more ambiguous, as indicated by the relatively lower precision and recall for the positive and neutral classes. KNN's reliance on proximity to labeled data points can sometimes lead to misclassifications when there are subtle differences between sentiments, particularly with short texts like tweets.

Naive Bayes, while fast and efficient, was the weakest performer in this study. Although it achieved reasonable performance in the negative class, its low precision and recall in the positive and neutral classes suggest that it struggles to differentiate these sentiments effectively. This could be due to the fact that Naive Bayes makes strong independence assumptions about the features (i.e., words in the tweets), which limits its ability to capture complex relationships between words that are essential in distinguishing subtle differences in sentiment.

These findings have important implications for sentiment analysis, particularly in the context of understanding public opinion about AI technologies like ChatGPT. The results demonstrate that SVM is the most reliable classifier for sentiment analysis tasks, as it can handle the complexity of human language better than KNN or Naive Bayes. Given the high recall and F1-scores for the negative class across all classifiers, it's evident that negative sentiment is often more straightforward to detect. However, differentiating between positive and neutral tweets remains challenging, especially for classifiers like Naive Bayes.

The strong performance of SVM suggests that it is the best-suited algorithm for applications that require a deep understanding of user sentiment, such as marketing campaigns, customer feedback systems, and brand reputation management. SVM's balance between precision and recall makes it particularly useful in situations where both false positives and false negatives could have significant business implications, such as identifying dissatisfaction among users or gauging public perception of AI technologies.

9 CONCLUSIONS AND FUTURE WORK

This study demonstrates the effectiveness of sentiment analysis in understanding public opinion about ChatGPT. The use of SVM, Naive Bayes, and KNN classifiers provided valuable insights into how different machine learning algorithms perform in sentiment classification tasks. Among these, SVM proved to be the most accurate, making it the best choice for analyzing social media data.

In the context of digital marketing, the ability to analyze public sentiment in real time allows businesses to engage with their customers more effectively. By understanding consumer attitudes, companies can enhance their products, improve customer relationships, and strengthen brand loyalty. This analysis highlights the importance of selecting the right algorithm for sentiment analysis tasks. While Naive Bayes is often used for its simplicity and speed, more complex models like SVM offer superior performance, especially in tasks requiring nuanced text classification. In future work, it would be beneficial to explore how combining classifiers through ensemble methods or using deep learning approaches like LSTMs (Long Short-Term Memory) might improve the detection of subtle sentiment differences, particularly for neutral sentiments.

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Digital Technologies in Education: Impacts and Factors influencing Digital Capacity and Transformation

Bouzidi Zair[1]
[1] *LMA Laboratory, Bejaia University, Exact Sciences Faculty, Bejaia, Algeria*
(zair.bouzidi@univ-bejaia.dz, abdelmalek.boudries@univ-bejaia.dz)

ABSTRACT

Digital technologies have changed the nature and scope of education and led several education systems worldwide to adopt strategies and policies for ICT integration. The latter brought about issues regarding the quality of teaching and learning with ICTs, especially concerning the understanding, adaptation, and design of the education systems by current technological trends. These issues were emphasized during the recent COVID-19 pandemic that accelerated the use of digital technologies in education, generating questions regarding digitalization in schools. Specifically, many schools demonstrated a lack of experience and digital capacity, which resulted in widening gaps, inequalities, and learning losses. Such results have engendered the need for schools to learn and build upon the experience to enhance their digital capacity and preparedness, increase their digitalization levels, and achieve a successful digital transformation. Given that the integration of digital technologies is a complex and continuous process that impacts different actors within the school ecosystem, there is a need to show how these impacts are interconnected and identify the factors that can encourage effective and efficient change in the school environments. For this purpose, we conducted a non-systematic literature review. The results of the literature review were organized thematically based on the evidence they presented about the impact of digital technology on education and the factors that affect the schools' digital capacity and digital transformation. The findings suggest that the impact of ICT integration in schools goes beyond students' performance in school subjects and touches on several school-related aspects, such as equality and social integration, as well as different stakeholders. Additionally, various factors affect the impact of digital technologies in education. These factors are interconnected and play a vital role in the transformation process. The study results shed light on how ICTs can positively contribute to the digital transformation of schools and which factors should be taken into consideration for schools to achieve effective and efficient change.

KEYWORDS: Digital capacity, Digital technologies, Digital transformation, Education, Impact.

1 INTRODUCTION

Digital technologies have changed the nature and scope of education. Recently, versatile and disruptive technological innovations, such as smart devices, Internet of Things (IoT), artificial intelligence (AI), augmented reality (AR) and virtual reality (VR), blockchain, and software applications, have opened up new opportunities to advance teaching and learning [1, 2]. Thus, in recent years, many education systems around the world have increased their investments in the integration of information and communication technologies (ICT) into teaching and learning practices [3, 4], educational agendas the adaptation of an ICT integration strategy or policy [5]. The latter has raised questions regarding the quality of teaching and learning with ICT [6], particularly regarding the understanding, adaptation and design of education systems in line with current technological trends [7].

Specifically, previous studies have shown that despite the investments that several countries have made in the integration of technology in schools, the results are not promising and the expected results have not been achieved [4, 8]. These issues have been highlighted during the recent COVID-19 pandemic as governments have been forced to move to online teaching at all levels of education [9]. Online education has accelerated the use of digital technologies, generating questions about digitalization in schools [10]. Specifically, many schools have demonstrated a lack of experience and digital capacity, leading to widening gaps, inequalities, and learning losses [11]. Such results have generated the need for schools to learn and build on the experience to improve their digital capacity and readiness [5] and increase their levels of digitalization [12]. Digitalization offers opportunities for fundamental improvements in schools [1, 13] and affects many aspects of a school's development [14]. However, this complex process requires large-scale transformative changes that go beyond the technical aspects of technology and infrastructure [15].

Digitization can support a school's digital transformation, which refers to "a series of profound and coordinated changes in culture, workforce and technology and operating models" [16] that bring cultural, organizational and operational change through the integration of digital technologies [17]. To succeed in their digital transformation, schools must increase their digital capability levels. Digital capacity refers to “the extent to which culture, policies, infrastructure as well as the digital skills of students and staff support the effective integration of technology into teaching and learning practices” [12]. Given that the integration of digital technologies is a complex and continuous process that impacts different actors within the school ecosystem [18], it is necessary to show how these impacts are

interconnected and to identify the factors that can encourage effective and efficient change in school environments. Based on the above, this study aims to shed light on all the impacts of digital technologies on education and identify the factors that affect the digital capacity and digital transformation of schools. Therefore, it will help to understand how ICT can positively contribute to the digital transformation of schools. More specifically, the document aims to answer the following questions:

a) What is the impact of digital technologies on education?

b) What factors could affect the digital capacity and transformation of schools?

To answer the research questions, we conducted a non-systematic literature review. The results of the literature review were organized thematically based on the evidence they presented on the impact of digital technology on education and the factors that affect the digital capacity and digital transformation of schools.

2 METHODOLOGY

The non-systematic literature review presented here covers the main theories and research published over the last 15 years on the subject. It was based on meta-analyses and review articles found in peer-reviewed scientific content databases and other key studies and reports related to the concepts studied (e.g. digitalization, digital capability) professional and international organizations (for example, the OECD).

Namely, we used the Scopus database to collect peer-reviewed academic articles. Scopus indexes various online education sector journals with international reach. Additionally, we used the comprehensive Google Scholar search engine to expand our searches based on relevant key terms or to include studies found in the reference list of peer-reviewed articles, and other key studies and reports linked to the concepts studied (e.g. digitalization, digital capacity) with professional and international bodies. Finally, we gathered sources from the Publications Office of the European Union (https://op.europa.eu/en/home) to find documents published by the EU that refer to policies related to digital transformation in education. First, we searched for resources on the impact of digital technologies in education by performing the following search queries: "impact" OR "effects" AND "digital technologies" AND "education", "impact" OR “effects” AND “ICT” AND “education”. We further refined our results by adding the terms “meta-analysis” and “review” or adjusting the search options based on the characteristics of each database to avoid collecting individual studies regarding the use of one or more digital technologies in teaching and learning.

We turned to meta-analyses and review studies because they consider the results of multiple studies providing important information about the state of research in a given area [19]. Individual studies were excluded because they make only limited contributions to a particular field. Additionally, effect size information reported in meta-analyses provides important insight into the extent of the possible impact of digital technology use on learning [20]. Although quantitative data is important, it does not provide explanations for the challenges or difficulties encountered when integrating ICT into learning and teaching [21]. In this regard, literature reviews were valuable sources as they provided a detailed understanding of the benefits and implications of integrating technology in schools. Primarily, the review studies provided in-depth qualitative evidence between the use of digital technology or self-reflection tools and their outcomes. In contrast, effect factors derived from meta-analyses of experimental studies have provided quantitative evidence since they involve a measurement of impact based on statistically verifiable results [21].

In the analysis presented here, we have also included policy documents and reports from professional and international bodies and government reports to gain a valuable understanding of this study's key concepts and policy recommendations regarding technology integration digital technology in education. These papers and reports have provided useful insights into recent and important evidence regarding the concept of digital capacity and educational transformation. The inclusion and exclusion criteria are presented in Table 1. To ensure reliable extraction of information from each study and to assist in research synthesis, we selected study characteristics of interest (impacts) and constructed coding forms. First, an overview of the synthesis was provided by the principal investigator who described the processes of coding, data entry, and data management. All coders worked independently based on common instructions. To ensure a common understanding of the process among coders, the sample of ten studies was tested. The results were compared and discrepancies were identified and resolved.

Table 1 Inclusion and exclusion criteria regarding the impact of digital technologies in education.

Inclusion criteria	**Exclusion criteria**
Papers since 2005	Theses and doctoral theses
Review and meta-analysis studies	Posters in conferences
Formal education K-12	Conference papers without proceedings
Peer-reviewed articles	Sources on higher education
Articles in English	
professional/international bodies, and government reports	
book chapters	

Additionally, to ensure an efficient coding process, all coders participated in group meetings to discuss additions, deletions, and modifications [22]. Due to the methodological diversity of the documents studied, we began to synthesize the results of the literature review based on similar study designs. Specifically, most meta-analysis studies were grouped into a single category due

to the fact that impact was measured quantitatively in the form of effect sizes that primarily related to student achievement [23]. Next, we organized the themes of qualitative studies on other categories based on their impacts. Finally, we synthesized data from reviews and meta-analyses across categories.

Table 2 The impact of digital technologies on school stakeholders based on the literature review

Impact	Model
Student	
Knowledge, skills, attitudes, and Emotions	
Learning gains from the use of ICTs across the curriculum	18; 25; 32; 33; 20; 37; 34; 30; 38; 41; 43; 44 45
Positive learning gains from the use of ICTs in specific school subjects (e.g. mathematics, literacy, language, Science	25; 46; 47; 28; 51; 32; 50; 55; 37
Positive learning gains for special needs students and low-achieving students	18; 25; 26
Opportunities to develop a range of skills (e.g., subject-related skills, communication skills, negotiation skills, emotion control skills, organizational skills, critical thinking skills, creativity, metacognitive skills, life, and career skills)	25; 36; 38; 20, 51
Opportunities to develop digital skills (e.g., information skills, media skills, ICT skills	Bouzidi, 2024
Positive attitudes and behaviors towards ICTs, positive emotions (e.g., increased interest, motivation, attention, engagement, confidence, reduced anxiety, positive achievement emotions, reduction in bullying and cyberbullying	25; 30; 20
Learning experience	
Enhance access to resource	13; 36
Opportunities to experience various learning practices (e.g., active learning, learner-centered learning, independent and personalized learning, collaborative learning, self-directed learning, self- and peer-review)	13; 36
Improved access to teacher assessment and feedback	35
Equality, inclusion, and social integration	
Improved communication, functional skills, participation, self-esteem, and engagement of special needs students	[55]
Enhanced social interaction for students in general and for students with learning difficulties	[60]
Teachers	
Professional practice	
Development of digital competence	25
Positive attitudes and behaviours towards ICTs (e.g., increased confidence)	26
Formalized collaborative planning between teachers	25
Improved reporting to parents	25
Teaching practice	
Efficiency in lesson planning and preparation	25
Facilitate assessment through the provision of immediate feedback	26
Improvements in the technical quality of tests	26
New methods of testing specific skills (e.g., problem-solving skills, meta-cognitive skills)	26
Successful content delivery and lessons	47
Application of different instructional practices (e.g., scaffolding, synchronous collaborative learning, online learning, blended learning, hybrid learning)	47
Administrators	
Data-based decision-making	
Improved data-gathering processes	25
Support monitoring and evaluation processes (e.g., attendance monitoring, financial management, assessment records)	55
Organizational processess	
Access to learning resources via the creation of repositories	55
Information sharing between school staff	55
Smooth communications with external authorities (e.g., examination results)	26
Efficient and successful examination management procedures	26
Home-school communication	
Support reporting to parents	55
Improved flow of communication between the school and parents (e.g., customized and personalized communications)	56
School leaders	
Professional practice	
Reduced headteacher isolation	55
Improved access to insights about practices for school improvement	55
Parents	
Home-school relationships	
Improved home-school relationships	
Increased parental involvement in children's school life	56

To establish a collective understanding of the concept of impact, we referred to a previous impact study which was conducted [24] with a similar scope. The aforementioned study examined the impact of technology in primary schools. In this context, impact had a more specific meaning related to ICT and was described as "a significant influence or effect of ICT on the measured or perceived quality of (parts of) education" [24]. In the study presented here, the main impacts refer to learning and learners, teaching and teachers, as well as other key stakeholders who are directly or indirectly linked to the academic unit.

3 IMPACTS OF DIGITAL TECHNOLOGIES

The results of the study showed the impacts of the use of digital technologies on the knowledge, skills and attitudes of students, on equality, inclusion and social integration, on the professional and educational practices of students. teachers and on other aspects and actors linked to school. The data also reported on various factors that could affect the digital capacity and transformation of schools, such as digital skills, personal characteristics and professional development of teachers, school leadership and management, administration, infrastructure, etc. The impacts and factors found in the literature review are presented below.

3.1. Impacts of digital technologies on students' knowledge, skills and attitudes

The impact of ICT use on students' knowledge, skills and attitudes has been studied very early in the literature. [18] found a slight positive effect between ICT use and student learning. Specifically, the author reported

that access to computers for each student could improve learning when used in computer-assisted instruction (CAI) programs in simulation or tutoring modes that are used to complement rather than replace teaching. The author reported studies that showed that teachers recognized the benefits of ICT for students with special educational needs; however, the impact of ICT on student achievement was unclear. [25] found a statistically significant positive association between ICT use and higher student achievement in primary and secondary education. The authors also reported improvements in the performance of low-performing students. The use of ICT resulted in other positive gains for students, namely increased attention, engagement, motivation, communication and process skills, teamwork and increased learning behavior. Evidence reported from qualitative studies showed that teachers, students and parents recognized the positive impact of ICT on student learning, regardless of their proficiency level (strong/weak students).

[26] documented studies that showed positive results of ICT-based learning to support low-achieving students and young people with complex lives outside of the education system. [32] reported moderate positive effects of teaching computer applications (computer-assisted instruction, computer simulations, and Web-based learning) compared to traditional teaching on elementary school students' achievement. Similarly, [34] reported small to moderate positive effects between the use of computer technology (CAE, ICT, simulations, computer-assisted instruction, digital and hypermedia) and student achievement in formal face-to-face classes compared to classes that did not use technology.

[36] found that the use of learning platforms (LPs) (virtual learning environments, management information systems, communication technologies, and information and resource sharing technologies) in schools provided more opportunities for primary and secondary students to access a variety and quality learning resources, engage in independent and personalized learning, conduct self-assessment and peer review, as well as opportunities for teacher evaluation and feedback. Similar findings were reported by [37], who documented a list of benefits and opportunities of using ICT. According to the author, the use of ICT helps students effectively and efficiently access digital information and course content, supports student-centered and self-directed learning, supports the development of an environment creative learning where more opportunities for critical thinking skills are offered and promotes collaborative learning in a distance learning environment. [21] found consistent but weak positive associations between technology use and learning outcomes of school-aged learners (5-18 years) in studies linking supply and use technology and level of success. Additionally, [38] reported a medium positive effect of technology on the learning effectiveness of primary school students compared to students who received traditional education.

The rise of mobile technologies and hardware devices has led to new research into their impact on teaching and learning. [35] reported a moderate effect on student performance of using mobile devices in the classroom compared to using desktop computers or not using mobile devices. [30] reported medium to small positive effects of technology integration (e.g., CAI, ICT) in the classroom on student achievement and attitudes compared to no technology use or its use to varying degrees. [39] found a small, statistically significant effect of using tablets and other smart devices in educational settings on students' academic achievement. The authors also reported that tablets provided additional benefits to students; namely, they reported improvements in students' note-taking, organizational and communication skills, and creativity.

[40] reported a small positive effect of individual laptop programs on students' academic achievement in all subjects. Other reported benefits included student-centered, individualized, and project-based learning, which increased learner engagement and enthusiasm. Additionally, the authors found that students in individual laptop-based programs tended to use technology more frequently than in classes without laptops and, as a result, they developed a range of skills (e.g., information, media, technological skills, organization skills). [42] found that most interventions that included the use of tablets across the curriculum reported positive learning outcomes. However, out of twenty-three studies, five studies reported no difference and two reported a negative effect on student learning outcomes with the use of tablets.

Recently, approaches referring to the impact of gamification with the use of digital technologies on teaching and learning have also been explored. [43] reported a moderate effect of gamification (features of video games) on student learning outcomes in formal education contexts compared to non-gaming contexts. [44] reported a medium effect of using educational games on academic achievement. Over the past two years, the effects of more advanced technologies on teaching and learning have also been studied. [45] found that augmented reality (AR applications) had a medium effect on student learning outcomes compared to traditional lectures. Similarly, [46] showed that AR had a medium impact on student learning gains.

It should be noted that the vast majority of studies refer to learning gains in specific subjects. Specifically, several studies have examined the impact of digital technologies on students' literacy skills and reported positive effects on language learning [25, 47, 48]; Furthermore, several studies have documented positive studies on specific areas of language learning, namely foreign language learning [49], writing [21, 40], reading and comprehension [33]. Effects of Computer Application on Elementary School Student's Achievement: A Meta-Analysis of Students in Taiwan. Computers in the Schools, 24(3-4), 43-64. https://doi.org/10.1300/J025v24n03_04 ; [50]. ICT also has a positive impact on students' performance in mathematics [25, 29, 40, 51, 52]. More specific positive learning gains have been reported in numerical skills, problem-solving skills and pattern exploration skills [21]

and metacognitive learning outcomes [52]. In addition to learning gains, studies have also reported improvements in motivation and interest [21] as well as increased confidence and engagement in mathematics [43]. Furthermore, study results have documented the positive effects of ICT on science learning [26, 33]. Effects of Computer Application on Elementary School Student's Achievement: A Meta-Analysis of Students in Taiwan. Computers in the Schools, 24(3-4), 43-64. https://doi.org/10.1300/J025v24n03_04
[40], [51]. Finally, some studies have documented that the use of ICT leads to positive impacts on student achievement in other subjects, such as geography, history and the arts [56], design and technology [25] and music and arts [38].

3.2. Impacts of digital technologies on equality, inclusion and social integration

Although most of the studies reviewed have focused on the impact of ICT on students' knowledge, skills and attitudes, some reports have also been written on other aspects that may be impacted in the school context, such as equality, inclusion and social integration. [56] documented research interventions examining how ICT can support students with additional or special educational needs. Although these interventions were conducted on a relatively small scale and primarily based on qualitative data, their findings indicated that ICT use improved communication, participation and self-esteem.
[54] reported that the use of digital technologies enhanced social interaction and improved academic performance of children with learning difficulties. [61] found that the role of ICT in inclusion and the design of educational and technological interventions was not sufficiently explored in educational interventions; however, some benefits of ICT have been found in the social integration of students. The issue of gender equality was mentioned in a small number of studies. [40] reported a statistically significant positive interaction between individual laptop programs and gender. Specifically, the results showed that both girls and boys benefited from the laptop program, but the effect on girls' achievement was smaller compared to the effect on boys' achievement. Results of a systematic review by [58] found no evidence that heavy computer use can reduce gender differences in anxiety, self-efficacy and self-confidence.

3.3. Impacts of digital technologies on the professional and educational practices of teachers

There is evidence from various research studies on the impact of ICT on teachers' teaching practices and student assessment. [59] found that student use of mobile devices enabled teachers to successfully deliver content (e.g., mobile serious games), lessons, and scaffolding and facilitated synchronous collaborative learning. Furthermore, ICT can increase the effectiveness of lesson planning and preparation by providing opportunities for a more collaborative approach between teachers. Sharing curricula and analyzing student data resulted in clearer goals and improved reporting to parents [25].

Additionally, the use and application of digital technologies in teaching and learning can improve teachers' digital skills. [25, 26] documented various studies which found that the use of digital technologies in education had positive effects on teachers' basic ICT skills. The greatest impact was seen among teachers with sufficient experience in integrating ICT into their teaching and/or having recently participated in advanced courses in the pedagogical use of technologies in teaching. [26] reported that the provision of fully equipped multimedia laptops and the development of online teacher communities had positive effects on teachers' confidence and competence in using ICT.

Additionally, the use of ICT for online assessment benefits teaching. In particular, online assessments support the digitalization of student work and associated logistics, enable teachers to gather immediate feedback and readjust to new goals, and support the improvement of the technical quality of tests providing more accurate results. In addition, ICT capabilities (p. productive in groups [26].

3.4 Impacts of digital technologies on other aspects and actors linked to school

There is evidence that the effective use of ICT and the data transmission offered by broadband connections have contributed to improved administration [25]. Specifically, ICT provides better management systems to schools that enable data collection procedures. [56] listed the improvements made to the school through the use of ICT in the following areas: attendance monitoring, assessment records, reporting to parents, financial management, creation of benchmarks for learning resources and information sharing among staff. This data can be used strategically for self-assessment and monitoring purposes which, in turn, can lead to improvements at the school. Furthermore, ICT has provided more efficient and effective examination management procedures, namely less time-consuming reporting processes than paper-based examinations and smooth communications between schools and examination authorities through the exchange of electronic data [26]. [40] reported that the use of ICT improved home-school relationships. Additionally, [57] reported several ICT programs that improved the flow of information from school to parents.

In particular, they documented that the use of ICT (learning management systems, emails, dedicated websites, mobile phones) provided opportunities for personalized and personalized information exchange between schools and parents, such as attendance records, upcoming assignments, school events, student grades, which generated positive results on learning outcomes and student achievement. Specifically, the exchange of information between schools and families motivated parents to encourage their children to exert effort in

school. The above findings suggest that the impact of ICT integration in schools goes beyond students' performance in academic subjects. Concretely, it affects a certain number of aspects linked to school, such as equality and social integration, professional and educational practices as well as the various stakeholders. In Table 2, we summarize the different impacts of digital technologies on school stakeholders based on the literature review.

3.4.1 Factors that influence the integration of digital technologies

Several authors have suggested that the impact of technologies in education depends on several factors and not on the technology itself. For example, [33]. Effects of Computer Application on Elementary School Student's Achievement: A Meta-Analysis of Students in Taiwan. Additionally, it is [42] suggested that the neutral findings regarding the impact of tablets on student learning outcomes should encourage educators, school leaders, and school officials to further study the potential of these devices in teaching and learning. Several other researchers have suggested that various variables play an important role in the impact of ICT on student learning, which could be attributed to context, teaching and professional development practices, curriculum, and learner characteristics [21, 34, 35, 38, 42, 53, 54, 55].

3.4.2 Digital skills

One of the most common challenges reported in studies using digital tools in the classroom was students' lack of skills on how to use them. It is found that students' lack of technical skills [37] is a barrier to the effective use of ICT in the classroom. [39] reported that students experienced difficulties when using tablets and smart mobile devices, which were associated with the technical issues or expertise required to use them, the distracting nature of the devices, and highlighted the need for professional development of teachers.

On another note, [9] reported studies that showed a strong positive association between teachers' computer skills and students' computer use. With this in mind, teachers' lack of ICT skills and familiarity with technologies could become an obstacle to effective use of technology in the classroom [9, 25]. It should be noted that the way teachers are introduced to ICT affects the impact of digital technologies on education. Previous studies have shown that teachers may avoid using digital technologies due to limited digital skills [25], or that they prefer to apply "safe" technologies, i.e. technologies that their own teachers have used and with which they are familiar [56]. In this regard, providing digital skills training and exposure to new digital tools could encourage teachers to apply various technologies in their lessons [56]. In addition to digital competence, school-based technical support has also been shown to affect teachers' use of technology in their classrooms [9]. Providing support can reduce time and cognitive constraints, which could result in limited integration of ICT into school lessons by teachers [57].

3.4.3 Personal characteristics, training approaches and professional development of teachers

Teachers' personal characteristics and professional development affect the impact of digital technologies in education. Specifically, Cheok and Wong (2015) found that teachers' personal characteristics (e.g., anxiety, self-efficacy) are associated with teachers' satisfaction and engagement with technology. [67] reported that lack of confidence, resistance to change and negative attitudes towards the use of new technologies in teaching are important determinants of the level of teachers' engagement with ICT. The author reports that providing technical support, motivational support (e.g., rewards, sufficient time for planning), and training on how technologies can benefit teaching and to learning can remove the barriers to ICT integration mentioned above. [55] found that comfort with technology is a significant predictor of technology integration and argued that it is essential to provide teachers with appropriate training and ongoing support until that they are comfortable with the use of ICT in class. [51] documented that teacher training in ICT had a significant effect with the use of ICT on student learning. According to [25, 26], the impact of ICT on student learning strongly depends on the teacher's ability to use it effectively for educational purposes. The results obtained from the Teaching and Learning International Survey (TALIS) (Organization for Economic Co-operation and Development, 2020) revealed that although schools are open to innovative practices and have the capacity to adopt them, only 39% of teachers in the European Union say they are well or very well prepared to use digital technologies for teaching.

It is shown that the positive effect of technology on student achievement depends on the instructional practices used by teachers [28, 29]. It is reported that learning was best supported when students were engaged in active, meaningful activities via technology tools that provided cognitive support [30].

Two different instructional uses of tablets [39] were compared and they found a significant moderate effect size when the devices were used in a student-centered context and approach rather than teacher-directed environments. Similarly, Garzon et al. (2019) and Garzon et al. (2020) reported that the positive results of integrating AR applications could be attributed to the existence of different variables that could influence AR interventions (e.g., teaching approach, learning environment and the duration of the intervention).

Additionally, the authors suggested that the instructional resources that teachers used to supplement their lessons and the instructional approaches they applied were critical to the effective integration of AR in education. [60] reported that effective use of computers is associated with training teachers to use computers as a teaching and learning tool. [40] noted that in addition to the strategies teachers adopted in teaching, ongoing professional development was also essential to ensure the success of technology implementation programs. [62] found that most research on the use of mobile devices to support learning indicated that insufficient teacher

preparation was a major barrier to implementing effective mobile learning programs in schools. [48] found that teacher training and support increased the positive impact of interventions on student learning gains.

It is [27] argued that positive impacts occur when digital technologies are used to enhance a teacher's existing instructional philosophies. It is [21] found that the types of technologies used and how they are used can also affect student learning. The authors suggest that teacher training and professional development focused on the effective pedagogical use of technology to support teaching and learning is an important component of successful teaching approaches [21]. It is [55] found that studies reporting ICT interventions in which teachers received training and support had moderate positive effects on student learning outcomes, which were significantly higher than studies where little or no details of training and support were mentioned. It is [37] reported that teachers' lack of knowledge and skills on the technical and pedagogical aspects of using ICT in the classroom, in-service training, teaching support, technical and financial support, as well as the lack of motivation and encouragement to integrate ICT into their teaching constituted significant obstacles to the integration of ICT into education.

- **School leadership and management**

Management and leadership are important cornerstones of the digital transformation process [63]. It is shown that documented leadership among the factors that positively impacted the successful implementation of technology integration in schools [40].

Strong leadership, strategic planning and systematic integration of digital technologies are prerequisites for the digital transformation of education systems [64]. Management and leadership play an important role in formulating policies that translate into practice and ensure that ICT developments are integrated into school life and the experiences of staff and students [56]. Policy support and leadership involves providing a comprehensive vision for the use of digital technologies in education, student and parent guidance, logistical support, and teacher training [65]. Unless there is whole-school engagement with accountability for progress at key points, it is unlikely that ICT integration will be sustained or become part of the culture [56], highlighting the importance of the principal's enthusiasm and hard work in inspiring school staff and students to cultivate a culture of innovation and achieve lasting digital change. Thus, school leaders must adopt and promote a whole-school strategy and build a strong mutual support system that enables the technological maturity of the school. In this context, school culture plays an essential role in shaping the mentalities and beliefs of all school stakeholders towards successful technological integration.

Specifically, school leaders must create conditions in which school staff are empowered to experiment and take risks with technology. For leaders to achieve the above, it is important to develop learning and leadership capabilities, advocate professional learning and create support systems and structures. Integrating digital technology into education systems could be difficult and leaders need guidance to achieve this. Guidance can be introduced by adopting new strategic planning methods and techniques for the integration of digital technologies [64]. Although the role of leaders is essential, their training is not as frequent as it should be. More specifically, only a third of education systems in Europe have implemented national strategies that explicitly refer to the training of school leaders.

- **Connectivity, infrastructure & government and other support**

The effective integration of digital technologies at all levels of education requires the development of infrastructure, the provision of digital content and the selection of suitable resources [66]. In particular, a high-quality broadband connection at school increases the quality and quantity of educational activities. There is evidence that ICT increases and formalizes cooperative planning among teachers and cooperation with managers, which in turn has a positive impact on teaching practices [25]. Additionally, ICT resources, including software and hardware, increase the opportunity for teachers to integrate technology into the curriculum to improve their teaching practices [9]. It is [40] found that the use of individual laptop programs led to positive changes in teaching and learning, which would not be accomplished if no infrastructure and technical support were provided to teachers. [9] reported that limited access to technology (insufficient computers, peripherals and software) and lack of technical support are significant barriers to ICT integration. Access to infrastructure refers not only to the availability of technology in a school, but includes providing the appropriate amount and types of technology in places where teachers and students can use them. Effective technical support is a central part of the school's overall ICT strategy [54]. It is [67] reported that the lack of technical support in the classroom and school-wide resources (e.g. by teachers. Additionally, poor and inadequate hardware maintenance and unsuitable educational software can discourage teachers from using ICT in education [25, 67].

Government support can also have an impact on the integration of ICT in education. More specifically, It is [25, 26] reported that government interventions and training programs increased teachers' enthusiasm and positive attitudes towards ICT and led to the systematic use of integrated ICT. Finally, another important factor affecting digital transformation is the development and quality assurance of digital learning resources. These resources may be supporting textbooks and related materials or resources that focus on specific topics or parts of the curriculum. Policies relating to the provision of digital educational resources are essential for schools and can be achieved through various actions.

- **Administration and management of digital data**

The digital transformation of schools requires organizational improvements in internal workflows, communication between different stakeholders and collaboration possibilities. it is [68] presented evidence

that digital technologies supported the automation of administrative practices in schools and reduced administrative overload. There is evidence that digital data affects the production of knowledge about schools and has the power to transform the way schooling takes place. Specifically, It is reported that data infrastructure in education is growing due to the demand for "information on student achievement, teacher quality, academic performance, and adult skills, associated with policy efforts to increase human capital and productivity practices". In this regard, practices such as datafication which refers to the translation of information about all kinds of things and processes into quantified formats have become essential for decision-making based on quality accountability data reporting of schools. The use of data could be transformed into in-depth knowledge about education or training through the use of ICT. For example, measuring students' online engagement with learning materials and drawing meaningful conclusions can allow teachers to improve their instructional interventions [68].

- **Socio-economic origin of students and family support**

Research shows that parents' active engagement in the school and their support of the school's work can make a difference to their children's attitudes towards learning and, therefore, their success [60]. In recent years, digital technologies have been used for more effective communication between school and family [57]. The European Commission (2020) presented data from a recent Eurostat survey regarding students' computer use during the pandemic. The data showed that younger students needed additional support and guidance from parents and that challenges were greater for families whose parents had lower levels of education and digital skills. zero or weak. In this regard, the socio-economic background of learners and their socio-cultural environment also affect academic performance [26].

It is [27] documented that computer use at home positively influenced student confidence and resulted in more frequent use in schools compared to students who did not have access at home. In this sense, socio-economic background affects access to computers at home [31] which in turn influences the experience of ICT, which is an important factor for academic success [26]. Furthermore, parents from different socio-economic backgrounds may have different abilities and availability to support their children in their learning process [41].

- **Socio-economic school context and emergencies**

The socio-economic context of the school is closely linked to the digital transformation of the school. For example, schools located in disadvantaged, rural or disadvantaged areas are likely to lack the appropriate digital capacity and infrastructure needed to adapt to the use of digital technologies during emergency periods, such as than the COVID-19 pandemic [41]. Data collected from school principals confirms that in several countries there is a rural/urban divide in connectivity [31]. Emergency periods have also affected the digitalization of schools. The Covid-19 pandemic has led to the closure of schools and forced them to look for various appropriate and connective ways to continue working on the curriculum [41]. The sudden large-scale shift to distance and online teaching and learning has also raised various challenges regarding the quality and equity of education, such as the risk of increasing learning inequalities, digital and social, and the difficulties encountered by teachers in dealing with them. demanding situation (European Commission, 2020). Looking at the results of the above studies, we can conclude that the impact of digital technologies in education refers to various stakeholders and touches many aspects of the school ecosystem. Figure 1 summarizes the factors that affect the impact of digital technologies on school stakeholders based on the results of the literature review.

- **Discussion**

The results revealed that the use of digital technologies in education affects different actors within a school ecosystem. First, we observed that as technologies evolve, the interest of the research community in applying them in schools also increases. Starting as early as 2005 where the use of interactive whiteboards was most commonly applied to school interventions (references), evolving towards the use of mobile devices and digital games (references) to more recent technological advances, such as applications AR and VR (references), technology has always been applied to improve school life.

This indicates that the value of technologies to support teaching and learning as well as other school-related practices is recognized by the research and school community. The impact results of the literature review indicated that ICT integration has weak effects [19, 40, 21, 30, 39] and is moderate [33, 35, 43, 44, 45, 46] on student learning outcomes.

Based on these findings, several authors have suggested that the impact of technologies in education depends on various variables and not on the technology itself, such as context, teaching and professional development practices, curriculum of study and learner characteristics [21, 34, 35, 38, 42, 53, 54, 55].

While the impact of ICT on student achievement has been studied in depth by researchers, other aspects related to school life that are also affected by ICT, such as equality, inclusion and social integration, have received less attention. Further analysis of the literature review revealed greater investment in ICT interventions to support learning and teaching in the core subjects of literacy, mathematics and science. These were the most commonly studied topics in the articles reviewed, often relying on national test scores, while studies of other areas, such as social studies, were limited [38, 56]. That said, research still lacks impact studies that focus on the effects of ICT on a range of curriculum subjects.

Qualitative research provided additional insights into the impact of digital technologies in education, documenting positive effects and providing more detail on implications, recommendations and future research directions. More specifically, the results regarding the role

of ICT in supporting learning highlight the importance of teachers' pedagogical practice and the learning context in the use of technologies and, therefore, their impact on teaching [30, 39].

The review also provided useful insights into the various factors that influence the impact of digital technologies in education. These factors are interconnected and play a vital role in the transformation process. Specifically, these factors include: a) digital skills, b) personal characteristics and professional development of teachers, c) school leadership and management, d) connectivity, infrastructure and government support, e) administration and data management practices, f) students' socio-economic context and family support, and g) socio-economic school context and emergency situations. It should be noted that we observed factors that influence the integration of ICT in education, but which can also be affected by it. For example, students' frequent use of ICT and use of laptops for educational purposes positively affect the development of digital skills [40] and at the same time, digital skills affect the use of ICT [21, 37].

4 CONCLUSION AND PERSPECTIVES

Digital technologies offer several opportunities for fundamental improvements in schools. However, investments in ICT infrastructure and professional development to improve school education have not yet yielded fruitful results. Digital transformation is a complex process that requires large-scale transformative changes that presuppose digital capability and readiness. To achieve such changes, all stakeholders in the school ecosystem must share a common vision regarding the integration of ICT in education and work towards achieving this goal. In this work, we have provided useful information on the impacts of ICT on different stakeholders in schools. Additionally, we have opened a forum for discussion on the factors that affect the digital capacity and transformation of schools. We hope that our study will inform policy, practice and research and lead to a paradigm shift towards more holistic approaches in impact study and evaluation.

- **Study limitations and future directions**

The study results were based on a non-systematic literature review based on the acquisition of documentation in specific databases. Future studies should investigate several other databases to corroborate and improve our results.

Additionally, search queries could be enhanced with key terms that could provide additional information on ICT integration in education, such as policies and strategies for ICT integration in education.

Furthermore, the study relied on meta-analyses and literature reviews to acquire evidence on the effects of ICT integration in schools. The nature of the above studies is different as they are based on different research methodologies and data collection processes. Even in similar methodological studies (e.g., meta-analyses), impact has been measured differently, depending on policies or research objectives (e.g., national exam results, pre/post testing). Furthermore, qualitative studies provided additional insights based on self-reports and research opinions on several different aspects and stakeholders that could affect and be affected by ICT integration. As a result, it was difficult to establish causal relationships between so many interrelated variables. Despite the challenges mentioned above, this study planned to examine academic units as ecosystems consisting of multiple actors by bringing together several variables from different research epistemologies to provide an understanding of ICT integration. We propose that future studies aim for similar investigations by applying more holistic approaches to impact evaluation.

- **How to Prepare to Digital Transformation**

- Converging Trends Drive Digital Transformation.
- Create Your Seven-Step Digital Transformation Plan.
- Define Objectives.
- Create Core Team.
- Analyze and Engage Stakeholders.
- Develop Digital Roadmap.
- Create Implementation Plan.
- Execute and Monitor.

Digital transformation is no longer a buzzword. It's a critical business necessity. By creating a digital organization, you can remain relevant and competitive. It's tough to remain effective in business without going digital. According to the research website Exploding Topics, 77 percent of companies have already started their digital transformation journey. The good news is that most organizations have embraced this critical imperative. The bad news: Only 35 percent of organizations are successful in their digital transformation efforts.

Converging Trends Drive Digital Transformation

The convergence of trends and technologies that includes the cloud, artificial intelligence, the Internet of Things, business process automation, and other advancements have led to dramatic change. Not just in the technologies powering business, but in the cultures that underlie how successful organizations operate on a day-to-day basis. True transformation is a journey. It requires a clear understanding of the market dynamics impacting your world, of your business objectives, and of the unique value you want to digitally deliver. It involves innovating business processes as well as business models. It's about creating new levels of efficiencies, customer experiences, and go-to-market strategies.

Take Microsoft's shift under CEO Satya Nadella, for example. The tech giant has successfully transitioned from a software-centric business into a cloud-based, service-based business model and organization. Microsoft set clear digital goals, assembled a dedicated cross-functional team, engaged stakeholders, and developed a robust digital strategy focused on Azure and Office 365. The implementation was carefully executed in phases, with continuous monitoring and adaptation to market responses and technological trends. Microsoft's shift wasn't just technological but also cultural, requiring a deep-seated change in mindset across the organization.

Another example of digital transformation in the manufacturing sector is General Electric. GE revolutionized its manufacturing by building its own digital platform, Predix, to predict when machines need repair before they break down. This smart system focused on preventive maintenance, and, combined with a virtual model that simulates a manufacturing line called a Digital Twin, helps GE make and improve products by running simulations. By focusing on digital software as a core capability, GE has made its factories smarter, preventing problems and saving time and money, changing the way the company creates and maintains its products.

- **Create Your Seven-Step Digital Transformation Plan**

Digital innovators who want to tackle transformation don't have to boil the ocean. The best transformations, whether digital or not, focus on quick wins and early adopters to build momentum. While a bigger-picture strategy can be helpful, just getting started is what's most important. Here's a seven-step approach for not just getting going with your digital transformation, but ensuring it's successful. It's based on my 30 years of strategy, change management, and culture transformation experience across dozens of Fortune 1000 companies, as well as mid-size organizations. Each step includes a core strategy supported by the three most critical key actions to take to drive the strategy successfully:

a) **Define Objectives**

Establish clear, measurable goals for your digital transformation that align with your organization's overall strategy.

Key actions:
- Conduct workshops with senior leadership to identify strategic objectives
- Translate these objectives into specific digital goals (e.g., enhancing customer experience, improving operational efficiency)
- Develop KPIs to measure the success of the digital transformation

b) **Create Core Team**

Assemble a cross-functional team with members from different departments to drive the transformation.

Key actions:
- Identify individuals with diverse skills (IT, operations, HR, etc.) and a digital mindset
- Assign clear roles and responsibilities to each team member
- Establish regular team meetings for progress updates and issue resolution

c) Analyze and Engage Stakeholders

Identify and understand the stakeholders impacted by the digital transformation and strategize their engagement.

Key actions:
- Map stakeholders based on their influence and interest in the project
- Develop tailored communication plans for each stakeholder group
- Schedule regular updates and feedback sessions with key stakeholders

d) **Develop Digital Roadmap**

Formulate a phased strategy that outlines the approach, technologies to be adopted, and implementation roadmap.

Key actions:
- Evaluate current digital capabilities and identify gaps
- Define optimal digital processes and applications
- Create a phased roadmap with clear milestones and deliverables

e) **Create Implementation Plan**

Develop detailed plans for the execution of the digital processes and applications.

Key actions:
- Define project scopes, timelines, and resource requirements for each initiative
- Develop risk management plans to address potential challenges
- Establish a governance model to oversee the implementation process

f) **Execute and Monitor**

Implement the transformation initiatives and continuously monitor progress against milestones and metrics.

Key actions:
- Execute initiatives according to the implementation plan
- Monitor progress using the defined KPIs and adjust strategies as needed
- Conduct regular team meetings to review progress and resolve issues

g) **Track and Optimize**

Assess progress, identify areas for ongoing improvement, and iterate implementation approaches to ensure agility.

Key actions:
- Gather feedback from stakeholders and analyze performance data
- Identify successes and areas needing improvement
- Develop a plan for continuous optimization and adaptation

In today's world, if you are not digitally innovating, you are likely declining as an organization. Use these strategies to stay ahead.

Keys to Digital Transformation
- Align on the Why of Digital Transformation.
- Prepare for Culture Change.
- Start Small But Strategic.
- Map Out Technology Implementation.
- Seek Out Partners and Expertise.
- Gather Feedback and Refine as Needed.
- Scale and Transform.

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5 DECLARATIONS

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*Availability of data and material: The data supporting this study's findings are available from the corresponding author. However, restrictions apply to the availability of these data, which were used in the LMA laboratory from the University of Bejaia, in Algeria for the current study, and so are not publicly available. Data are however available from the corresponding author upon reasonable request and with permission of Managers of the LMA laboratory.

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Economic environment surveillance to predict Issues and disruptions through multimodal deep learning, smart education, and secure information

Bouzidi Zair[1], Boudries Abdelmalek[1]
[1] *LMA Laboratory, Bejaia University, Exact Sciences Faculty, Bejaia, Algeria*
(zair.bouzidi@univ-bejaia.dz, abdelmalek.boudries@univ-bejaia.dz

ABSTRACT

This study explores economic environment monitoring to predict problems and disturbances through multimodal deep learning, smart education, and secure information. Education plays a leading role in raising awareness, mitigating issues and disruptions, and overall human security to improve economic activities. It is based on a CNN-LSTM multimodal deep learning model. The study discusses the integration of artificial intelligence (AI), IoT technologies, big data, smart data, supercomputers, and social networks into economic monitoring, and the use of smart education and safe news to prevent problems and disturbances. This multimodal model improves economic activity by alerting people, particularly managers, about an ongoing event through interactive smart education. LSTMs dependency learning, using commercial, marketing, or financial data, and encapsulation, using connected objects, smart data, and social networking. Our new model is shown to learn multiple aspects of marketing, business, and finance. The model is evaluated on the challenging business and financial fraud detection tasks. It is more accurate than other existing neural networks, and it takes less time to train.

KEYWORDS: Big Data, CNN-LSTM-based multimodal deep learning model, Connected objects (sensors), Economic activities, Smart education, Secure information; Social networks

1 INTRODUCTION

In our daily lives, business, marketing and financial information from multiple sources (connected objects, smart data and multiple social media sources) is circulating. Capturing content[2] from connected objects, smart data or multiple social media sources is important for a complete view. Managers are challenged by the sheer volume of information available on the Internet. Several artificial intelligence tools [1] and [2] have been developed for helping administrators identify and filter useful shared content. There is also research that warns[1], educates[2] and raises awareness[3, 4]. The design of multimodal deep learning to enhance economic activities using big data, high-performance computing and secure information education. A new model based on CNN-LSTM for learning long term dependencies is proposed. A new model based on CNN-LSTM for learning long-term dependencies is proposed. This new concept integrates artificial intelligence, deep learning and social media to manage economic activity [6, 7].

Building on previous works [2, 3, 5, 6, 7] that provide the context for this approach, this model combines representation training with alerting. This study monitors the network environment to identify content relevant to an impending crisis. This could be a public health crisis. This data can then be used for updating (alerts or intelligence) for citizens and managers who need to make quick and effective decisions to modify trends in order to prevent a major, uncontrollable local crisis (shortage of flour, milk, especially for children, drinking water...) that might trigger riots, looting, sabotage...).

2 BACKGROUND & RELATED WORKS

There is a lot of research on forecasting financial time series [8, 9]. Research on fraud detection is common [8]. In contrast, only two studies exist on pricing [10] and one on supermarket product placement. Twitter (now X) is the first social network for tweeting news [11, 12, 13]. Next, an NN-based crisis management model for improving alerts [1] using Twitter (now X) and Facebook. FFNN-based ALE to improve web-based alerting and education follows. The first to use multiple sources across the web.

While socializing is still the dominant function of networks, they rank as the fourth favorite source of information. Networking before, during and after an event can help facilitate sharing. Thanks to Web 2.0, the spread of social media transforms knowledge from expert to everyday knowledge co-produced by stakeholders. More and more research is being done on using data from social networks to gain insights into human activities ranging from epidemiology to stock market forecasting. But making sense of this vast and rapidly changing data is a difficult task. In terms of online methodology, the listening and monitoring approach of this study consists of collecting all content from social media conversations, news or any information on the web; cleaning the data from duplicate and replicated content, enabling relevance thanks to neural learning, with the learning corpus obtained thanks to tagged messages. The relevant content is analysed and verified by the model. This ensures appropriateness and alerts managers.

Shelf space is one of retail's most important resources, given today's wide variety of products and shopping patterns. Retailers can increase profits and

reduce costs by managing shelf space and display. By using learning models to organise supermarket shelves by grouping products that are usually bought together, the research study can extract the following relationship: customers who buy product X at the end of the week in summer usually also buy product Y (see Table 2). To improve the accuracy and efficiency of fraud detection mechanisms and to study electricity consumers' fraud behaviour, [14] combines LSTM and EHWS techniques. It addresses the huge problem of non-technical losses (NTL), also called electricity fraud, for utilities. According to the anti-fraud service of the Algerian tax authority's general directorate, a total of 385,714 counterfeit goods will be seized by the tax authorities in 2020.

Table 1: Comparison of techniques and methods in models using different sources

Ref	Method	Sources of Capturing Content
[12]	Game-based learning for flooding Twitter	Twitter
[13]	An educational objective of higher education, specifically related to Twitter	Twitter
[19]	Socio-temporal context summary Twitter	Twitter
[20]	Twitter crisis response semi-automated AI-based classifier	Twitter
[11]	Abstract-extractive approach to summarise contextual crisis tweets Twitter	Twitter
[1]	NN-based warning model	Facebook & Twitter
[2]	FFNN-based ALE to enhance warning and education	All the Web
[8]	LSTM-based ALE to enhance warning and education	All the Web
[3, 4, 5, 6, 7, 16]	CNN-LSTM-based crisis management model to improve web-based alerting, awareness and training	All the Web
[21]	RNN-based model	Smart Data & All the Web
[17, 18]	Sensor-based model Sensor	Sensor
[14]	Detection of economic electricity meter anomalies and customer fraud cases	Sensor
Our New Approach	Traffic environment monitoring for warning, awareness, and sustainability with safety education	Connected objects (Sensors), smart data & All the Web

Another example is the credit institute that uses data mining to decide to grant a loan based on the applicant's profile, application and previous credit history. There is also overbooking (optimising seats in planes, hotels, etc.), targeted offers (organising advertising campaigns and promotions), analysing business practices, strategies and their impact on sales. This knowledge is initially unknown. It may be correlations, patterns or general trends in the data. Experimental data is needed to correct or estimate difficult mathematical modeling parameters. Data Mining is a field that has emerged with the explosion of stored information, particularly with advances in processing speed and storage media.

Table 2: Economic activity examples

Models	Economic Activities
[22]	Novelty fraud detection
[23]	Trading performance
[10]	Forecasting the exchange rate
[9]	Trading on the stock exchange
[21]	Improving warning and education with RNN-based Model
[8]	Improving warning and education with LSTM-based ALE
[5, 6]	Improving warning and education with CNN-LSTM-based Model
[24]	Financial time series forecasting
[25]	Company shares
[14]	Detection of economic electricity meter anomalies and customer fraud cases
[15]	385,714 counterfeit products were confiscated by the Algerian tax authorities in 2020, according to the anti-fraud service of the Algerian tax administration

Data mining aims to find valuable information in large amounts of data to understand or predict future data behaviour. Data mining has used various statistical and artificial intelligence tools. They are an essential part of Big Data. Data analytics refers to a process that uses pattern recognition, statistical methods and mathematics to discover new knowledge from massive amounts of data. Fraud detection is of interest in terms of unsupervised and/or supervised classification (see Table 3). In unsupervised learning, the class labeling is either not known or assumed not to be known, and clustering is used to find (i) a clear cluster that includes fake specimens, or (ii) remote fake specimens that do not belong to any cluster that includes genuine specimens, treated as outlier detection problem. Supervised learning uses known class labels to construct binary classifiers. Fraud (including cyberfraud) detection is increasingly threatening and fraudsters seem to be several steps ahead of organisations, finding new loopholes and bypassing them easily. On the other hand, organizations invest huge amounts of money, time and resources to predict and mitigate fraud close to, if not in real time. Financial fraud occurs in areas such as banking, insurance and investment. It can be both offline and online. Offline fraud includes falsifying accounts, counterfeiting, etc.

Technological advances and breakthroughs in deep learning models have promoted intelligent automated trading and decision support in financial markets, particularly equities and forex. Fundamental analysis uses or mines textual information like financial news, company reports and other economic factors like government policies to predict price movements.

Table 3: Domains of application for smart data

Applications Domains	Limitations
Financial services	Fraud Detection and Prevention
Retail	- Analyzing customer sentiment - Offering personalized and contextual promotions
Telecommunications industry	Possibility of: - Better allocating bandwidth based on real-time needs, and - diagnosing antenna condition
Understand the market conditions	Costs
Increased productivity	Security and Privacy Concerns
Fraud detection	/
Production	Preventive Maintenance
Healthcare	- Monitoring patient vital signs, - Reducing readmission rates
Oil industry	- Proactive repairing infrastructures, and - Balancing the power delivered according to consumption
- Balancing the power delivered according to consumption	- Balancing the power delivered according to consumption
Public sector	- Detecting and preventing intrusion attempts on the network, and - Predicting epidemic risk
Transport sector	Possibility of detecting risky conduits

Big data is primarily data that is too large, complex, disparate, or rapidly changing for current computing methods to analyse and use correctly and quickly. Smart data is about extracting useful, high-quality information from large, disparate data sets, while addressing quality, security, privacy and data use. In this way, knowledge is generated from the data. This data can then be used to generate value-added knowledge that underpins this new data economy. That's why it's important to turn big data into smart data. Big Data" is the term used to describe the ability to quickly collect, store, distribute, manage and analyse large amounts of structured information. Data from different sources can arrive at the system at different speeds. Parallelism allows these large amounts of data to be processed, and Hadoop allows big data to be structured and analysed. Hadoop, open source software for distributed processing of large datasets, is designed to scale from a single server to multiple machines. Smart data always combines analysis with human intelligence to provide comprehensive, synthesised, useful business information (see Table 5).

This model aims to support the introduction of crisis warning training for citizens, trainees and future leaders. The training tool is used in three modes [2]. Novice mode allows the trainee to use extensive automated learning tools, such as observing and experimenting. By experiencing, observing and failing, the learner can learn progressively. Beginners can always ask an intelligent learning tool to generate a next step.

This tool analyses the knowledge of this step, provides the optimal option and a list of relevant steps. The student can choose any operation if he is not satisfied with the optimal operation suggested by the system. The online manual allows the student to access all previous courses by revisiting all previously studied concepts, restarting all previously studied cases and continuing all cases. This mode provides reference access to all learning, supported by example-based online help. During public economic crises, educational messaging helps to increase situational awareness.

Many academic institutions collaborate with hospitals, professional bodies, and governmental and non-governmental agencies in designing and adapting educational curricula. The aim is to develop essential knowledge and skills to effectively standardise best practice in managing new crises.

$$\hat{Y}_{t+1}, \hat{Y}_{t+2}, \dots, \hat{Y}_{t+K} = \boldsymbol{arg} \max_{X_{t+1},\dots,X_{t+K}} \left(P(X_{t+1},\dots,X_{t+K} \mid Y_{t-J+1}, \dots, Y_{t-J+K}\right) (1)$$

3 NEW MULTIMODAL DEEP LEARNING MODEL FOR ECONOMIC ENVIRONMENT MONITORING

The new multimodal CNN-LSTM model is presented. The LSTM layer handles temporal correlations (see Figure 2). It is extended by convolutional structures in both input and output states. A network model for these space-time prediction tasks was created using a stack of CNN-LSTM layers and an encoding prediction structure (see Figure 3). The goal of crisis prediction is to use previously observed social networks to prevent an event in a local area like Algiers, London or Paris.

From an automatic learning perspective, this is a spatio-temporal prediction problem. Consider a dynamic system represented by an MxN lattice. Each cell of the grid contains P time-varying measures (word, bias). Each observation can be represented by a tensor X of RPxMxN, where R denotes the domain of observed features. If periodic observations are recorded, the study has a sequence of tensors X1, X2, ..., Xt. This is formulated by Eq. (1) as the most probable series of length K from all previous series of length J, including the current series:

A 2D map is observed at each timestamp. If we divide this map into non-tiled, non-overlapping areas and represent the pixels within each area as its measures (using the multi-modal deep learning model CNN-LSTM), the problem is naturally to predict the space-time sequence. Spatiotemporal sequence prediction differs from one-step time-series prediction because it involves both spatial and temporal structures.

Content e, denoting input to the network, is defined by equation (2):

$$e = (w_1, \dots, w_i, \dots, w_n) \quad (2)$$

containing words wi ∈ W, each from a finite vocabulary V. Cn is the set of social media content.

After defining an error function, the (learning) problem is an optimization problem: find the error minimizing

coefficient w*. In logistic regression, the error function is convex. A classifier is available once the optimal w* coefficient vector has been determined. This requires an independent test set to estimate the error probability of the classifier. CNNs are normalised variants of multilayer perceptrons (each neuron is connected to the next layer). Full connectivity makes them susceptible to overfitting, as in (3).

$$\forall n \in [1, 2n_c^{[l]} Conv\left(a^{[l-1]}, K_{x,y}^{(n)}\right) = \varphi^{[l]}\left(\sum_{i=1}^{n_H^{[l-1]}} \sum_{j=1}^{n_W^{[l-1]}} \sum_{k=1}^{n_C^{[l-1]}} K_{i,j,k}^{(a)} * a_{x+i1,y+j-1,k}^{[l-1]} * b_n^{[l]}\right) \quad (3)$$

$$Dim\ Conv\left(a^{[l-1]}, K^{(n)}\right) = \left(n_H^{[l]}, n_W^{[l]}\right)$$

It wants to learn a generic space as formulated by this formula:

$$E_K = \max_{k \in [1,K]} (e_k) \quad (4)$$

normalize the differences in equation (4):

$$E_K = \max_{k \in [1,K]} (e_k)$$

Where $\boldsymbol{E_K} = \mathbf{E} - [\boldsymbol{R} + \boldsymbol{D} + \boldsymbol{F}]$

• R, D & F denote respectively the set of duplicate re-tweets, duplicate contents and false alerts.
• Figure 1 shows how the multimodal hybrid model based on Deep CNN-LSTM works.

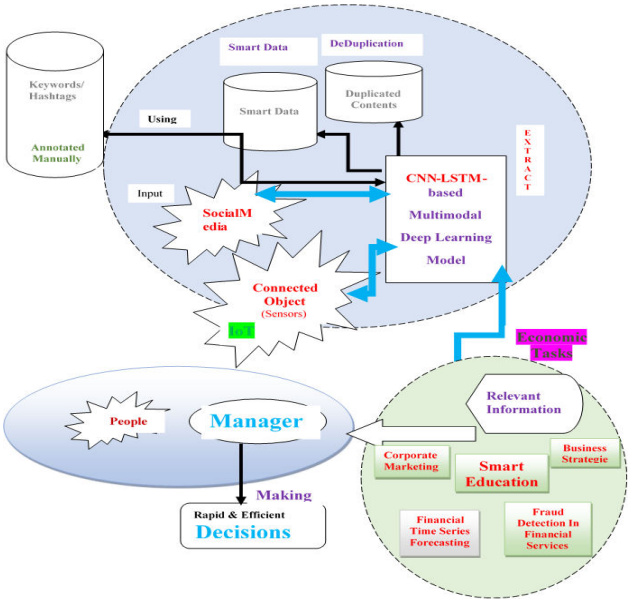

Figure 1: Functioning of the multimodal hybrid model based on Deep CNNLSTM.

• The CNN-LSTM-based multimodal deep learning model can explain the transformation of e_i into e_k by

$$\exists\, j \in [1, M] \,|\, h_j \in \boldsymbol{H} \,\&\, \exists\, l \in [1, L] \,|\, w_l \in \boldsymbol{W},$$

$$\max_{k \in [1,K]} \left(e_i \to e_k = e_i \,|\, e_i\ is\ relevant\ for\ h_j\ \&\ w_l\right)$$

$$with\ i \in [1, N]\ \&\ e_i \notin [\mathbf{R}, \mathbf{D}, \mathbf{F}]$$

Where **R**, **D** & **F** denote the duplicate retweets, duplicate content, and false alert set respectively.

The objective is then to maximise the size of the set K of E_K. Figure 3 shows the architecture of the Deep CNN-LSTM based economic monitoring model. This involves using deep learning, statistics and mathematics to analyse large volumes of data. In the online tutorial mode, at any time during the training, the trainee has a menu to access all previous courses, such as:

• Present any previously learned concept,
• Demonstrate all examples and analyse problems explained or solved. This mode gives access to the course material as a reference [2, 3, 8]: thereby
• Supporting online help based on examples. Training in commercial, financial, or fraud prediction [3] consists of:
• Advice to always pay attention to the quality of the products to be consumed, with the reinforcement of preventive hygiene, namely:
  – Check the quality, price, manufacture, and expiry date of each product
  – Strengthening preventive hygiene,
  – check that each product has indications visible on its packaging, how to store it, manufacturing date, expiry date, batch number
• Respect the conditions for using the product,
• Do not use anything without reading the instructions,

Table 4: Comparing techniques and methods in models with education.

Models	Educational Methods
[11]	An abstractive-extractive approach to situational tweet summarization in crisis events
[3, 4, 5, 6, 7, 16]	Managing crises through education, based on CNN-LSTM
[11]	The importance of education during crises
[12]	Opportunities and challenges of education programs
[2]	FFNN-based model with smart education
[21]	RNN-based ALE to enhance awareness
[8]	LSTM-based model with smart education
New Approach	Traffic environment monitoring for warning, awareness, and sustainability with safety education

Table 5: Comparison of methods and techniques in fake news prevention models.

Models	Methods
[6]	Model economic environment monitoring to enhance economic activities in sustainability using deep learning with economic education from various sources
[7]	Smart education to manage emergency crises with secure information
[5]	Modeling CNN-LSTM-based model for economic monitoring and crisis forecasting in sustainability
[3]	Enhancing trade, business, financial time series prediction, fraud detection, and marketing with DL, big data, and HPC with safe information
[4]	Smart education with DL and social networks to manage sustainability with safe news
[16]	Fake news detection based on context
New Approach	CNN-LSTM-based Multimodal DL with Big Data for economic environment monitoring to improve Marketing, Business Strategies, Fraud

	Detection, Financial Time Series Forecasting

- End anarchic and uncontrolled buying,
- Promoting health and hygiene and
- Avoid inappropriate use (social, cultural).

This multimodal deep-learning model supports an introductory course preparing economic personnel, including managers, to meet public consumption needs. It consists of standardizing good service practices by developing essential skills, knowledge and expertise in the field of expertise of companies and business workers in general in the event of a crisis, namely:

- Skills appropriate to the sales service position or function on demand,
- Unique skills with a focus on their level, not the role,
- Specific roles and skills,
- Graded skills required according to managing the local economic process,
- Skills based on different target groups, and
- Applying transversal skills to business staff.

4 RESULTS AND DISCUSSION

Here, the effectiveness of the proposed deep CNN-LSTM model was tested against the benchmark: The RNN and LSTM prediction methods are the widely used deep learning models. In the experiment, these deep learning / machine learning models have to be trained (find the best over-parameters), including finding the neuron number, the layer number, and the activation function for the deep CNN - LSTM multi-modal deep learning model. It was also possible to determine the final configuration values. The research aims to study global changes affecting population vulnerability to climate change and extreme events, and develop strategies to help communities cope with climate change impacts.

Table 6: Comparison of sustainable methods and techniques.

Models	Methods
[6]	Using deep learning with economic education from various sources to model the monitoring of the economic environment to strengthen economic activities in sustainability
[7]	Emergency crisis management with secure information through education
[5]	Modeling CNN-LSTM-based model for economic monitoring and crisis forecasting with safe news in sustainability
New Approach	CNN-LSTM-based Multimodal DL with Big Data for economic environment monitoring to improve Marketing, Business Strategies, Fraud Detection, Financial Time Series Forecasting approach

Electricity fraud detection approach [14] using a combination of Long Short-Term Memory (LSTM) methods and robust Exponential and Holt-Winters Smoothing (EHWS) methods, using sensors to improve the accuracy and efficiency of fraud detection mechanisms, while studying the fraudulent behavior of electricity consumers. It addresses the huge problem of non-technical losses (NTL), also known as electricity fraud, for electricity distribution utilities.

Table 7: Examples of percent of the relevant content of electricity fraud detection in Algeria

Models	Electricity Fraud Detection in Algeria (%)
Naive Bayes (NB) [26]	31.90
Random Forest (RF) [27]	30.16
Support Vector Machine (SVM) [17]	34.91
Neural Network (NN) via Twitter & Facebook [1]	40.17
Feed-forward Neural Networks (FFNN) via All the Web [2]	45.15
Recurrent Neural Network (RNN) via Smart Data & All the Web [3]	35.93
LSTM via Smart Data & All the Web [3]	41.78
New Approach via Sensor, Smart Data & All the Web	87.40

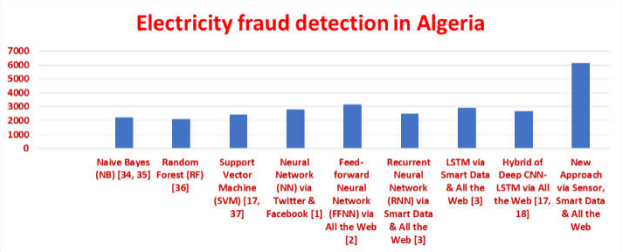

Figure 2: Examples of percent of Relevant Content of electricity fraud detection in Algeria from March 2020 to date.

According to the Algerian tax authority's anti-fraud department, a total of 385,714 counterfeit goods will be seized in 2020. The aim is to maximise the size K of the EK set. Reliable connectivity and data security enable seamless, efficient remote control and monitoring services. Remote services turn the device into a state-of-the-art IoT solution. It allows remote access to fire detection tools to manipulate, maintain and live monitor fire detectors and alarms, and report faults to intelligent devices. Table 12 is an example of a COVID-19 assessment. Examples of relevant content for a set of hashtags and keywords from multiple sources for the Algerian forest fire on 16-19 August 2021. Each news item is represented by a sequence of transactions T= (t1, ..., tn). COVID-19 for Algeria, from March 2020 until today, for a set of hashtags and keywords for all social networks.

5 CONCLUSION AND PERSPECTIVES

In conclusion, using a CNN-LSTM-based multimodal deep learning model for economic monitoring and crisis forecasting can fundamentally change how people, especially managers, improve economic activities. The study investigated integrating IoT, big data, HPC, and multiple social media technologies for economic

monitoring and crisis forecasting. The results provide insight into the perceived impact on warning, effectiveness, user satisfaction, and favorable attitudes. It shows that multimodal deep learning based on CNN-LSTM can improve economic activities and crisis prediction. Citizens and administrators may conduct economic transactions in full confidence, in a regulated and secure environment where information will be protected. The results of the research agree with the idea that this new multimodal deep learning approach for economic monitoring and crisis forecasting systems can bridge the gap between theoretical understanding and practical implementation.

Although the research highlights the possible benefits of this new approach, the validation of this new system will require feedback on the use of this new approach for economic surveillance and crisis prediction using descriptive statistics through sampling. This will be the role of future work. The study presented an ad hoc real-time multimodal deep learning model. It is based on a CNN-LSTM for educational warning to prevent events. These include data from networked objects, smart data, and multiple social media. Such an approach is particularly useful for improving economic activity. The community can be alerted to potential events, informed of status, and request help. With data, the content is written informally, with no syntax, logic, or noise. There are also indicators of pollution, temperature, humidity, etc. Therefore, it may be biased towards certain domains. Multimodal deep learning model features are developed by analyzing specific event content.

In future works, this research study has several potential applications. Validating relevant information (avoiding misuse), using different languages (including Arabic and French), and extracting the most useful to allow the community to live easily and comfortably, saving the lives of those stuck under the rubble, avoiding any complications, difficulties, material, social or even professional. The real-time paradigm could be extended by using big data to search for information about past events, validating a possible warning to keep people safe. In addition, quantitative research involves surveying a sample of clients and managers to gauge their views on how to improve economic monitoring and crisis forecasting through education.

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6 DECLARATIONS

*Funding does not require any funding: this work is within the framework of research * Conflicts of interest: All metrics are the property of the LMA laboratories of the University of Bejaia, Algeria *Availability of data and material: The data supporting this study's findings are available from the corresponding author. However, restrictions apply to the availability of these data, which were used in the LMA laboratory from the University of Bejaia, in Algeria for the current study, and so are not publicly available. Data are however available from the corresponding author upon reasonable request and with permission of Managers of the LMA laboratory.

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Integrating AI-driven sentiment analysis and data augmentation in mobile apps to support mental health of chronic disease patients

Embarki Omar[1], Laifa Meriem[2]
[1]Department of Computer Science, University of Mohamed El Bachir El Ibrahimi, Bordj Bou Arreridj, Algeria (embarki24@gmail.com)
[1,2] Laboratory of Informatics and Its Applications of M'sila (LIAM), M'sila, Algeria (meriem.laifa@univ-bba.dz)
https://orcid.org/0000-0002-2010-9527

ABSTRACT

Artificial Intelligence (AI) offers new opportunities to manage and monitor mental health, particularly through sentiment analysis (SA) of digital communications. However, there is a lack of research on Pre-trained Language Model (PLM) for Algerian dialects, coupled with a scarcity of datasets for training the models. This paper addresses the gap by focusing on Algerian Arabic and its dialects in the healthcare context. Precisely, we conducted experiments to compare the performance of DziriBERT using various text augmentation techniques to tackle data imbalance. Moreover, we proposed a more suitable Data Augmentation (DA) strategy to improve the model performance. Notably, our proposed augmentation technique outperformed traditional techniques, achieving the best performance results. This study demonstrates that PLMs tailored for Algerian Arabic, combined with data augmen- tation, can significantly improve sentiment classification of user-generated content. Additionally, we developed a real-time sentiment analysis system deploying the best fine-tuned model, offering low-cost and timely support for chronic disease patients within Algerian healthcare systems.

KEYWORDS: Artificial Intelligence, Mental Health, Sentiment Analysis, Pre-trained Language Model, Algerian dialects, Algerian Arabic, DziriBERT, Data Augmentation, Sentiment Classification, Chronic Diseases, Healthcare Systems, Transfer Learning, Fine-tuning.

1 INTRODUCTION

We, Algerians, are experiencing a demographic shift where longer lifespans are accompanied by an increase in chronic diseases, a phenomenon known as "morbidity expansion," where people live longer but with more years spent in poor health [1]. From 2002 to 2019, the prevalence of chronic conditions in Algeria rose significantly due to lifestyle changes, including unhealthy diets, reduced physical activity, and higher obesity rates, along with an aging population and improved diagnosis and screening practices [1]. This rise in chronic illness is accompanied by an increase in mental disorders, highlighting a complex and often underestimated relationship between physical and mental health [2]. Research indicates a significant prevalence of mental disorders among those with chronic diseases, with rates as high as 36.6% [3] reflecting that mental disorders can worsen chronic disease management and are also linked to higher rates of chronic illnesses.[4]. Therefore, it is becoming necessary to improve the healthcare system and consider an integrated approach that combines mental and physical health services. On the other hand, Digital marketing in healthcare is increasingly personalized, using AI-driven content, telehealth promotion, and targeted ads to engage patients with chronic diseases and mental health needs. Social media and community-building strategies help reduce stigma and foster support, while AI chatbots and gamified apps enhance patient interaction and adherence, as well as their engagement.

The Algerian mental health care system faces challenges such as resource shortages, a reliance on hospital-centered care, uneven access, and persistent stigma, with services concentrated in the northern region and lacking community-based care [5]. Additionally, the system suffers from outdated approaches, a shortage of professionals, and legislative and implementation gaps [6]. Artificial Intelligence (AI), particularly through Natural Language Processing (NLP) and Large Language Models (LLMs), offers promising advancements in mental health diagnosis, monitoring, and treatment, potentially enhancing diagnostic accuracy, personalizing care, and addressing shortages [7] [8].

However, implementing models that can handle Alge- rian text is still a challenge given the fact that Algerians speak many vernacular languages. Furthermore, there are currently no studies – to the best of our knowledge– that addresses the use of AI tools to improve the Algerian mental health system. One important obstacle that is hindering the advancements in this path is the lack of context-related datasets. In an attempt to address this issue and put the foundation stone towards developing a reliable mental health monitoring system for chronic disease patients, we propose in this study a mobile ap- plication for real-time sentiment analysis (SA) dedicated to chronic diseases' patients. Behind the scenes, our application makes use of the resulting fine-tuned Transfer Learning (TL) model trained on a dataset that wascollected in a previous work. The main contribution of this paper is three folds:

- Evaluating the performance of a specific Algerian TL model, namely DziriBert on a new dataset.

- Proposing a new data augmentation strategy to improve the model performance.
- Creating a real-time SA system offering low-cost and timely support to chronic disease patients, which can be integrated in Algerian health systems easily.

The remaining of this paper is organized as follows: Section II presents the background and foundation of this study. Section III provides a detailed description of our methodology, while we present and discuss the results in Section IV. Section V provides an overview of our application for detecting sentiments from user-generated content in real-time. We conclude the paper in Section VI with implications of our work and future directions.

2 BACKGROUND

Sentiment analysis is increasingly used in healthcare research to understand patients' emotional and psychological experiences with chronic diseases [9]. It effectively classifies feedback, identifying dissatisfaction in areas like service delivery and highlighting positive sentiments regarding staff interactions and treatment [10]. It can also enable targeted interventions that improve both medical care and patient satisfaction [11].

In mental health monitoring, SA is becoming an invaluable tool [8]. It is used to analyze social media content to identify individuals at risk for depression or suicidal thoughts through their language patterns [12]. Moreover, SA improves diagnostic accuracy by detecting subtle linguistic cues, enabling earlier detection and more effective interventions. It also personalizes mental health treatment by continuously monitoring emotional language for real-time therapeutic adjustments [4] [7].

Recently, researchers have been exploring the landscape of mental health applications highlighting their significant potential. For instance, Gadgil et al. [13] presented a comprehensive study on the creation and functionality of their mental health app, emphasizing its diagnostic capabilities, sentiment analysis of user journaling, and integrated chatbot support. On the other hand, Meyer & Okuboyejo [14] focused in their work on sentiment analysis of user reviews for existing depression apps, revealing that features related to medical assessments often trigger negative emotions, while supportive resources and therapeutic treatments are more positively received.

However, Integrating these apps into Algeria's healthcare system is challenging due to linguistic complexities and a lack of relevant datasets. While recent TL has improved SA of Algerian Arabic dialects, the scarcity of datasets remains a major challenge. Data augmentation (DA) offers a potential solution by generating essential training data for effective mental health monitoring platforms.

Research has shown positive outcomes when combining TL and DA in various domains. Prades [15] explored the use of LLMs and DA for binary sentiment classification with a small dataset, finding that using "nlpaug" for synonym replacement and GPT-2 for synthetic data generation significantly improved LLM performance through fine-tuning and soft prompting.

Omran et al. [16] studied DA's impact on SA of translated texts across English, Modern Standard Arabic (MSA), and Bahraini dialects. By employing the "random swap" technique and using an LSTM model, the study found improved accuracy and generalizability, particularly in low-resource languages. Similarly, Badri et al. [17] investigated the use of PLMs for Arabic hate speech detection, demonstrating that DA enhanced classification metrics across various dialects. While these techniques have been successful in other areas, their application to mental health monitoring for chronic disease patients remains under-explored, which is the gap this study seeks to fill.

3 METHODOLOGY

Our methodology emphasizes using DA to balance the used dataset and improve model robustness against diverse dialectical variations, as illustrated in the architecture presented in Fig.1.

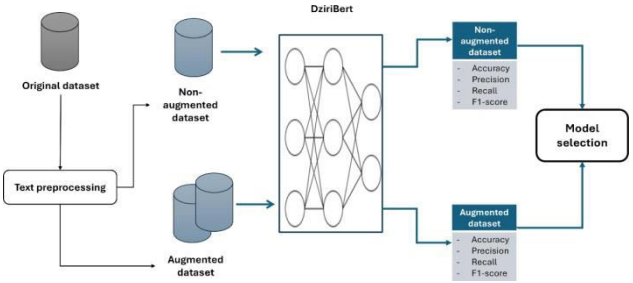
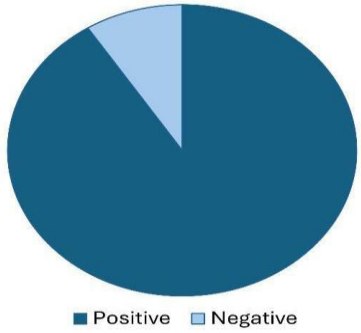


Figure 1. Our proposed methodology

In this study, we used a dataset collected by Arbouche and Adjout [18]. The dataset contains comments collected from different Facebook groups and pages dedicated to people with chronic diseases in Algeria. These comments were cleaned by identifying and removing duplicates, correcting typing errors, and removing missing data. The final dataset contained 2981 comments written in MSAand Algerian Dialects. The cleaned dataset was annotated by three annotators. Fig.2. presents the distribution of labels of the final original annotated dataset. It is clear that the dataset is imbalanced. We noted that most comments were supportive and positive, which is under- standable in such open space for ill individuals. Next, we performed essential preprocessing steps, including letter normalization, removal of specific symbols and repeated letters, and eliminating unknown characters (non-Arabic), URLs, diacritics, punctuation, and user mentions.



Figre 2. The labels' distribution of the final annotated dataset

For SA, we selected DziriBERT which is a bidirectional transformer developed by Abdaoui et al. [19] for the Algerian Arabic dialect. It was tested on two text classifi- cation tasks, namely SA and emotion detection achieving new state-of-the-art results in analyzing Algerian dialectal Arabic. Moreover, it has been widely and successfully used for SA of Algerian dialects in different contexts [20], [21]. We evaluated the performance of the chosen model under different conditions, particularly focusing on DA strategies.

For text DA, we employed standard augmentation meth- ods including random insertion, random deletion, word shuffling, and text masking. Additionally, we introduced a novel augmentation strategy inspired by the random insertion approach and designed to enhance the model's performance. This technique involves breaking the text into 4-word groups (4-grams) and identifying the 25 most common sequences. These 4-grams are then randomly inserted back into the original text to create variations. Each original sequence undergoes this process five times, resulting in multiple augmented versions.

Comparative analyses were conducted using consis- tent configurations: 5 epochs, a batch size of 8, and a gradient accumulation step of 4. The models were trained and evaluated on both original and augmented data in a Kaggle environment, with performance met- rics such as accuracy, precision, recall, and F1-score, supplemented by visualizations like confusion matrices, Precision-Recall Curves (PRC), and Receiver-operating characteristic Curves (ROC). The dataset was divided into training (80%) and testing (20%) sets.

4 RESULTS AND DISCUSSION

The conducted experiments revealed critical insights into the role of DA when dealing with small and imbalanced datasets.

Table I Model performance using the original dataset

	Precision	Recall	F1-score
Negative	00	00	00
Positive	0.91	0.99	0.95
Weighted Average	0.84	0.91	0.87
Accuracy		0.91	

Table I presents the performance metrics of DziriBERT evaluated on the original dataset, highlighting its high precision and recall for positive sentiment predictions. This indicates that DziriBERT effectively identifies and classifies positive instances. However, its performance on negative instances is notably weaker, suggesting the model struggles to detect any negative sentiments.

The issue is exacerbated when fine-tuning on a small, imbalanced dataset, where positive instances outnumber negative ones. This can lead to a model biased towards the majority class (positive sentiment), resulting in unreliable classifications and under-representation of negative sentiments. The findings emphasize the risk of misleading predictions when fine-tuning on imbalanced data, underscoring the need for strategies like DA, re-sampling, or class weighting to improve the model's generalization across all sentiment classes.

Table .II displays the performance metrics of DziriB- ERT after fine-tuning using various augmentation strate- gies, with Fig.3 and Fig.4 illustrating the corresponding ROC and PRC, respectively. Among standard augmenta- tion techniques, Word Shuffling and Text Masking show the highest performance, with accuracy, precision, recall, and F1-scores ranging from 0.73 to 0.74.

TABLE II. Model performance using the augmented dataset.
Accuracy (Acc), Precision (Pr), Recall (Re), and F1-score (F1)

	Acc	Weighted Average			Negative			Positive		
Augmentation strategy		Pr	Re	F1	Pr	Re	F1	Pr	Re	F1
Random Insertion	0.71	0.71	0.71	0.71	0.69	0.72	0.71	0.73	0.70	0.72
Random Deletion	0.70	0.70	0.70	0.70	0.66	0.74	0.70	0.73	0.65	0.69
Word shuffling	0.73	0.74	0.74	0.73	0.71	0.76	0.73	0.77	0.71	0.74
Text masking	0.73	0.73	0.73	0.73	0.69	0.76	0.73	0.76	0.96	0.72
Our method	0.86	0.85	0.86	0.86	0.84	0.83	0.84	0.87	0.88	0.87

However, our custom augmentation strategy significantly outperforms these standard techniques, achieving superior scores across all metrics, with an accuracy of 0.86. The success of our approach can be attributed to its tailored design of the augmentation technique which allowed creating new mean- ingful

sentences instead of random words. Furthermore, the fine-tuning process was conducted with the base layer frozen, which allows for a more controlled and gradual introduction of complexity during training. This technique helps in avoiding overfitting and ensures that the model builds on the learned features while adapting to the new data. The combination of our advanced augmentation strategy and controlled fine-tuning approach led to improved overall performance and robustness of DziriBERT.

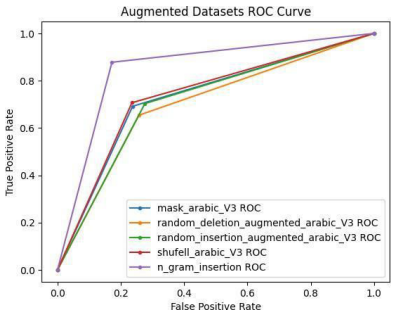


Figure 3. augmented dataset ROC

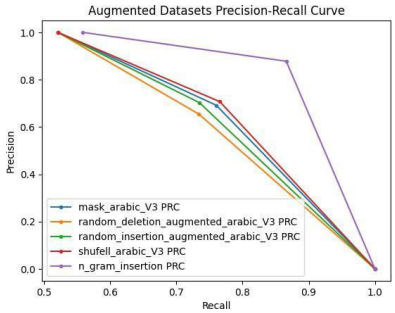


Figure 4. augmented dataset PRC

5 THE MOBILE APPLICATION PRESENTATION

To put the new fine-tuned Dziribert to use, we designed and deployed a mobile app that individuals with chronic diseases can use, which can be integrated in Algerian healthcare systems easily and with low costs. Fig.5. presents the app general architecture. For authentication, patients have the option to either register themselves or have their account created by their healthcare facility (Fig. 6).

Upon logging in, users are presented with the following home screen (Fig.7.) with three options:

1) Emergency Button: Sends an emergency request to the healthcare facility requesting immediate assis- tance (see Fig.7.). This feature helps individuals who may suffer a health emergency and require immediate help.

2) "How You Feel Now" Button: This option allows users to record their feelings up to three times a day. It requires a mandatory comment (see Fig.8). Users will get notified daily to add their comments. The entered textual data will be sent to the server to be stored in the database and analyzed using the fine-tuned DziriBert for monitoring purposes."Chat Now" Button: For emotional support, users can engage in a chat with our app (see Fig.9). The chatbot is created using Gemini LLM from Google AI Studio with a master prompt for response guidance. User messages are captured by the server, processed, and stored in the database to assess and support the user's mental health using DziriBert pre-trained as explained in previous sections.

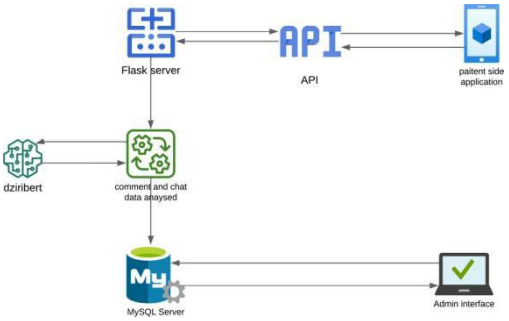


Figure 5. The app general architecture

Figure 6. Authentication screen

Figure 7. Home Screen

For the admin side, the use of single page applications is needed for rapid use (See Fig. 10 and Fig.11). We implemented a feature that notifies the administra- tor if a patient has experienced overall poor

mental health for more than five days in a row. This alert indicates that the patient may be struggling and requires personal assistance. The analysis is automated and does not require assistance from the administrator.

Figure 8. How do you feel" screen

Figure 9. "Chat Now" Screen

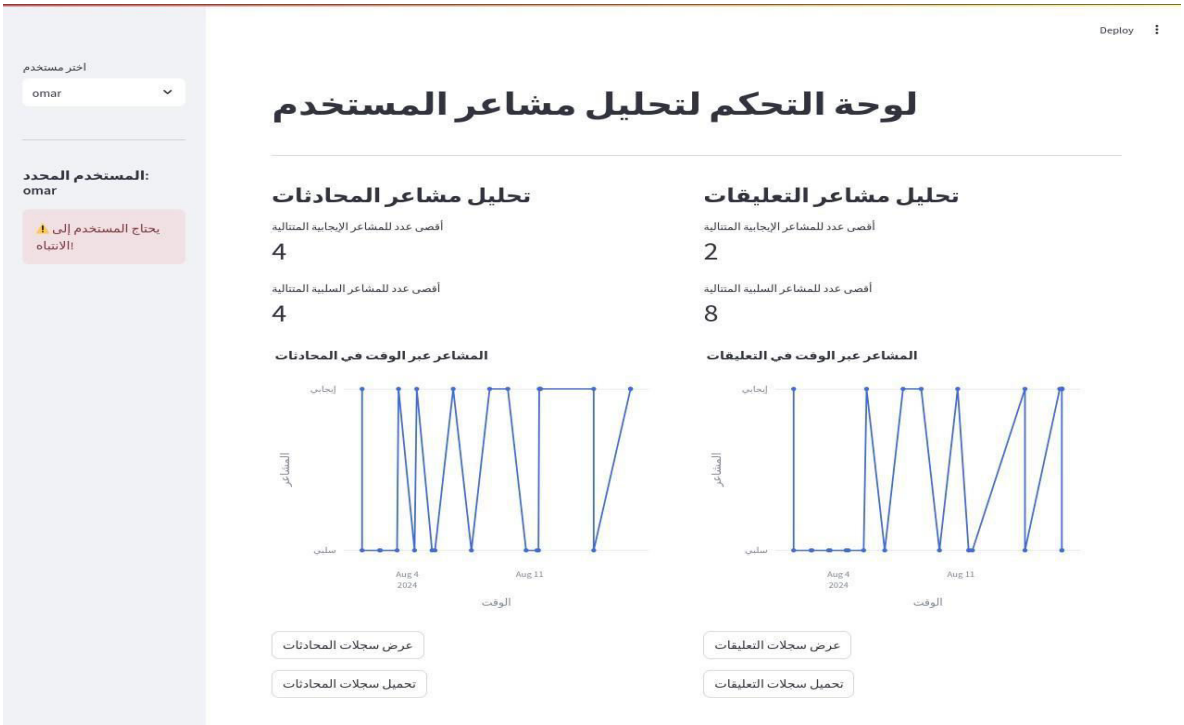


Figure 10. Sentiment Analysis Dashboard

Figure 11. Daily Sentiment Analysis

6 CONCLUSION

Algeria's healthcare system requires urgent changes to improve individuals' lives. This study provided a glimpse to the huge possibilities available for improving our health- care system. Our methodology allowed for a thorough investigation of the impact of data augmentation on SA classification in the context of Algerian Arabic text, addressing the challenges of data scarcity and datasets imbalance in the healthcare field. The results highlighted the importance of carefully managing the fine-tuning process of PLMs. What can be gained in substantial performance, maybe lost in adaptability and effectiveness with unseen data. Understanding the trade-offs involved provides valuable guidance for optimizing transfer learning models in the context of small and imbalanced datasets. On the other hand, the integration of AI-driven sentiment analysis and data augmentation in mobile mental health apps offers a low-cost, scalable solution that not only sup- ports the mental health of chronic disease patients but also enhances efficiency in healthcare and digital marketing. By enabling real-time, personalized care and precise audience targeting, this application reduces operational costs while improving patient outcomes and engagement. This model exemplifies AI's potential to address critical business challenges in healthcare, demonstrating its value as a transformative tool for cost-effective, high-impact service delivery. Still, it is worth mentioning that our application requires improvements to address the special needs of people with mental disorders and instability. To address this limitation, we aim in future work at collaborating with doctors from both sectors of mental illness, and chronic diseases in order to address the appropriate design and to add new features that can help patients. Furthermore, we aim to implement other Arabic pre-trained language models and even create a new model that can handle the complication of the healthcare field.

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AI-Driven Solutions for a Smarter Energy Future Case of study: Electricity demand forecasting

FALI Fatima[1] and **CHERFAOUI Yasmine**[2]
University of Sciences and Technology HOUARI BOUMEDIÈNE
([1]*ffali@usthb.dz*, [2]*cheryasmine@gmail.com*)

ABSTRACT

Neural networks (NNs) have gained promi- nence in the optimization of smart grid systems due to their ability to handle nonlinear rela- tionships and learn from vast datasets. This paper explores the application of neural net- works to optimize key operational parameters in smart grids, such as load balancing, energy demand forecasting, and fault detection. We present a framework for integrating neural net- works into smart grid infrastructure, analyze the benefits of deep learning models over tradi- tional methods, and discuss the potential chal- lenges related to data quality, real-time pro- cessing, and scalability. Our findings demon- strate that neural networks can improve grid efficiency, reduce energy costs, and enhance the reliability of power delivery systems.

KEYWORDS: Neural network, Smart grid, Machine learning, Discretization.

1 INTRODUCTION

1.1 Background

Smart grids represent a paradigm shift in the en- ergy sector, integrating digital technology to op- timize power management and distribution. This modern approach aims to enhance the efficiency, reliability, and sustainability of electricity delivery systems. Unlike traditional grid management methods, which often rely on manual control and reactive measures, smart grids leverage advanced technologies to enable real-time monitoring, anal- ysis, and control of power flow.

One of the key advantages of smart grids is their ability to incorporate data-driven models, such as neural networks. These models can analyze vast amounts of data from sensors, meters, and other sources to gain valuable insights into grid behav- ior. By leveraging neural networks, smart grids can optimize various aspects of energy manage- ment, including load forecasting, voltage regula- tion and Fault detection and diagnosis.

By integrating digital technology and leveraging AI, smart grids offer a more intelligent and adap- tive approach to energy management. This trans- formation is essential to meet the growing demand for electricity, integrate renewable energy sources, and ensure a reliable and sustainable power supply for the future ([1], [2], [3],...)

1.2 Neural Networks in Optimization

Neural networks, particularly deep learning archi- tectures, have emerged as a powerful tool for opti- mizing smart grid operations. These complex al- gorithms are capable of modeling intricate nonlin- ear relationships in data, making them well-suited to address the challenges inherent in modern en- ergy systems. Neural networks offer several advantages over traditional methods for smart grid optimization, including:

- **Nonlinear relationships:** Deep learning models can capture complex, nonlinear re- lationships between variables, which is often the case in real-world energy systems. A
- **Adaptability:** Neural networks can learn and adapt to changing conditions, making them suitable for dynamic environments like smart grids.
- **High accuracy:** Deep learning models have demonstrated superior performance in vari- ous prediction and optimization tasks.
- **Large-scale data processing:** Neural net- works can handle large datasets, which is es- sential for analyzing the vast amount of data generated by smart grids.

By leveraging the power of neural networks, smart grids can become more intelligent, adaptive, and resilient, paving the way for a sustainable and effi- cient energy future. For a comprehensive overview of the state-of-the-art in machine learning and deep learning applications for smart grids, the reader is referred to the reviews by [4] and [5].

2 PROBLEM DEFINITION

2.1 Smart Grid Optimization Challenges

Smart grid optimization presents several challenges, including:

- **Load Balancing:** Balancing the distribu- tion of energy across the grid helps to prevent overloading and ensure reliable power sup- ply. Deep learning can be used to optimize load allocation by considering various fac- tors, such as generation capacity, transmis- sion constraints, and consumer preferences.
- **Energy Demand Forecasting:** Accurate prediction of energy demand is crucial for grid stability and efficient resource alloca- tion. Deep learning models, such as recurrent neural networks (RNNs) and long short- term memory (LSTM) networks, can analyze historical data and real-time patterns to forecast future demand with

high accuracy.

- **Fault Detection:** AI-powered algorithms can analyze sensor data to detect faults or anomalies in the grid, enabling timely main- tenance and reducing downtime. Deep learn- ing techniques, such as convolutional neural networks (CNNs), can be used to identify patterns in sensor data that indicate poten- tial faults.
- **Renewable energy integration:** Integrat- ing renewable energy sources like solar and wind power into the grid presents challenges due to their intermittent nature. Deep learn- ing models can help predict the output of these sources and optimize grid operations accordingly.

These problems involve complex, nonlinear interactions between different variables, which neural networks are well-equipped to handle. In this paper the intention is particularly ad- dressed to electricity demand forecasting. Hence, in the context of smart grids, accurate demand forecasting is essential for several reasons:

- Load balancing: Prevents blackouts by en- suring that power supply matches demand.
- Operational efficiency: Reduces wastage of energy and optimizes the use of power plants.
- Integration of renewables: Helps accommo- date unpredictable renewable energy sources like solar and wind.

Traditional methods for demand forecasting, such as time series analysis and autoregressive mod- els, struggle to capture the complex patterns of electricity consumption. This is where neural net- works demonstrate their strength.

2.2 Neural Networks and Electricity Demand Forecasting

Neural networks [6] are computational models inspired by the human brain, consisting of layers of interconnected nodes (neurons). These models are particularly well-suited for capturing complex patterns and relationships in data, which is critical for electricity demand forecasting. Two significant categories of neural network algorithms exist:

- **Feedforward Neural Networks (FNNs)**: These are straightforward networks that only allow information to move from input to out- put in a single direction; nevertheless, they perform less well with time-dependent data [7].
- **Recurrent Neural Networks (RNNs)**: Specifically designed for sequence data, as they allow information to persist over time.
  - **Long Short-Term Memory (LSTM)** :A type of RNN that addresses the problem of vanishing gradients, making it highly effective for long-term forecasting [8].
  - **Gated Recurrent Units (GRU)**: A simplified version of LSTMs with com- parable performance but fewer parame- ters to optimize, making them faster to train [8, 9].

3 CASE STUDY: ELECTRICITY DEMAND FORECASTING USING NEURAL NETWORKS

3.1 Dataset Description and Preprocessing

Our study utilizes a comprehensive dataset encompassing historical electricity consumption within the city of Algiers. This data spans a pe- riod of twenty-one years, ranging from 2002 to 2023. The dataset is comprised of the following key variables:

- **Quarterly Electricity Demand (Con- sumption):** This data provides insights into the city's electricity usage patterns through- out the year, allowing for a seasonal anal- ysis. This crucial variable, sourced directly from SONALGAZ (the Algerian electricity company), forms the basis for our forecast- ing model.
- **Quarterly temperature (Mean, Max- imum and Minimum):** Obtained from *open-meteo.com* a reputable source for mete- orological data, this data allows us to exam- ine the influence of temperature fluctuations on electricity demand.
- **Quarterly GDP Growth Rate:** Retrieved from the Ministry of Finance website, this data helps us understand the relationship be- tween economic activity and electricity con- sumption.

Raw meteorological data, originally collected on a monthly basis, was transformed into quarterly averages to align with the granularity of the other data. Additionally, all the data was normalized to ensure consistency and comparability across dif- ferent variables.

3.2 Model Architecture

- **FNN:** A basic neural network without any recurrent connections. It treats the input features as independent predictors and doesn't account for time dependencies.
  - **LSTM:** A type of Recurrent Neural Network (RNN) designed to capture long-term dependencies in time series data.
  - **GRU:** A simpler version of LSTM that re- duces computational complexity while retain- ing much of the forecasting power.

Each model was trained using the Adam opti- mizer, with Mean Squared Error (MSE) as the loss function. Hyperparameters such as learning rate, batch size, and number of layers were tuned using grid search.

3.3 Results and Discussion

The performance of each model was evaluated us- ing three key metrics:

- **Mean Absolute Error (MAE):** The av- erage absolute difference between predicted and actual values.
- **Root Mean Squared Error (RMSE):** The square root of the average squared dif- ference between predicted and actual values.
- **Mean Absolute Percentage Error (MAPE):** The average percentage differ- ence between predicted and

actual values.

- **FNN:** As expected, the Feedforward Neu- ral Network showed the lowest performance. It struggled to capture the seasonal patterns present in the data, which led to higher pre- diction errors.
- **LSTM:** The LSTM model significantly out- performed the FNN model. It was better at capturing the seasonal and economic fluctu- ations that influence quarterly electricity de- mand.
- **GRU:** The GRU model showed the best overall performance, with slightly better re- sults than LSTM. The GRU's ability to han- dle long-term dependencies and its simpler structure allowed it to train more efficiently while maintaining accuracy.

Table 1: Comparison of model performance

Model	MAE	RMSE	MAPE (%)
FNN	21.45	28.93	6.12
LSTM	14.32	20.58	4.25
GRU	13.94	19.80	4.01

Error Distribution Analysis**
The error distribution for each model was an- alyzed to identify where the models performed well and where they struggled. The table below presents the maximum and minimum prediction errors for each model over the test period:

- The **GRU** model showed the smallest maxi- mum error, indicating that it was more reli- able in extreme cases, such as predicting de- mand during the peak summer and winter months.
- The **LSTM** model also performed well, but its slightly more complex architecture may have led to some overfitting during training, which is reflected in slightly larger errors.
- The **FNN** model had the highest maximum error, especially during peak periods where temperature changes and GDP had signifi- cant impacts on electricity demand.

Table 2: Maximum and minimum prediction errors for each model

Model	Max Error(GWh)	Min Error(GWh)
FNN	35.5	10.2
LSTM	21.8	5.8
GRU	19.2	5.1

3.4 Computational Efficiency

Training and inference times were also recorded to compare the computational efficiency of each model.

- The **FNN** model trained the fastest due to its simpler architecture, but its predictive performance was poor.
- The **LSTM** model took the longest time to train due to its complexity, but it achieved good results.

The **GRU** model trained faster than LSTM and provided comparable, if not slightly bet- ter, accuracy, making it the most efficient model in this study.

Table 3: Training and inference times for each model.

Model	Training Time(hrs)	Inference Time (ms)
FNN	0.8	10
LSTM	2.1	25
GRU	1.6	20

5 CONCLUSION

This study demonstrated that recurrent neural networks, particularly GRU and LSTM, are highly effective in forecasting quarterly electricity de- mand when temperature data and GDP are used as input features. The GRU model provided the best balance between accuracy and computational efficiency, making it the optimal choice for this forecasting task.

The study highlights the potential of neural net- works for improving electricity demand forecast- ing, which is critical for managing supply and de- mand in smart grids. Future work could focus on integrating additional external factors, such as weather forecasts and energy prices, to further im- prove forecasting accuracy.

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Artificial Intelligence Tools in Predicting Tourism Demand: Roles and Applications and a Case Study of Airbnb

BOUMERDASSI Farida[1], FATHI Hanane[2]
[1] *Abdallah Mersli University Center,Tipaza,Algeria (boumerdassi.farida@cu-tipaza.dz)*
[2] *Abdallah Morsli University Center,Tipaza,Algeria(fathi.hanane@cu-tipaza.dz)*

ABSTRACT

This research article seeks to illustrate the significance of artificial intelligence techniques in forecasting tourist demand using a case study of Airbnb. The research indicates that the corporation use AI techniques to examine prior data, industry patterns, and user habits for predicting future trends. This method has enhanced dynamic pricing tactics, allowing the corporation to augment income by swiftly adapting to high-demand times. These techniques have improved customer satisfaction by providing suitable rates at optimal periods and minimizing vacancies via precise forecasts of property demand. Ultimately, operational efficiency has been enhanced by the automation of procedures and the reduction of human involvement in pricing modifications.

KEYWORDS: Airbnb, demand forecasting, big data, machine learning, dynamic pricing, tourism industry,

1 INTRODUCTION

Artificial Intelligence (AI) has emerged as a key catalyst for digital change in the tourist industry, providing sophisticated tools for big data analysis and forecasting the fluctuating patterns of tourism demand. Due to the unpredictable characteristics of this sector, influenced by economic, social, and seasonal elements, the use of AI technology has become crucial for improving the competitiveness and sustainability of tourist businesses.

Organizations may correctly estimate and anticipate tourist demand trends by using machine learning algorithms and time series analysis methodologies. This facilitates the execution of dynamic pricing plans, enhanced resource allocation, and the alignment of services with changing market demands. Furthermore, the amalgamation of AI with contextual variables—such as local happenings, meteorological fluctuations, and global travel patterns—yields sophisticated insights to facilitate data-driven decision-making. AI solutions has the capacity to enhance operational efficiency while also being important in providing tailored traveller experiences, cultivating consumer loyalty, and creating sustainable economic value. Consequently, investing in AI-driven demand forecasting is a crucial foundation for fostering innovation and assuring the sector's preparedness for future transitions.

1.1. Objectives of the Research

Identifying Artificial Intelligence Tools in tourist Demand Prediction: Examining the many tools and methodologies used by artificial intelligence to evaluate data and forecast tourist trends, grounded in the theoretical framework of the research.

Investigating the Influence of Artificial Intelligence Tools on tourist Demand Forecasting: Analysing the effect of these tools on prediction precision and efficiency relative to conventional methodologies used in forecasting demand within the tourist industry.

Applying the theoretical framework to an Airbnb case study: Utilizing Airbnb as a case study to illustrate the use of artificial intelligence techniques in forecasting tourist demand, and how these tools have enhanced pricing strategies, customer happiness, and operational efficiency.

1.2. Validity of the Research

This study underscores the importance of artificial intelligence techniques in enhancing tourist demand forecasting, a crucial subject in the digital era marked by substantial technological breakthroughs. This research examines the influence of these technologies on forecasting techniques within the tourist sector, offering critical insights into enhancing supply and demand management, therefore benefitting both tourism enterprises and customers. The research also improves organizations' capacity to adapt to shifts in customer behavior and market trends, resulting in enhanced operational efficiency and financial rewards.

1.3. Research Methodology

The research approach employs a case study of Airbnb, concentrating on the company's use of artificial intelligence capabilities to forecast vacation demand. Data will be gathered from several sources, including corporate reports, prior research, and literature evaluations about the use of artificial intelligence in the tourist sector. The research will evaluate Airbnb's actual performance using AI-driven data and juxtapose it with conventional predicting techniques.

1.4 Research Problem

The primary research issue is to assess the efficacy of artificial intelligence techniques in anticipating tourist demand in comparison to conventional approaches. In what ways might artificial intelligence technologies boost forecast accuracy and hence improve tourist strategy in response to evolving market behaviors? Do these technologies provide concrete economic and operational benefits in comparison to conventional approaches that depend only on historical data?

2 FUNDAMENTAL PRINCIPLES OF TOURISM DEMAND

2.1 Demand for Tourism

The complexity of the tourist business has resulted in several definitions of tourism demand. Their most notable representatives are:

- "Tourism demand refers to the aggregate number of tourists utilising tourism facilities, encompassing both local residents and international visitors." (Matar, 2014)
- Tourism demand refers to the aggregate quantity of individuals that journey or want to go to use tourism facilities and services in locations far from their workplaces or residences. (J.page, 2007)

2.2. Determinants of Tourism Demand

- Price: An inverse correlation exists between price and demand; reduced prices result in heightened demand.
- Income: There exists a direct correlation; elevated income enhances tourist demand, elucidating the discrepancy between affluent and impoverished nations.
- Population: Demand is influenced by the population size and its demographic composition (age, socioeconomic class).
- Leisure time: An increase in leisure time correlates with heightened tourist demand (Wassila & S, 2019)
- Marketing strategies: They aim to incite demand and convert it from potential to real.
- Technology: Technological advancements augment tourist demand by enhancing transportation and expanding leisure time.
- Educational and cultural attainment: Advanced education enhances the desire to explore many cultures and sites.
- Political and security stability: Stability fosters tourist links and amplifies demand.
- Currency exchange rate: It influences international tourism; a decline in the value of the currency of a host nation enhances the buying power of visitors.
- The complexity of tourist excursion methods diminishes demand . (Fatoum.Y & Siham, 2017)

3 PREDICTING THE DEMAND FOR TOURIST SERVICES

3.1 The notion of predicting tourist demand

Forecasting is predicting future events via the examination of historical data and present indications. According to (Mouloud, 2002), predicting tourist demand is a prospective process that depends on the examination of historical data and contemporary indicators to project future demand. (Dodine, 2012)

3.2 The significance of predicting tourist demand

Demand forecasting is a strategic instrument for attaining equilibrium between supply and demand, since it facilitates:

- Enhancing planning and management: optimized resource allocation.
- Augmenting client experience: elevating the quality of services provided.
- Cost reduction: eliminating unnecessary expenditures.
- Formulating strategic decisions: include the initiation of marketing campaigns or the allocation of resources to new locations. (Saad & Ikhlas, 2018)

3.3 Techniques for Predicting Tourism Demand

Methods are categorized into qualitative and quantitative.

3.3.1 Qualitative methodologies

Depend on expertise and instinct, used in the absence of previous facts. The most significant of which are:

- Sales Force Estimates: These rely on reports from sales personnel, however they may be influenced by individual bias. (Aziz, 2020)
- Expert Panels: Utilized in extraordinary situations, however they are costly and exhibit variability among specialists. (Tai & H.A, 2009)
- Marketing Research: Precise in the near term, although needs consistent effort . (Tai & H.A, 2009)
- Delphi Method: It relies on the insights of a panel of experts while maintaining their anonymity. (2024)

3.3.2 Quantitative Models

Depend on statistical and mathematical frameworks. The most notable among them are:

- Time Series Models
- ARIMA/SARIMA: Examination of seasonal and non-seasonal patterns.
- MARIMA: Consolidation of data from several sources.
- GARCH: Examination of demand variability with less emphasis on forecasting.

- Econometric Models

- ECM: Error Correction Model, proficient in elucidating both short-term and long-term connections.
- TVP: Time-varying parameters, very adaptable to fluctuations in data.
- VAR: Multivariate Autonomous Model, considers all variables as internal determinants.
- ADLM: Autodistributed Model, examines delayed temporal effects.

– Hybrid Models
- TVP-ECM: Integrates the flexibility of TVP with the precision of ECM, used for predicting demand levels and growth.
- EC-LAIDS and TVP-LR-AIDS: Examine the elasticity among tourism locations.
  – The Almost Ideal Demand System Model (AIDS) It examines the impacts of substitution and complementarity among tourist locations and is used to investigate the elasticity of pricing and expenditures.
  – Fundamental Models as a reference for evaluation (Baseline Models)
- Naïve: presumes the persistence of existing demand.
- Naïve 2: depends on perpetual growth rates.

- Exponential Smoothing: enhances historical patterns while maintaining simplicity. (Haiyan & Gang, 2008);

4 ARTIFICIAL INTELLIGENCE INSTRUMENTS FOR PREDICTING TOURISM DEMAND

The tourist business is now experiencing a transformative period as artificial intelligence and big data redefine the industry. These technologies provide unparalleled prospects for customization, operational efficiency, and sustainability in the travel experience.

4.1 The notion of artificial intelligence within the realm of tourism

Artificial intelligence (AI) refers to the capacity of computers to emulate human cognitive processes, including voice recognition, decision-making, and pattern recognition. According to Sttaf (2024), artificial intelligence significantly enhances tourist services by using technologies such as machine learning, deep learning, and natural language processing to evaluate extensive tourism data and derive precise insights. These technologies facilitate the delivery of new services, including tailored travel advice, virtual customer support assistants, adaptive reservation systems, and dynamic pricing that adjusts based on historical data and predictive analytics. Simultaneous translation and virtual tours improve the trip experience and provide easy, complete services to tourists, resulting in a qualitative transformation in the tourism sector and an increase in consumer satisfaction. Engage in extensive travel. (Ibrahim & Mustapha, 2024)

4.2. Techniques of Artificial Intelligence Applied in Tourism Demand Forecasting

Forecasting tourism demand depends on the analysis of extensive data and historical trends to discern market patterns and predict fluctuations in demand. The used artificial intelligence methods comprise: Machine learning: used to evaluate extensive datasets and uncover intricate patterns in visitor demographics, temporal factors, geographical regions, and seasonal trends. This encompasses prediction models and deep learning algorithms, like ARIMA and LSTM, for the analysis of time series.

– Sophisticated data examination:
- Analysis of extensive data: aggregated from reservation platforms and social media.
- Geospatial analysis: to examine the geographical distribution of demand using cartographic representations.
- Clustering: to categorize travelers based on their behavioral patterns.

- Predictive modeling: use methods like multiple regression and statistical models to examine causal linkages among elements influencing demand, such as health issues like the COVID-19 pandemic. (Pais & Viana.Sonia, 2024)

4.3 Prevailing Artificial Intelligence Instruments in Tourism Demand Forecasting

– Google Analytics: to assess visitor activity on websites.
– IBM Watson: To derive insights from large datasets and assess sentiment.
– Microsoft Azure Machine Learning: For the creation of prediction models with machine learning
– SAS Analytics: For the analysis of large datasets and the application of prediction models
– TensorFlow and PyTorch: For constructing neural networks and deep learning models for data analysis.

4.4 Benefits of Artificial Intelligence in Predicting Tourism Demand

- Enhancing the precision of forecasts and predictions.
- Immediate forecasting and optimal resource allocation.
- Enhancing client experience via the provision of tailored services.
- Adjusting to unforeseen events, including natural catastrophes.

4.5 Challenges of Artificial Intelligence

- Data complexity resulting from the influence of several variables on tourism.
- Dependence on previous data that may lack accuracy in emergency scenarios.
- Concerns around the privacy and security of personal information.

- Challenges in predicting inside volatile contexts, such as economic crises or natural catastrophes. (Arcis & M.Grundner, 2021)

5 Airbnb Case Analysis

A concise overview of the evolution of the Airbnb concept: The concept of Airbnb was initiated in 2007 by Brian Chesky and Joel Gasia, who had challenges in affording their apartment rent in San Francisco owing to exorbitant rental prices. They capitalized on a significant conference in the city by arranging three air beds in the living room and offering breakfast, resulting in the inception of the "Air Bed & Breakfast" idea. (Alfoutouh,I, 2019).

a) ***Growth and advancement***

- Initial success: The proposal garnered the interest of tourists, prompting the development of an online platform for temporary lodging rentals.
- Global expansion: The platform diversified to include a range of assets, from flats to distinctive locations like castles.
- Funding: It secured substantial funding to broaden its worldwide activities.

The significant data sources used by Airbnb and their function in predicting demand:
- Historical data: Comprises details on prior bookings, including pricing, seasonal intervals, and duration of stay. This data aids in forecasting future trends.
- Current market data: Observing rivals' pricing and occupancy rates, and assessing prompt fluctuations to modify prices accordingly.
- External factors: The influence of local events and holidays, meteorological conditions, and flight statistics on demand fluctuations.
- User behavior: Monitoring search activities and preferences, including favored areas and desired property kinds.

b) ***The data processing chain of Airbnb***

1. Data extraction: Acquiring data from internal (reservations) and external (weather, events) sources.
2. Data storage: Employing solutions such as Amazon S3 for the storage of enormous data volumes and adaptable database systems like Apache Cassandra.
3. Data processing: Real-time processing with Apache Kafka. Conduct a comprehensive analysis of Apache Spark to examine trends and patterns. (Ibrahim & Mustapha, 2024)

c) ***Models and methodologies used in demand forecasting***

1. Machine learning models: Training neural networks to discern patterns in extensive datasets using frameworks such as TensorFlow and PyTorch, integrating seasonal indications and market movements to enhance precision.
2. Time series analysis: Employing models such as ARIMA to comprehend seasonal and prospective variations.
3. Reinforcement learning: Facilitates price adjustments in accordance with market feedback.
4. Elasticity models: Examining the effect of price fluctuations on demand.

d) ***The economic implications of demand forecasting for Airbnb***

1. Enhance revenue: Dynamic pricing adjusts to increased demand during peak periods.
2. Competitive advantage: Providing appealing competitive pricing, hence decreasing vacancy rates. Enhance consumer satisfaction: Equilibrate equitable pricing and augment host revenues.
4. Operational Efficiency: Minimize human intervention in pricing adjustments and enhance inventory management. Ryan O., 2021

e) ***Technologies facilitating model deployment***

1. Utilize containers like Docker to guarantee models operate seamlessly across various settings. Kubernetes systems: for the management and deployment of models at scale.
3. Continuous Learning: Update models with fresh data to maintain alignment of projections with market conditions. (HELLOPM, 2024)

Through these techniques, Airbnb established a responsive system to market swings, so reinforcing its status as a creative worldwide platform within the tourist sector.

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Impact and Benefits of Artificial Intelligence in Digital Marketing: Case of Insurance Companies in Algeria

khoukhi Abderrahmane
[1] *Senior Professor Associate in management, Boumerdes, Algeria*
a.khoukhii@univ-boumerdes.dz

ABSTRACT

Artificial Intelligence (AI) is transforming digital marketing practices globally, and Algeria's insurance sector is no exception. This article explores the impact of AI on digital marketing in Algerian insurance companies and highlights its benefits in customer engagement, operational efficiency, and market competitiveness. By implementing AI-driven tools such as chatbots, predictive analytics, and automated campaigns, Algerian insurers are improving service delivery, personalizing customer experiences, and optimizing marketing strategies. However, challenges like high costs, skill gaps, and regulatory concerns need to be addressed to maximize AI's potential.

KEYWORDS: Artificial Intelligence, Digital Marketing, Insurance, Algeria, Personalization, Automation, Customer Experience.

1 INTRODUCTION

The insurance industry in Algeria is experiencing a digital revolution, driven by advancements in technology and changing customer expectations. Digital marketing has become an essential tool for insurance companies to reach diverse demographics effectively. Artificial Intelligence (AI) enhances this process by enabling data-driven decision-making, automation, and personalization. This study examines the impact and benefits of AI in digital marketing, focusing on how it helps Algerian insurance companies achieve their business objectives.

2 CONTEXT AND PROBLEM

The insurance sector in Algeria faces several challenges. First, competition is fierce, with a growing number of local and international players. Second, consumer expectations are rapidly changing, with an increasing demand for personalized services that are accessible at all times.

Artificial Intelligence, with its capabilities in automation, predictive analysis, and personalization, could address these challenges. However, its adoption by insurance companies in Algeria remains slow due to several factors: the lack of local expertise, limited technological infrastructure, and some resistance to change within companies.

Thus, the central problem of this article is: *To what extent can Artificial Intelligence improve the digital marketing strategies of insurance companies in Algeria, and what is its impact on commercial performance and customer experience?*

3 LITERATURE REVIEW

3.1Artificial Intelligence in Digital Marketing

Digital marketing has been deeply influenced by the integration of AI. Studies show that AI enables increased service personalization, which is crucial in the insurance sector where each client has specific needs (Kumar et al., 2020). AI also allows businesses to analyze large amounts of data to predict consumer behavior and create smoother user experiences with tools like chatbots, email automation, and product recommendations. AI applications in digital marketing are diverse:

- **Personalization of customer experience**: AI allows offers to be personalized based on the profile and behavior of users. For example, machine learning algorithms can analyze customer data to offer tailored insurance products.
- **Advertising campaign automation**: AI optimizes marketing campaigns in real-time by adjusting ads based on consumer behavior.
- **Customer relationship optimization**: Chatbots and virtual assistants enable immediate responses to customer queries, enhancing the customer experience.

3.2 AI in the Insurance Sector

In the insurance sector, AI is used to improve risk management, fraud prevention, and customer experience. The use of chatbots and virtual assistants, for example, allows insurance companies to handle customer requests in real-time, reducing operational costs. Moreover, AI-powered predictive models help insurers assess risks more accurately and adjust their offerings accordingly.

3.3. AI Adoption in Algerian Companies

AI adoption in Algerian companies remains limited, mainly due to the lack of technological infrastructure and the shortage of local AI skills (Benabbas et al., 2019). However, some companies are beginning to experiment with these technologies, although in a sporadic manner and without a true long-term digital strategy.

4 METHODOLOGY

The study follows a **mixed-methods approach**, combining both qualitative and quantitative research. It is

based on primary data collected through **semi-structured interviews** with marketing managers from insurance companies in Algeria and **questionnaires** distributed to a sample of clients. Secondary data will be obtained from sector reports, case studies of international companies that have integrated AI, and academic publications.

5 EXPECTED RESULTS

5.1. Personalization and Effectiveness of Marketing Campaigns

The adoption of AI is expected to enable insurance companies to improve the personalization of their offers. Data analysis will allow more precise targeting of customer needs and tailored insurance products. This approach could increase conversion rates and improve customer loyalty.

5.2. Optimizing Customer Relationships

AI tools such as chatbots will allow insurance companies to automate responses to customer queries, reducing response times and enhancing customer satisfaction. Additionally, companies could use predictive analytics tools to anticipate customer needs and offer proactive services.

5.3. Adoption Challenges

One of the main challenges will be the lack of infrastructure and AI skills in Algeria. While technologies are available, their effective implementation will require significant investments and the training of qualified human resources.

6 DISCUSSION

The impact of AI on digital marketing for insurance companies in Algeria is undoubtedly positive, but its adoption remains constrained by contextual challenges. AI integration could revolutionize insurance marketing in Algeria, particularly in the areas of service personalization, campaign optimization, and customer experience enhancement. However, for this transformation to be sustainable, investments in infrastructure, training, and AI awareness are crucial.

6.1. The Impact of AI on Digital Marketing in Algerian Insurance Companies

6.1.1 Enhanced Customer Insights

AI enables insurers to analyze large volumes of customer data to identify behavior patterns, preferences, and potential needs. This insight helps companies segment their audience more effectively and create targeted marketing campaigns.

Example: Alliance Assurances uses AI to segment customers based on driving history, income levels, and policy preferences, allowing them to tailor motor insurance policies to specific customer groups.

6.1.2 Improved Customer Engagement

AI-powered chatbots and virtual assistants enable real-time interactions with customers, ensuring instant responses to queries and enhancing overall satisfaction.

Example: CARAMA, an AI chatbot deployed by Algerian insurers, answers policy-related questions, assists in claims filing, and provides payment reminders in Arabic, French, and English, ensuring a seamless customer experience.

6.1.3 Automation of Marketing Campaigns

AI automates repetitive tasks such as email campaigns, social media postings, and ad targeting. This allows marketing teams to focus on strategy and creativity.

Example: Société Algérienne des Assurances (SAA) implemented an AI-driven email marketing system that personalizes content based on customer lifecycle stages, leading to higher open and click-through rates.

6.1.4 Fraud Detection and Risk Mitigation

AI systems detect anomalies and suspicious activities, reducing fraud in the insurance sector. These insights can be integrated into marketing strategies to highlight the company's commitment to security and transparency.

Example: AI detected repeated claims with similar patterns at SAA, helping prevent fraudulent activities while boosting customer trust.

6.2. Benefits of AI in Digital Marketing for Algerian Insurance Companies

6.2.1 Increased Efficiency

AI streamlines operations by automating routine tasks, reducing the workload for human agents. This efficiency translates into faster responses and better resource allocation.

Benefit: AI has reduced claim processing time by 40% in some Algerian insurance firms, improving customer satisfaction and operational performance.

6.2.2 Personalization and Customer Retention

AI enables hyper-personalization by offering customized recommendations and services, enhancing customer loyalty. Insurance companies can now deliver unique experiences tailored to individual customer profiles.

Benefit: Personalized marketing campaigns by Alliance Assurances led to a 25% increase in policy renewals in 2023.

6.2.3 Cost Savings

While AI implementation may require initial investments, the long-term cost savings are significant. Automating customer service and marketing reduces staffing costs and increases scalability.

Benefit: CARAMA chatbot reduced customer service costs by 30% for participating companies.

6.2.4 Competitive Advantage

AI adoption gives early movers a significant edge over competitors by enhancing customer experience, streamlining operations, and driving innovation.

Benefit: Companies using AI-driven digital marketing have reported a 20% higher market share compared to non-adopters in Algeria.

7 CONCLUSION

Artificial Intelligence represents a major strategic lever for insurance companies in Algeria, with the potential to profoundly transform their digital marketing practices. However, the challenges related to infrastructure, skills, and technological integration require a gradual approach and adaptation to the local context. Companies that succeed in overcoming these obstacles will reap substantial benefits in terms of commercial performance and customer satisfaction.

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Leading in the digital era

Meroua Amina Ferhi [1] , Asma Aissaoui [2], Idris Touati [3]
[1] *University of M'hamed bougara ,Boumerdes,Laboratory the Future of the Algerian Economy Outside of Hydrocarbons, Algeria(m.ferhi@univ-boumerdes.dz)*
[2] *University of M'hamed Bougara, Boumerdes Laboratory the Future of the Algerian Economy Outside of Hydrocarbons, Algeria (as.aissaoui@univ-boumerdes.dz)*
[3] *University of M'hamed Bougara, Boumerdes, Algeria (touatiidris@yahoo.fr)*

ABSTRACT

Future information technology (IT) leaders won't be technology leaders, they'll be business leaders who understand technology. Leading the Digital Workforce takes a fresh look at technology leadership, exploring how to lead and manage in today's digital workplace where the pace of change is exponential. This paper walks through the deference between traditional leadership and leading technologists, building a high-performance team. Technology leadership requires a unique set of skills, which is why traditional leadership approaches don't always work, so we provides actionable advice on how to create a culture of innovation while driving successful change initiatives.

KEYWORDS: Digital Workforce, information technology, technology leadership, Leading.

1 INTRODUCTION

Technology leaders require a unique set of skills and abilities, They need to understand complex technical concepts and communicate them in a way that businesses can understand. They need to think strategically and anticipate future needs and technology trends. They need to manage and motivate teams of engineers, many of whom are quirky, introverted, and sometimes lost in the details. This is the environment where a technology leader is expected to foster a culture of innovation and creativity and encourage collaboration, Technology leaders also play a vital role in the success of any organization that relies on technology, which is now every organization. The demands and pressure to go faster and do more have never been higher, That's why this papers came to answer the question : How to lead in the digital era ?

2 TRADITIONAL LEADERSHIP AND TECHNOLOGISTS

Traditional leadership styles that are usually effective in many contexts often become insufficient or less so when applied to technologists, because of differences in cognitive models, work styles, and intrinsic motivations. The following categories are given (Fournier, 2017):

2.1 Command-and-control is hardly effective

- Autonomous characteristics: The traits that technological professionals display are basically those of independent thinkers and adept problem solvers. An excessively hierarchical, command-and-control approach to managing their work largely disregards their special intellect and innovative spirit. The best results for technologists usually occur when they are given autonomy in their work. If one were to dictate every aspect of how the work is to be done or indulge in micromanagement, it would likely breed resentment, a lack of engagement, and lower productivity.
- Intrinsic motivation: Most of the technologists have a tendency to be motivated by an actual interest in their area of research and a desire for dealing with complex issues; whereas conventional methods, those of which are mainly based on the use of external inducements, like additional payment or promotion, cannot hold good. Overall, shifting the focus to the inner values and importance of what matters is usually more effective.

2.2 The specific customs and protocols of the outcomes of the work

- Focus on results: Technologists tend to focus on the end results (a working product, a solution to a problem) rather than adhering to a process. Too much attention to strict adherence to inflexible processes, standard operating procedures, and detailed documentation can, to technologists, seem full of inefficiencies and frustrations. While process is important to ensure quality and consistency, it needs to be flexible enough to allow for creative problem-solving.
- Acceptance of failure: Technological advancement is often a process of experimentation or taking a risk. Failures are quite common in such a process, as they offer very important learning opportunities. A dictatorial leadership style that punishes failure may choke innovation and risk-taking at the very outset.

2.3 Insufficient Comprehension of Technical Aspects

- Barriers in Communication: A leader who is devoid of a strong background in technology cannot clearly communicate with his/her subordinates. They will not be able to comprehend the technical elegance of the job to conceive relevant and supportive comments. Such lacks will lure in frustration and mistrust.

- Disparities in Evaluation: The traditional leader may not be able to judge the work properly without a technical base, which may lead to unfair evaluations or, at times, failure to recognize great performances. This affects morale and damages interpersonal relationships.

2.4 Resistance to Change

- Constant Evolution of Technology: It will always be an evolving arena. Traditional leadership is usually all about stability, the maintenance of order, and the negation of change; it is quite the opposite for technologists, who belong to an environment that fosters dynamics, where there is constant change and required learning. When leadership resists change, it makes the team members feel stifled and not challenged.
- Adaptive Challenges: The rigid structure of the traditional command-and-control leadership style may clash with the dynamic requirements of a fast-evolving gaming environment. Technologically, the requirements can frequently change during the development phase of an ecosystem. This often leads to friction because a leader who sticks rigidly to conventional ways and opposes change will cause project delays (Patrick, 2023).
- Traditional leadership is likely to focus on top-down control, strict adherence to established protocols, and external motivators. On the other hand, the leadership model envisioned for technologists is that which is flexible, collaborative, and supportive—one that values individual freedoms realized through experimentation, as well as the nurturing of innovation and independent thought. In order to respond to an apparent lack, a leader needs to actively take part in ensuring that the team they lead is availed of clear communication and efforts to understand their position and motivations.

3 BUILDING A HIGH PERFORMANCE TEAM: ATTRACT AND RETAIN TECHNICAL TALENT BETTER IN A HYBRID WORK MODEL

The accommodation and retention of technical talent in a hybrid work model will be very complex and multi-dimensional, with an approach that considers the unique needs and aspirations of this rare and highly sought-after workforce. The main strategies are put forth as follows (brown, 2023) :

3.1 Attraction

- Competitive Compensation and Benefits: Technical talent is in great demand. Provide competitive pay, comprehensive health insurance coverage, retirement plans, and any other benefits that exceeds local and industry averages significantly. Consider additional perks: tuition reimbursement or professional development stipends.
- Flexible Work Arrangements: Emphasize the flexibility built into the hybrid model. It is crucial to outline the available options for remote work, office-based work, or a mix of both clearly. Offer flexible scheduling options whenever possible. This will be a substantial draw for the best talent in the tech industry.
- Meaningful Work and Opportunities: The motivation in technical professionals is often based on a compelling urge toward challenging and impactful projects. Make sure to emphasize the importance of what your organization does and opportunities for growth, innovation, or using the latest technologies in contributing toward important initiatives. Show an opportunity to use state-of-the-art technologies and lead important initiatives.
- Nurture a positive organizational culture: Show that your organization is genuinely a friendly and welcoming place for employees, focused on teamwork, collaboration, open communication, balance between work and personal life, and opportunities for professional growth. It is this affirmative and supportive culture that will attract and retain high achievers.
- Contemporary Technology and Tools: Technical talent looks to work with the latest in technology. Your organization needs to arm them with modern tools and infrastructure that will help improve productivity and efficiency, whether they are working from home or in the office.
- Talent Branding and Recruitment Strategy: Through effective employer branding, proactively communicate your organization's commitment to hybrid work arrangements and its positive workplace culture. Use targeted recruitment methods to find the best-fit candidates: network with industry contacts, attend relevant events, and use online platforms for sourcing quality talent. Consider also employee referral programs, which are known to be one of the most effective sources of qualified candidates.

3.2 Retention

- Regular Discussion and Feedback: Maintain open and transparent communication with your team members, speaking to them individually as well as in groups. Provide them with constructive criticism regarding their performance at regular intervals. Seek their suggestions on the processes and technologies used.
- Invest in People Development: Provide opportunities for continuous learning and development. This may include online courses, conferences, workshops, certifications, or mentoring programs. Show commitment to people's growth and development in their careers.
- Empowerment and Trust: There is a need to empower each member of the team with powers and confidence that will enable him to perform his responsibilities effectively. Micromanaging should be reduced as much as possible, but rather inspire individuals to take responsibility for their tasks. There are regular

review sessions that they have everything needed to adequately perform their duties.

- Work-Life Balance Advocate: modeling the behavior and encouraging staff to balance work demands with personal-life responsibilities; flexible scheduling and adequate vacation leave; policies that support the meeting of family and individual needs.
- Nurture Teamwork and Collaboration: Create the channels through which employees can interact and collaborate—even across a hybrid workforce. That could be done with social activities virtually, virtual collaboration tools, in-person team building, or frequent updates. It's important that remote workers feel included in team discussions and activities.
- Performance Review: Conduct periodic performance review through fair and open methods. Use this opportunity to acknowledge achievements, provide constructive feedback, and have a discussion over professional development goals.
- Address Concerns Immediately: Concerns and challenges must be addressed quickly and efficiently. Create a culture where sharing issues or problems is not an issue. Solve the problem together and amicably (Ries, 2017) .

All of the above strategies in attracting and retaining top talent, even in the face of challenges presented by a hybrid work model, can help any organization build a strong, highly motivated technology team. Most of all, this depends upon the commitment toward the well-being, professional development, and success of employees within the company. Practical advice on creating an innovation-friendly environment while successfully carrying out change initiatives.

4 PILLARS OF DIGITAL LEADERSHIP

In figure 1, each pillar covers a unique aspect of using digital technologies for leadership purposes.

Figure 1. Pillars of digital leadership

- Student Engagement and Learning: The pivotal domain emphasizes the importance of harnessing digital tools and resources to better engage learners and facilitate the educational process.
- Learning Spaces & Environment" component will focus on creating digital learning environments that engage, are accessible, and support students. It would involve the design of effective online learning spaces, use of appropriate technologies, and development of a positive digital learning culture.
- Professional Learning and Growth: This dimension brings into light the continuous professional development and competency enhancement of individuals through the use of digital platforms and resources.
- Communication is the building block which focuses on straightforward, productive, and strategically driven communications through digital channels.
- Public Relations: This practice focuses on using digital media to maintain and boost the public image and reputation of an organization or a person.
- Branding: It involves creating and maintaining a strong digital brand.
- Opportunity: The last pillar is about the identification and capitalization of opportunities arising from the digital context. This includes strategic planning and innovation (Sheninger, 2020).

5 DIGITAL TRANSFORMATION MANAGEMENT SKILLS

The infographic bellow (Hill, 2022) shows that the key leadership quality to tackle digital transformation is adaptability by a huge margin: 71%. This underlines that the digital landscape is continuously dynamic and fast-*moving; strategies will need to be quickly changed, new* technologies taken on board, and ways found of responding to surprises and disruptions.

The high percentages for curiosity (48%) and creativity (47%) further underscore proactive and innovative leadership. Indeed, successful digital transformation requires leaders who can explore new possibilities with a notable capability for generating novel solutions and approaches. A curious leader is more likely to find emerging trends and opportunities, while a creative leader is able to find innovative ways to leverage those opportunities.

Notably, "Comfort with Ambiguity" also made the list, at 43%. In many ways, digital transformation is inherently ambiguous and subject to incomplete information. For these reasons, leaders who effectively operate in ambiguous situations, can make decisions based on partial data, and manage associated risk are crucial to navigate such inherent complexities.

The relatively lower comfort with ambiguity percentage compared to adaptability, curiosity, and creativity might mean that though the ability to work with uncertainty is great, being able to adapt, innovate, and investigate new ideas can be more crucial in the case of effective leadership through digital transformation. These four qualities together provide a picture of the leader who is not only reactive but proactive, innovative, and resilient in the light of uncertainty. Lack of any one of these aforementioned traits can considerably reduce the effectiveness of digital transformation initiatives.

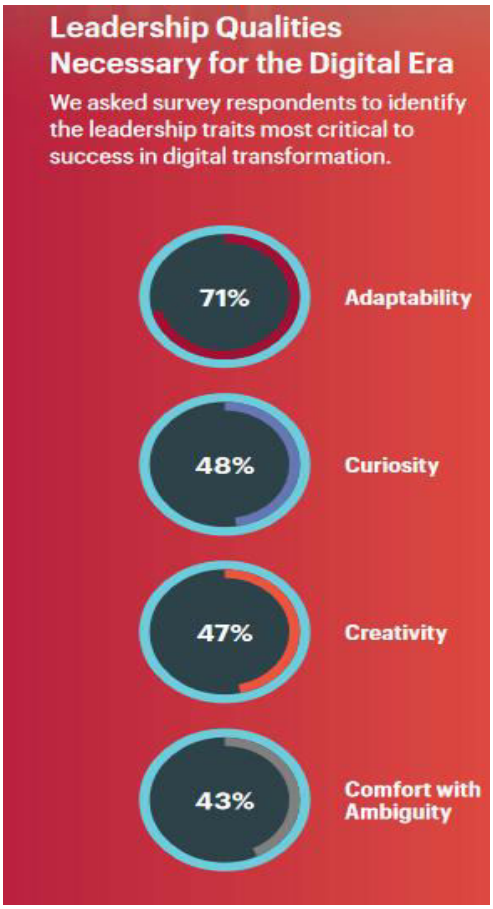

Figure 2. Leadership qualities necessary for the digital era

6 CLOSING THE DIGITAL SKILLS GAP

This infographic (Hill, 2022) shows survey data on how leaders are expanding their digital knowledge. Highlights of the executive survey include the following: 80% learn using digital and printed resources. This suggests a high level of reliance on available material to enable self-directed learning and points to the availability/accessibility of such resources. 77% utilize external trainings and instruction. This suggests a high investment in formal learning opportunities to develop digital skills, showing commitment to structured professional development. 53% participate in coaching or "reverse mentoring" with digital natives. This is quite an interesting finding, underlining the realization of the need to learn from younger generations native to digital technologies. This approach shows readiness to adopt less traditional models of mentorship to bridge the gap in digital skills.

Taken together, the data suggest a multi-dimensional approach to digital literacy development among leaders, including self-directed learning, structured professional development, and innovative mentoring strategies. The high percentages across all three approaches suggest a pervasive and proactive effort to enhance digital capabilities within leadership ranks.

Figure 3. Pillars of digital leadership

7 CONCLUSION

This study explored the challenges associated with leading a digital workforce, emphasizing how traditional approaches to leadership are insufficient in such contexts. The research underlines that leadership should be flexible, collaborative, and supportive, giving full autonomy, intrinsic motivation, and a tolerance for failure. It also builds on the importance of a sound technical understanding, effective communication, and a willingness to change within leadership roles. It also gives recommendations for strategies that might be used to attract and retain technical talent in a hybrid work model, based on competitive compensation, flexible work conditions, opportunities for meaningful work, and positive organizational culture.

Based on the findings, the following recommendations are made: Adopt a flexible leadership style and collaborative: move away from command-and-control models to supportive and empowering, giving a lot of autonomy to technologists to think independently. Give priority to open communication and feedback: clearly establish effective communication channels and foster a culture of open dialogue and constructive feedback.

Strong technical skills within leadership: Make sure leaders are skilled technically enough to understand how to speak to and manage their teams' results. Embrace change through experimentation and innovation, understanding failure as a source of learning and embracing technology change.

Invest in attracting and retaining talent: offer competitive compensation and benefits, flexible work arrangements, and opportunities for professional development. This will attract highly qualified technical professionals and also help retain them. Foster a positive and supportive culture at work. Implementation of the suggestions mentioned above can highly lead to improved leadership in a digital workforce, hence making the organization more productive, innovative, and successful.

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Artificial Intelligence in Digital Marketing

Bahnes Nacera[1], Haddadi Mohamed[2]
[1]Faculty of exact sciences and computer science, university of Abdelhamid Ibn Badis
Mostaganem, Algeria (nacera.bahnes@univ-mosta.dz)
[2]Department of financial sciences and accounting, Faculty of Economics, Business and Management Sciences, University of M'hamed BOUGARA, Boumerdes, Independence Avenue, 35000 Boumerdes, Algeria (m.haddadi@univ-boumerdes.dz)

ABSTRACT

Digital marketing (DM) as a new approach of marketing uses information technology in the process of creating communicating and delivering value to the customer, in a way that favors the business. AI-based DM tools offer advanced capabilities for analyzing a huge quantity of data known as Big Data, which enables audience segmentation, predictive modeling of consumer behaviors, and real-time campaign adjustments. This article delves into the impact of AI on DM, exploring its applications, benefits, challenges and future trends. Although there are several challenges, the advantages of AI present substantial prospects for businesses to refine their marketing operations and attain enhanced success. As AI technologies persist in their advancement, their potential to reshape the DM domain becomes increasingly apparent, giving rise to considerable implications for businesses and their digital outreach strategies.

KEYWORDS: Digital Marketing (DM), Artificial Intelligence (AI), DM tools, Big Data. AI technologies, DM strategies.

1. INTRODUCTION

With the advent of Web 2.0, the field of advertising has changed dramatically where the consumer is becoming a dominant element of marketing, while new technologies are constantly changing the rules with innovative practices using applications and websites. DM is currently one of such marketing strategies in which many companies are dedicating greater investment, especially in the situation of the COVID-19 pandemic, DM played a crucial role in e-commerce of products and services [1].

DM offers a range of benefits including global reach, cost-effectiveness, targeted advertising, measurable results, and enhanced engagement. So, it provides businesses with the tools and capabilities to efficiently reach and engage with their audience, optimize marketing efforts, and achieve better results compared to traditional marketing methods. DM allows marketers to accurately measure the results of their actions [2]. The digital revolution in marketing has brought great challenges for businesses. For example, with the development of social media, companies have lost control of the message that they want to convey to their audience. It has been demonstrated that consumers consult online reviews prior to making a purchase. Furthermore, research indicates that the majority of purchases are influenced by user-generated content. Therefore, users' content on social media motivates and convinces consumers more than advertising. Blogs, forums and other online discussion groups are also important sources of consumer information. However, it is a challenge for companies to maintain a healthy reputation in an environment where social media plays a very important role [3].

On the other hand, AI is quickly changing the world of digital marketing where it allows automation of marketing tasks, generating content, introducing innovative ways to enhance customer engagement, streamline operations and optimize campaign performance [4]. With AI technologies, companies have the ability to analyze big data, recognize patterns, make predictions, and even make decisions with minimal human intervention [5, 6]. AI can be used to examine information from consumer interactions across many channels, including social media, email, and website visits, to spot trends and forecast which marketing messages will be most successful for particular customer segments [7]. With AI-powered tools, the companies can predict future demand for products or services based on historical data, market trends, and consumer behavior, enabling better inventory and marketing planning.

The remainder of this paper is divided as follows: Section 2 gives a brief definition about marketing and its variants. Section 3 illustrates AI, its tools, and AI future for DM, and challenges. Finally, Section 4 provides a brief conclusion.

2. MARKETING

Marketing is a dynamic and strategic process that entails the comprehension and fulfillment of customer requirements through the generation, dissemination, and distribution of valuable offerings. It comprises a multitude of activities with the objective of fostering relationships, facilitating transactions, and attaining organizational success [8]. In this section, we present marketing concepts and DM.

2.1. Key Marketing concepts

Marketing is based on several keys to convince the customer such as [9]:

a) Market Research: The process of gathering and analyzing data about consumers, competitors, and market trends to make informed marketing decisions.
b) Segmentation: Dividing a market into distinct groups of consumers with similar needs or characteristics to target specific segments more effectively.
c) Targeting: Selecting specific segments to focus marketing efforts on based on their attractiveness and alignment with organizational goals.
d) Positioning: Crafting a unique image and value proposition for a product or service in the minds of consumers to differentiate it from competitors.
e) 4Ps of Marketing: Product, Price, Place, and Promotion are the key elements of a marketing strategy used to meet customer needs and achieve business objectives.
f) Digital Marketing: Marketing has been influenced by the widespread use of the Internet, where online platforms and technologies, such as social media, search engines and email, allow companies to reach and interact with the target audience.

2.2 Digital Marketing

The term of DM refers to all marketing activities that take place online. It is a collective term that includes the digital communication and promotion channels that businesses can use to connect with existing and potential customers [10]. The terms internet marketing, e-marketing and online marketing are often used to describe DM, which are very much synonymous.

DM strategies such as social media marketing allows the development of products of the client's preference since the social networking platforms like Facebook and Twitter facilitate research in a more personalized way in order to develop products that necessarily enhance the customer experience. DM offers numerous benefits that make it a vital component of modern business strategies [11].

1. Global Reach: DM allows businesses to reach a global audience without the geographical constraints of traditional marketing. An e-commerce store can attract customers from around the world through targeted online ads and social media.
2. Cost-Effectiveness: Compared to traditional marketing channels like TV, DM often has lower costs and offers better Return On Investment (ROI). Social media advertising and email marketing campaigns can be executed on a smaller budget, especially with platforms offering pay-per-click (PPC) options.
3. Targeted Advertising: DM enables precise targeting based on demographics, interests, behavior and location. For example, Google Ads and Facebook Ads allow businesses to target ads to users who have shown interest in specific products or services.
4. Measurable Results: DM provides detailed analytics and performance metrics, making it easier to measure the effectiveness of campaigns. Google proposes "Google Analytics" that can track website traffic, conversion rates and user behavior, allowing businesses to adjust strategies in real-time.
5. Enhanced Engagement: Digital channels facilitate direct and interactive communication with customers, leading to higher engagement. Existed social media platforms enable real-time interaction through comments, likes and shares, fostering a sense of community and engagement.
6. Personalization: DM allows personalized content and messaging tailored to individual user preferences and behavior. In this axis, Email marketing platforms can send personalized offers based on past purchases and browsing behavior.
7. Flexibility and Agility: DM campaigns can be quickly adjusted or optimized based on performance data and changing market conditions. A company can modify its PPC ad copy or budget allocation based on real-time results to maximize effectiveness.
8. Increased Brand Awareness: Consistent DM efforts can significantly boost brand visibility and recognition across various online channels. Regular content updates on a blog and social media can keep the brand top-of-mind for potential customers.
9. Improved Customer Insights: DM tools provide valuable data about customer behavior, preferences, and interactions. Social media analytics and website tracking can offer insights into what content resonates most with your audience.
10. Scalability: DM strategies can be scaled up or down easily to match business growth and changing objectives. A small business can start with modest online advertising budgets and increase investment as it grows.
11. Better Conversion Rates: Testing different versions of a landing page can identify the most effective design and messaging to increase conversions.
12. Access to Various Channels: DM encompasses a range of channels, including social media, email, search engines, and content marketing, offering multiple touch points for reaching customers. A comprehensive digital strategy might include SEO (Search Engine Optimization), social media posts, email newsletters, and content marketing to engage with customers at different stages of their journey.
13. 24/7 Availability: DM operates around the clock, allowing businesses to reach customers at any time. Automated email campaigns and online ads can be delivered and interacted with at any hour of the day.
14. Competitor Analysis: DM tools can help monitor and analyze competitor activities and strategies. Tools like SEMrush [12] or Ahrefs [13] provide insights into competitors' SEO and paid search strategies.
15. Enhanced Customer Service: DM channels provide platforms for real-time customer service and support. Live chat features on websites or customer service through social media can address customer inquiries quickly.
16. Local Marketing Opportunities: DM allows for targeted local marketing efforts to attract nearby customers. There are tools such as Local SEO and Google My Business listings which can help businesses appear in local search results and attract customers from their immediate area.

3. AI FOR DM

AI involves creating systems that can perform tasks requiring human-like intelligence. These tasks include learning from data, making decisions, and recognizing patterns. In DM, AI leverages algorithms, machine learning and deep learning to analyze vast amounts of data, automate processes, and predict consumer behavior [14]. The application of AI in DM strategy will assist organizations in gaining, growing and maintaining customer loyalty by facilitating a more comprehensive understanding of customer needs and behavior. Actually, AI is reshaping DM by enabling more personalized, efficient, and data-driven strategies. Embracing AI technology can lead to more effective campaigns, improved customer experiences, and better overall performance in the digital landscape [15].

3.1. Benefits of AI in DM

The integration of AI into DM 3strategies has the potential to confer significant advantages to marketers. Currently, AI is undergoing a transformation that will facilitate enhanced productivity, efficiency and increased profitability for organizations. AI-based digital marketing can assure [16, 17]:

- **Adapted Recommendations:** Customers can receive customized recommendations from chatbots and virtual assistants powered by AI based on their interests and prior encounters with a brand.
- **Enhanced Personalization:** AI allows for the creation of highly tailored marketing messages and product suggestions, leading to improved customer engagement and conversion rates.
- **Increased Efficiency:** Automation of repetitive tasks reduces manual effort and errors, freeing up time for strategic planning and creative work.
- **Data-Driven Insights**: AI provides deep insights into customer behavior and market trends, enabling more informed decision-making and strategy development.
- **Real-Time Optimization:** AI can be utilized to optimize marketing efforts in real-time by modifying targeting, content, and ad placements based on consumer behavior and other pertinent data. AI enables real-time adjustments to marketing strategies and campaigns, enhancing responsiveness and performance.
- **Cost Savings:** Automation and improved targeting reduce marketing costs and increase ROI.

3.2. AI tools for digital marketing

Developing AI tools for marketing refer to software and technologies that utilize AI to enhance, automate, and optimize various aspects of DM strategies. These AI tools empower marketers to make data-driven decisions, personalize customer experiences, and streamline marketing operations, ultimately enhancing overall marketing effectiveness and ROI [18]. There are several classes of AI-based tools that are characterized by certain differences in target audience, main objective such as analytics and data prediction, automation of Marketing, Chatbots and customer service, creation of content, targeting, optimization of image and video, personalization, etc [19, 20, 21, 22]. Table 1 summarizes the benefits and use cases of the famous AI-based tools used by companies for the marketing of their products or services. As technology becomes increasingly affordable and accessible, AI technologies will emerge as the most valuable tool for digital marketers. Such techniques will exert a significant influence on customers in their selection of appropriate brands and products.

AI technology applications are set to disrupt the digital marketing environment over the coming decade. Each tool category addresses specific aspects of digital marketing, and many businesses use a combination of these tools to achieve comprehensive and effective marketing strategies.

Table1. AI tools for marketing company products and services.

AI tools class (Example)	Primary Function	Aims	Use Cases	Usage
Analytics and Data Prediction Tools (Google Analytics with AI [23], HubSpot [24])	Analyze and predict data trends and user behavior.	Provides actionable insights, forecasts future trends, and helps in making data-driven decisions.	Tracking user interactions, forecasting marketing performance, and optimizing campaigns based on data trends.	High
Marketing Automation Tools (Mailchimp [25], Marketo [26])	Automate repetitive marketing tasks such as email campaigns and social media posting.	Saves time, increases efficiency, and ensures timely communication with prospects and customers.	Sending personalized emails, scheduling social media posts, and automating lead nurturing workflows.	High
Chatbots and Customer Service Tools (Drift[27], Intercom [28])	Provide real-time interaction and support to users through AI-powered chatbots.	Enhances customer engagement, provides instant responses, and reduces the need for human intervention.	Handling customer queries, qualifying leads, and providing 24/7 support	Moderate
Content Creation Tools(Copy.ai[29], Jasper.ai [30])	Generate marketing content such as blog posts, ads, and social media updates.	Speeds up content creation, maintains consistency, and provides creative suggestions.	Writing blog articles, crafting ad copy, and generating social media posts.	Moderate
Advertising and Targeting Tools (Facebook Ads with AI, Google Ads with AI [31])	Optimize ad campaigns by targeting specific audiences and adjusting bids.	Improves ad relevance, increases ROI, and enhances targeting accuracy.	Managing pay-per-click (PPC) campaigns, optimizing ad spend, and targeting specific demographics.	High
SEO Optimization Tools (Clearscope [32], Surfer SEO [33])	Optimize website content for better search engine rankings.	Improves search engine visibility, provides keyword recommendations, and enhances content relevance.	Keyword research, content optimization, and improving on-page SEO factors.	Moderate
Personalization Tools (Dynamic Yield [34], Optimizely. [35])	Personalize user experiences based on behavior and preferences.	Increases user engagement, boosts conversion rates, and enhances customer satisfaction.	Customizing website content, personalizing product recommendations, and optimizing user experiences.	Moderate
Sentiment Analysis Tools (Brandwatch [36], Lexalytics [37])	Analyze and interpret user sentiment from online sources.	Understand public perception, manage brand reputation, and identify potential issues.	Monitoring social media sentiment, analyzing customer feedback, and managing brand image.	Low
Image and Video Optimization Tools (Canva with AI[38], Adobe Sensei [39])	Create and optimize visual content using AI-powered features.	Enhances visual content creation, provides design suggestions, and automates editing tasks.	Designing marketing graphics, editing photos and videos, and creating visually appealing content.	Low

3.3 Challenges

Nevertheless, further research is required to examine the ethical implications, keeping up with rapid technological changes, data security and other issues associated with the deployment of AI in the context of DM [40, 41].

- **Integration of AI and Automation:** Effectively integrating AI and automation tools into marketing strategies while ensuring they complement human creativity and judgment, misalignment can lead to ineffective use of technology and missed opportunities for optimization. As multiple sources of information give consumers the power of knowledge and comparison, the challenge of competition is greater for businesses. Also, the constant evolution of technology and its entry into the daily lives of consumers has knocked down obstacles

such as geographical borders or time. Consumers now want the information in real time. So, businesses need to be available 24 hours per day, 7 days per week.

- **Data Privacy and Security:** Ensuring compliance with data protection regulations and safeguarding customer information while leveraging AI. Companies must ensure that customer data is handled responsibly and securely. This includes obtaining consent, protecting data, and being transparent about data usage.
- **Ethical Concerns:** Using AI technologies, ethical issues must also be taken into consideration. Addressing ethical issues related to AI, such as transparency and potential biases in decision-making algorithms.
- **Ad Fraud and Bot Traffic:** Ad fraud, including fake clicks and impressions generated by bots, can waste advertising budgets and distort performance metrics (Reduced ROI on ad spend and inaccurate data for decision-making).
- **Keeping Up with Rapid Technological Changes**: Another challenge for companies is the staffing of the DM department with the right professionals, who will know how to manage digital communication and advertising channels, and will be systematically informed about the new possibilities that technology constantly offers; also, they must be able to cope with new trends such as the Internet of Things (IoT). So, the fast-paced evolution of digital tools and platforms requires marketers to stay updated with the latest technologies and trends. Falling behind can result in missed opportunities and outdated strategies.
- **Managing Multi-Channel Strategies:** Coordinating marketing efforts across various channels (social media, email, SEO, PPC, etc.) to ensure a cohesive strategy can be complex with inconsistent messaging and missed opportunities for cross-channel synergies.
- **Content Overload and Differentiation:** With the vast amount of content being produced, standing out and engaging your target audience effectively is increasingly difficult with lower engagement rates and ineffective content marketing.
- **Measuring ROI and Attribution:** Accurately measuring the ROI and attributing conversions to the right marketing channels can be complex and challenging to understand the effectiveness of marketing campaigns and make informed budget decisions.
- **Personalization and Customer Expectations:** Meeting the growing demand for personalized experiences while maintaining scalability and efficiency. Failure to meet customer expectations can lead to decreased engagement and loyalty.
- **Budget Constraints:** Allocating marketing budgets effectively across various channels and initiatives while dealing with constraints. Limited resources can restrict the scope and effectiveness of marketing campaigns.
- **Algorithm Changes and Platform Policies**: Integrating AI tools and technologies can be complex and requires technical expertise and resources. Frequent changes in algorithms and policies by platforms like Google and Facebook can impact visibility and performance. Unpredictable changes can affect traffic, engagement, and overall campaign effectiveness.
- **Skill Shortages and Talent Management:** Finding and retaining skilled digital marketing professionals with expertise in various areas such as SEO, PPC, content marketing, and data analysis. Skill gaps can hinder the execution of effective marketing strategies and innovation.
- **Consumer Behavior Changes:** Rapid shifts in consumer preferences and behaviors require marketers to adapt quickly. They will have outdated strategies and missed opportunities if they do not align with current consumer needs.
- **Competition and Market Saturation:** Increased competition and market saturation in many digital marketing niches make it harder to capture attention and gain market share. Higher costs for customer acquisition and the need for more innovative approaches to stand out.

3.4 The Future of AI in DM

As AI technologies continue to advance, their potential to reshape the DM landscape is becoming ever more apparent, leading to profound implications for businesses and their communication strategies. Therefore, AI in DM promises even greater advancements where AI will have a vital role in the future marketing as it is the most recognized and personalized. Emerging trends include [42-44]:

- **Predictive Analytics:** Using AI to forecast future trends and customer behavior. With deep learning in e-commerce, algorithms could accurately identify future market points.
- **Advanced Personalization:** Enhancing customization with deeper data insights and machine learning.
- **AI-Powered Content Creation:** Automating content generation and creative processes.

To successfully navigate these challenges, it is essential to adopt a strategic approach, engage in continuous learning, and demonstrate adaptability. Those businesses that are able to successfully address these issues will gain a competitive advantage, optimize their marketing efforts, and achieve superior results in the digital landscape.

4 CONCLUSION

DM is a methodology that employs digital platforms to disseminate information about a brand, product, or service online. Consequently, customers have access to new online tools and platforms, such as social media, through which they can express their views on a company's advertising message and share personal experiences of a product or service with other users, thereby influencing potential consumers. DM offers numerous benefits to companies principally due to its capacity to communicate in real time with consumers. During the past years, digital marketing has emerged as a dominant force within the marketing industry.

AI tools utilize a variety of techniques, including algorithms, machine learning, natural language processing, and data analysis, to improve the efficiency, effectiveness, and personalization of marketing endeavors while also reducing the time required for such activities. However, AI-based DM presents a range of challenges that businesses must navigate to succeed in the competitive online landscape.

While there are challenges to be addressed, the benefits of AI offer significant opportunities for businesses to enhance their marketing efforts and achieve greater success. As AI technologies continue to evolve, their capacity to transform the DM landscape becomes increasingly evident, giving rise to significant implications for businesses and their digital outreach strategies.

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Artificial Intelligence as a Key Factor in the Evolution of Digital Marketing Strategies: Applications and Impacts

NESSAH Imene [1] Dahmouni Khelidja [2]
[1] *M'Hamed Bougara University, Boumerdès, Algeria (i.nessah@univ-boumerdes.dz)*
[2] *M'Hamed Bougara University, Boumerdès, Algeria (k.dehmouni@univ-boumerdes.dz)*

ABSTRACT

Artificial Intelligence (AI) is increasingly recognized as a pivotal element in marketing strategies, profoundly influencing our daily interactions more pervasively than is often acknowledged. In the dynamic arena of digital marketing, where shifts occur instantaneously and relevance can yield substantial benefits, AI has become indispensable. This article seeks to comprehensively examine the diverse applications of AI within digital marketing. Its primary objective is to clarify AI's capabilities in identifying, engaging, and delighting customers within the digital domain. AI's integration into digital marketing is long-standing, with its influence on marketers' daily operations growing more salient. As AI technologies advance, their applications are expected to broaden considerably. AI, defined as the simulation of human cognitive processes designed to learn, plan, and solve problems, harnesses data, interactions, and assorted methodologies to perpetually refine and personalize the customer experience, often astounding us with its capacity for seamless adaptation, a stark contrast to typical human endeavors.

Key Words: Artificial Intelligence (AI), Digital Marketing, Digital transformation, machine learning.

1 INTRODUCTION

Recent advancements in technology have markedly influenced various sectors, with artificial intelligence (AI) emerging as a crucial driver across numerous industries. In the realm of digital marketing, AI plays a critical role in augmenting the efficacy of marketing initiatives, enhancing customer engagement, and thereby amplifying marketing efficiency. This paradigm shift opens novel avenues for creativity and innovation in organizational communication with customers.

- **Research Problem:** Amidst the relentless evolution of AI and its expanding implementation in digital marketing, this study delves into how AI technologies and their myriad applications can bolster the effectiveness of digital marketing strategies and enhance customer experiences. Moreover, it probes into the strategies organizations might adopt to maximize the benefits of this technology in their interactions with customers. From this central issue, several subsidiary questions emerge:

_ What exactly is meant by artificial intelligence, and what are its principal varieties?

_ What constitutes Digital Marketing, and what are its core strategies?

_ What are the ethical challenges and considerations associated with AI usage?

Study Objectives:

This study is designed to:

_ Comprehend the fundamental principles of artificial intelligence.

_ Catalog various AI applications and gauge their impact on digital marketing.

_ Illuminate the ethical challenges associated with AI deployment.

- **Research Methodology:** The methodology employed in this study encompasses descriptive and analytical approaches, constructing a theoretical framework through a synthesis of scientific materials pertinent to the subject drawn from a spectrum of international sources.
- **Study Divisions:** To ensure a thorough examination of the study's focal issues, the research is segmented into three principal sections:

_ Theoretical Framework of Artificial Intelligence.

_ Digital Marketing and Digital Transformation in its Strategies.

_ Applications of Artificial Intelligence and Factors Influencing the Effectiveness of Digital Marketing.

_ Ethical Challenges and Considerations in Using AI in Digital Marketing.

2 THEORETICAL FRAMEWORK FOR ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI) is both a scientific discipline and a branch of engineering dedicated to the creation of computer systems that mimic human intellectual processes. This section explores the concept of AI, detailing its types, characteristics, and advantages.

2.1 Concept of Artificial Intelligence

Artificial Intelligence is broadly defined as a suite of theories and methodologies applied to fabricate machines capable of exhibiting human-like intelligence [1]. The term encompasses the application of computers to emulate intelligent behavior with minimal human oversight. Poola elucidates AI as "the endeavor to develop advanced systems that surpass human abilities in various domains [2]." AI is further characterized as behaviors and functionalities of computer programs that mimic human cognitive functions and operational patterns. Its most salient features include the capacity for learning, reasoning, and adapting to novel scenarios without explicit programming [3].

AI is also conceived as "the study and design of intelligent agents," where an intelligent agent is a system that perceives its environment and takes actions maximizing its chances of achieving specific goals [4]. Kevin Warwick defines AI as a technology enabling computers to execute tasks traditionally requiring human intellect [5], such as learning from experiences, speech recognition, comprehending natural language, and decision-making [6]. Moreover, AI involves the capability of programs to undertake certain cognitive tasks autonomously, underpinned by machine learning algorithms and deep learning techniques [7].

Marvin Lee Minsky perceives AI as the craft of creating computer programs that undertake tasks usually performed satisfactorily by humans because they necessitate high-level mental processes such as cognitive learning, memory organization, and critical thinking [8]. From these diverse perspectives, a synthesized definition emerges: Artificial intelligence is a scientific and technical domain focused on developing computer systems that simulate human intelligence and perform tasks generally requiring human cognition. This includes capabilities such as learning from experiences, recognizing patterns, making decisions, and responding to new, unprogrammed situations.

AI systems aim to comprehend their environment and make decisions that optimize their likelihood of success, with minimal direct human intervention. The field also encompasses the creation of advanced technologies like machine learning and deep learning, which empower machines to exceed human capabilities in specific tasks through enhanced performance and adaptability over time.

2.2 Types of Artificial Intelligence

AI involves the development of intelligent entities and can be segmented into various types based on its capabilities and functions. The principal categories include Narrow AI, General AI, and Superintelligent AI, each illustrating the diversity in AI applications across different fields and underscoring the essential distinctions among these types.

2.2.1 Narrow Artificial Intelligence (ANI)

Artificial Narrow Intelligence (ANI), also known as weak AI or narrow AI, is specifically designed to perform a singular or a limited range of tasks within a tightly defined context. ANI processes data at exceptional speeds, significantly enhancing productivity and efficiency across a myriad of practical applications. Notably proficient in tasks such as facial and object recognition within vast databases, ANI enables rapid, data-driven decision-making. Despite its prowess in specialized domains, ANI is limited by its inability to generalize, that is, to apply learned knowledge across varying domains. For example, an ANI system adept in image recognition cannot leverage its expertise for speech recognition tasks, highlighting the ongoing challenge of cross-domain knowledge transfer [9].

2.2.2 General Artificial Intelligence (AGI)

General Artificial Intelligence (AGI), also referred to as strong AI or deep AI, embodies the ambition that AI can fully simulate human intelligence. AGI is distinguished by its potential to learn from and adapt to repetitive tasks, aiding significantly in problem-solving scenarios. In theory, AGI would possess the capability to understand and emulate human thought processes. However, the realization of AGI remains elusive in current research endeavors. For AGI to be successfully implemented, it must demonstrate an ability to acquire comprehensive knowledge and mimic the full spectrum of human capabilities [10].

2.2.3 Artificial Super Intelligence (ASI)

Artificial Super Intelligence (ASI) encompasses cutting-edge models that are currently in experimental stages. These models strive to extensively simulate human cognitive abilities. There are primarily two types of ASI under development. The first type seeks to comprehend human emotions and thought processes that influence behavior, yet it currently has limited capabilities in social interactions. The second type is designed around the 'theory of mind' concept, enabling these systems to articulate their internal states, anticipate the emotions and intentions of others, and interact accordingly. This category represents the vanguard of super-intelligent machines, heralding a potential new era of cognitive technology [11].

2.3 Characteristics of Artificial Intelligence:

Artificial intelligence is characterized by a suite of features that render it invaluable across numerous sectors. Key characteristics include:

- **Machine Learning:** This facet enables machines to autonomously learn from data and enhance their performance over time without being explicitly programmed for each specific task. Techniques such as deep neural networks are utilized to decipher patterns and forecast outcomes [12].
- **Artificial Neural Networks (ANNs):** ANNs empower machines to process and generate human language, supporting applications ranging from machine translation to interactive personal assistants like Siri and Google Assistant [13].
- **Pattern Recognition:** AI systems exhibit the capacity to identify patterns within large datasets, facilitating specific decision-making processes, such as voice or image recognition [14].
- **Artificial Neural Networks:** These are mathematical models that simulate the way the human brain works by using layers of artificial neurons. They are used in applications such as image recognition and text classification [15].
- **Reinforcement Learning:** This approach involves a system learning through a method of rewards for correct decisions and penalties for errors, progressively refining the behavior of the intelligent

agent. This method finds applications in diverse areas, including robotics and electronic gaming [16].

- **Expert Systems:** Relying on a comprehensive knowledge base, these systems are employed for reasoning and decision-making in specialized fields such as medicine and law [17].

2.4 Advantages of Artificial Intelligence

The implementation of artificial intelligence systems delivers myriad benefits across diverse commercial landscapes, highlighted by the following [18]:

- **Reduction of Human Error:** AI tools are instrumental in decreasing errors while enhancing accuracy and efficiency. These systems process decisions based on a comprehensive amalgamation of data and predetermined rules, devoid of emotional influences, thereby rendering their outcomes more consistent and precise.
- **Continuous Operation:** Unlike humans, AI systems do not require breaks or sleep, allowing them to operate around the clock, 24 hours a day, seven days a week. Studies suggest that humans are optimally effective for only about 3 to 4 hours daily, whereas AI systems can function incessantly without fatigue. Furthermore, AI systems process information and execute tasks more rapidly than humans and can manage multiple tasks concurrently with high accuracy. This capability is particularly beneficial for handling repetitive tasks swiftly and effectively, thus boosting productivity.
- **Assistance in Inventions:** AI significantly contributes to innovation across all sectors by aiding in the resolution of complex problems, thereby accelerating the pace of discovery and development.
- **Unaffected by Emotions:** AI operates on a logic-based framework, uninfluenced by the emotional variances that often affect human decision-making. This impartiality ensures that AI decisions are devoid of personal biases, often resulting in more objective and accurate outcomes.
- **Risk Avoidance:** AI systems can undertake tasks that present substantial risks to human operators. For example, AI-driven robots can be deployed for hazardous missions, such as space exploration or deep-sea ventures, performing with precision and safety.

3. DIGITAL MARKETING AND DIGITAL TRANSFORMATION IN ITS STRATEGIES

Digital Marketing represents a transformative approach in the digital era, crucial for enhancing marketing activities through leveraging advanced technologies and the internet to effectively connect with customers. It capitalizes on information technology to craft and execute marketing strategies that maximize effectiveness in customer communications and help achieve organizational objectives.

3.1 Concept of Digital Marketing

In the past few decades, Digital Marketing has revolutionized traditional marketing strategies, aligning them with the contemporary shifts of the digital age. This evolution employs a plethora of advanced tools and modern technologies to conduct marketing operations, especially in areas such as marketing communications, information and communication technology, product presentation, and the execution of marketing transactions through various innovative channels. A prime example is the digital marketing of banking services, which utilizes these tools to reach and engage diverse customer segments. According to Judy Strauss and Raymond Frost, Digital Marketing involves harnessing information technology to enhance marketing activities, including communication processes and the creation and exchange of offers that add value to customers, partners, and the wider community [19]. Digital Marketing also entails the strategic use of the internet and associated digital information and communication technologies to fulfill marketing objectives [20]. Moreover, it is characterized as "the application of data and electronic tools to plan and implement the conception, distribution, and pricing of ideas, goods, and services to facilitate exchanges that meet individual and organizational goals [21]."

Additionally, Digital Marketing is recognized as the process of building and sustaining customer relationships through online activities to support the exchange of ideas, products, and services that align with the goals of both parties involved [22]. It is deemed the most essential method for companies to interact with customers via the internet and other interactive technologies, covering a wide spectrum of IT-related applications with three primary objectives [23]:

- Transform marketing strategies to enhance customer value through more effective segmentation, targeting, and differentiation.
- Plan and execute more efficiently the design, distribution, promotion, and pricing of products, services, and ideas.
- Create exchanges that satisfy both consumer needs and organizational customer goals.

3.2 Digital Marketing Strategies:

Strategy, as understood by strategists, refers to the methods employed to achieve specific objectives, emphasizing how an organization can meet its goals rather than the nature of the goals themselves. The origin of the term "strategy" is notably military, where it might involve a state's goal to win a war by positioning forces in a particular country at a strategic time and place to accomplish a predefined task. Analogously, in the commercial realm, an organization formulates goals to achieve its defined objectives. The Digital Marketing strategy is articulated as a marketing approach that exploits an organization's electronic capabilities to meet specific targets. It represents a synthesis of technological strategy and marketing strategy [24]. Marketers leverage

digital technologies to implement a specific strategy, leading to the formulation:

Digital marketing Strategy = Marketing Strategy + Information Technology

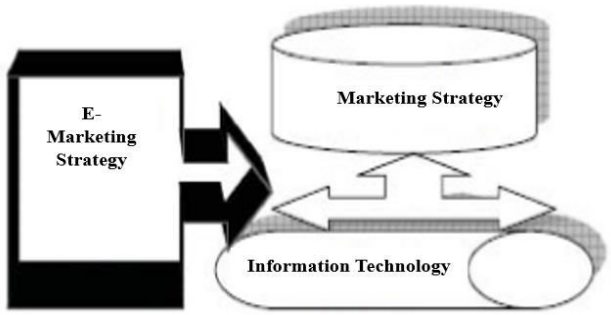

Figure 1 : Digital Marketing Strategy
Source: Mustafa Yousif Kafi, *Digital Marketing in the Light of Technological Changes*, Dar Ruslan, 2010, p 77.

This comprehensive description underscores the integration of digital tools and strategies within the realm of Digital Marketing, highlighting their crucial role in effectively engaging modern consumers and achieving business objectives. Contemporary Digital Marketing strategies are predominantly crafted to attract customers and cultivate mutually beneficial relationships with them and suppliers by enhancing value and fostering loyalty. Digital Marketing strategies have evolved through the integration of the internet and marketing databases to bolster customer relationship management. Irvine Clarke III and Theresa B. Flaherty identify several strategic approaches [25]:

- **Stealth Marketing through Networks:** This strategy involves a wide array of entertainment-related offerings provided by the organization in collaboration with partners and advertisers, establishing a web presence that captivates numerous potential customers. This is achieved through special offers and a rewards system that engages users upon registration and customer identity verification online.
- **Targeted Promotion and Advertising:** Utilizing affiliate marketing strategies and rewarding customer identification, organizations can tailor promotions and advertisements more closely to the actual interests of the customer. This targeted approach ensures that marketing efforts are not only more relevant but also more likely to result in engagement and conversion.
- **Cross-Marketing:** Beyond advertising tailored to customer interests, the integration of customer data with external information enables entertainment organizations to engage in joint marketing initiatives. For instance, an entertainment company might merge online consumer data with offline magazine subscription data to craft special promotional offers for lifestyle-related shows, enhancing the effectiveness of Digital Marketing campaigns.
- **Customer Retention:** The improved integration of the internet with databases allows entertainment organizations to leverage initiatives such as offering discounts on subscriptions to print advertisements, special television and sports shows related to reality TV, holiday promotional offers, and exclusive lifestyle TV programs available to members through the associated Digital Marketing channels. This retention strategy is validated by customer registration data and frequent purchases through online platforms.

4 APPLICATIONS OF AI AND FACTORS INFLUENCING THE EFFECTIVENESS OF DIGITAL MARKETING

AI applications play a pivotal role in augmenting the efficacy of digital marketing strategies. This section will delve into the various factors influenced by AI that are redefining organizational interactions with customers and refining marketing operations.

4.1 Factors Influencing the Use of Artificial Intelligence in Digital Marketing

As technological advancements surge, AI has emerged as a cornerstone in the enhancement and evolution of digital marketing strategies, embodying multiple elements that redefine organizational customer interactions and marketing executions. N.Thilagavathy and E.Praveen Kumar highlight the following factors [26]:

- **Customized Experience:** Customers increasingly value personalized engagements, such as tailored gifts or special offers. It is imperative for organizations to collect detailed customer data and employ AI to analyze behavioral patterns to customize products and services effectively. This personalization fosters a deeper connection and satisfaction among customers.
- **Real-Time Reaction:** AI significantly enhances customer loyalty by offering swift resolutions to their issues. For instance, AI-driven chatbots can deliver instant responses to customer queries, thereby boosting satisfaction and retaining customer interest.
- **Customer Behavior Prediction:** AI excels in predicting the behavior of both current and potential customers by utilizing Data Management Platforms (DMPs) to gather comprehensive user data across the internet, not just from a single site visit. This capability allows organizations to tailor their offerings more precisely to customer needs and target potential customers more strategically, thereby crafting more effective marketing strategies. With ongoing improvements in data collection and analytical techniques, the precision of these predictions improves, enabling organizations to better anticipate sales trends and enhance their Return on Investment (ROI).
- **Increasing the Return on Investment:** AI contributes to improved image recognition quality, which in turn boosts company revenues. AI also plays a crucial role in resolving security concerns and ensuring faster, more efficient payment transactions. Machine learning

technologies identify patterns in user behavior, enabling the creation of customized marketing campaigns. This results in more personalized product and service offerings, saving resources that would otherwise be expended on unengaged customers.

- **Advertising:** Organizations place substantial emphasis on advertising for promoting their products, both in digital and traditional media. This strategy is pivotal as it reduces the need for manual labor. Customer data is particularly invaluable in crafting personalized advertisements. AI tools scrutinize all gathered customer data to discern diverse interests, providing a structured approach that allows organizations to tailor their advertisements. This precision targeting grants organizations a competitive edge, enabling them to position their advertisements more accurately and effectively than their competitors.
- **Search Engine Optimization (SEO):** SEO is the practice of optimizing web pages to achieve the highest possible rankings in search engine results. It involves the application of scientific techniques, including computational algorithms, fuzzy intelligent systems, machine learning technologies, and web crawlers and data analysis. These technologies are employed to parse and comprehend the extensive data collected from the internet, which in turn improves the visibility and ranking of web pages in search engine results.
- **Social Media Marketing:** Research in social media marketing largely focuses on analyzing customer behavior and intentions through data analysis and image understanding, showing gradual advancements in the application of technologies like machine learning and data mining. These technologies are increasingly used across digital marketing to extract and analyze data from diverse sources, including blogs, websites, and e-commerce platforms. The applications of these technologies in marketing include extractive summarization, expert systems, customer decision support systems, text analysis, and predictive analytics, all of which serve to refine marketing strategies and enhance customer engagement.
- **Pay-Per-Click (PPC) and Ad Targeting:** Machine learning is extensively applied in scientific research to optimize bidding strategies and ad targeting through sophisticated ad models. Various criteria are analyzed to determine their impact on the likelihood of clicks and conversions. Machine learning offers new insights and uncovers hidden patterns, significantly improving the effectiveness and efficiency of advertising campaigns.
- **Chatbots:** In the realm of digital marketing methods, research in automated chat systems demonstrates significant potential to enhance marketing effectiveness. There is a robust ongoing research effort across sectors such as healthcare, education, digital consulting, and insurance, aiming to develop interactive simulation software that interacts with humans. This software utilizes AI subfields like decision support systems, neural networks, and autonomous exploration processes. These technologies are crucial in improving customer interactions and providing immediate, sophisticated solutions to inquiries and issues.
- **Semantic Search:** The field of scientific research in semantic search and related technologies has advanced significantly beyond commercial applications. It includes a vast array of scientific publications addressing search engines, information retrieval, global websites, data mining, social networks, the internet, educational algorithms, machine learning, information analysis, natural language processing systems, query processing, information management, decision support systems, user interfaces, web search, and more. Over 2000 scientific publications have detailed the advancements in web technologies and their applications. From web design and development to web applications, web services, mobile-compatible sites, and data representation, artificial intelligence (AI) plays a crucial role in enhancing processes in web development.
- **Voice Search:** Research on voice search within digital marketing remains limited, yet significant strides are being made in other scientific domains. Notably, key studies are focusing on personal voice assistant technologies and speech recognition. These technologies foster a flexible interaction style, allowing the user and the system to function as equal participants, capable of delivering precise and clear responses to web queries.

4.2 Applications of Artificial Intelligence in Digital Marketing

Artificial intelligence significantly amplifies the effectiveness of Digital Marketing through a range of applications:

- **Content Generation:** AI has the capability to create content from scratch based on input data. This technology is invaluable for conserving time and resources. AI systems can autonomously generate reports and news articles based on existing data and information, a practice now employed by major news organizations such as BBC News, The New York Times, and The Washington Post [27].
- **Product Recommendations:** AI-driven product suggestions and recommendations are among the most impactful applications of AI in Digital Marketing. Tailored and dynamic recommendations for online shoppers can significantly boost the conversion rates for the products suggested [28].
- **Content Analysis:** AI is utilized to analyze online customer behavior and deliver customized content based on individual interests. This capability enables companies to provide a personalized and more effective marketing experience [29].
- **Voice Interaction:** AI technologies understand and respond to voice commands, interacting with customers via voice assistants such as Alexa and Google Assistant. This application enhances the shopping experience by making it smoother and more convenient [30].

- **Big Data Analytics:** AI is employed to sift through vast amounts of data to decipher customer behaviors and predict future needs. These insights allow marketers to fine-tune their strategies for optimal results [31].
- **Chatbots:** AI-powered chatbots interact with customers, providing support and facilitating transactions. These tools improve the customer experience by offering immediate and effective responses [32].
- **Dynamic Pricing:** AI employs dynamic pricing techniques to automatically adjust prices based on various factors such as demand, competition, and customer profiles. This strategy helps maximize profits by optimizing pricing in real time [33].
- **Customer Understanding:** AI algorithms analyze real-time discussions about a brand, gauging customer sentiments and feedback. This intelligence enables marketers to adapt their marketing messages based on whether the brand is mentioned in positive, negative, or neutral contexts within chat communities and comments. Using this information, campaigns can be strategically reformed to attract customers more effectively and address product weaknesses [34].

5. Challenges and Ethical Considerations in Using Artificial Intelligence in Digital Marketing

Utilizing artificial intelligence (AI) in digital marketing introduces several challenges and ethical considerations that need careful scrutiny:

- **Privacy and Data Breach:** The extensive collection and analysis of data by AI tools present significant privacy risks. Companies might use this data in ways that consumers find intrusive or unethical, raising ethical questions about transparency and the necessity of securing user consent before data collection and utilization [35].
- **Algorithmic Bias:** AI algorithms can exhibit biases due to the data used in their training or the design of the algorithms themselves. Such biases can lead to unfair or discriminatory outcomes, such as disproportionately targeting certain demographics with specific advertisements based on flawed assumptions [36].
- **Accountability and Responsibility:** Determining who holds responsibility when AI makes an incorrect decision or harms consumers is a critical issue. It is essential to establish clear accountability for the actions made by AI systems, addressing who will be legally and ethically liable [37].
- **Transparency:** There is a need for users to comprehend how AI systems formulate their decisions, particularly in contexts such as recommendations or advertisements they encounter. Enhancing transparency in AI operations is vital for fostering trust among users [38].
- **Cybersecurity:** AI systems are susceptible to cyber threats, which can jeopardize user data security. Ensuring robust protection for these systems and safeguarding the data they process are paramount ethical challenges [39].
- **Consumer Deception:** The application of AI in marketing may result in unintentional or deliberate consumer deception. For instance, algorithms could alter content or advertisements to make them seem more appealing than they truly are, potentially leading to misinformed consumer choices [40].
- **Autonomy and Reduced Human Interaction:** The increasing reliance on automation through AI might diminish human interaction in marketing. This shift could lead to a more impersonal customer experience, where reliance on algorithms overshadows direct human engagement [41].
- **Commercial Exploitation:** AI has the potential to exploit consumers' psychological or emotional vulnerabilities by manipulating their preferences or behaviors. For example, AI can pinpoint moments when consumers are more likely to make impulse purchases and prompt businesses to capitalize on these vulnerabilities [42].
- **Information Misleading:** AI-driven content promotion can contribute to the dissemination of misinformation or false information, especially as intelligent bots that propagate fake news or incorrect content become more prevalent [43].
- **Impact on Competition:** The deployment of AI in marketing can unfairly impact market competition. Larger companies with the resources to invest in AI technologies may gain substantial advantages over smaller entities that lack similar capabilities [44].
- **Impact on Mental Health:** Constant exposure to personalized content through AI might negatively affect mental health. Users may experience pressure or anxiety if targeted by advertisements that highlight sensitive life issues or promote unattainable ideals of beauty or success [45].
- **Loss of Human Control:** As reliance on AI for marketing decisions grows, there might be a diminishing human capacity to oversee these processes. This scenario could lead to an over dependence on intelligent systems that may make choices contrary to human values or ethical standards [46].
- **Economic Exploitation:** AI has the potential to target economically vulnerable groups with special offers and pricing strategies, potentially exacerbating social and economic disparities. Marketers might exploit data analytics to identify demographics more susceptible to economic exploitation, presenting them with exaggerated offers or unfair terms [47].
- **Weakening Trust in Technology:** The unethical use of AI can erode public trust in technology. A lack of transparency regarding how personal data is utilized in decision-making processes can lead to perceptions of omnipresent surveillance, causing discomfort and distrust among users [48].
- **Undermining Creativity:** The reliance on AI for marketing strategies may diminish the need for human creativity. AI systems often prioritize proven ideas over novel or unconventional ones, potentially stifling innovation and discouraging creative risk-taking [49].

- **Emotional Manipulation:** Certain AI applications employ emotional manipulation techniques to sway consumer decisions. These methods, which might leverage content that triggers fear, anxiety, or desire, pose ethical questions about the legitimacy of such strategies in promoting products or services [50].
- **Impact on Human Jobs:** The escalating use of AI in marketing could reduce the demand for human labor, leading to job losses in certain sectors. This trend raises significant concerns about balancing technological advancements with the preservation of employment opportunities |51].
- **Legal Issues:** Marketers utilizing AI are confronted with legal challenges, particularly concerning data protection and privacy rights. As AI technologies continue to advance, existing laws may need to be revised to accommodate new scenarios and ensure robust consumer protection [52].

6 CONCLUSION

Artificial intelligence (AI) significantly shapes the landscape of digital marketing, introducing novel pathways for creativity and innovation in organizational communication with customers. However, the deployment of these technologies demands a thorough comprehension of the associated ethical and legal challenges to ensure that their integration advances human values without compromise.

The application of AI in digital marketing not only enhances strategic operations and transforms customer interactions but also necessitates a careful balance between technological innovation and human interaction. This equilibrium is crucial for achieving sustainable success in the rapidly evolving digital realm.

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Artificial intelligence in digital marketing communication to meet the challenges of sustainable tourism development: Chatbot technology as an example

Noureddine Lamri [1]
[1] *Laboratory of Entrepreneurship, Human Resources Management and Sustainable Development, University of Blida 2, Algeria (n.larmri.etu@univ-blida2.dz)*

ABSTRACT

This study aims to present a vision of chatbots, or as they are called chatbots, which is considered one of the most important outcomes of the Fourth Industrial Revolution as an essential and strategic input to facilitate the performance of tasks and operations related to digital marketing communication, which makes them able to survive and compete in this highly competitive market, as we have tried through This research paper highlights the role of chatbots in facing the challenges of sustainable development in the tourism sector, in addition to presenting some leading international experiences in this field. Through this study, we concluded that chatbots play a pivotal role in developing marketing communication in light of digital trends and modern technology, as it is the first interface that the customer deals with and influences his attitudes and reactions towards the organization. Thus, he works as a modern marketing man and contributes to maintaining resources that can be exploited in more creative and innovative processes in sustainable development in the tourism sector.

KEYWORDS: chatbot, artificial intelligence, tourism, sustainability, marketing communication, digital communication.

1 INTRODUCTION

In recent years, the world has witnessed significant growth in intelligent technologies, especially artificial intelligence, and the resulting modern applications in all sectors. It is a new era. All institutions are heading towards digitalization, which embraces and impacts many times in new and unexpected ways. The tourism sector is not far from following the global path towards digitization and exploiting electronic media to ensure successful communication with customers and marketing tourism services through all available electronic channels with the possibility of continuous innovation accompanied by permanent innovation.

Since the potential of artificial intelligence is limitless, instead of being limited to call centers, artificial intelligence can play a role in many roles in all stages of the institution's activity, from a virtual assistant to a personal shopper for clients, by harnessing data to develop effective marketing strategies.

Tourism was one of the first sectors to digitize business processes on a global scale. This is due to the characteristics of its services, and the possibility of providing some of them via the Internet, where it started providing booking services, Online Flights & Hotels to Become a Leader in the digital field. With the transformation of information and communication technology (ICT) has become a global phenomenon, tourism has been one of the first to adopt new technologies and platforms consistently [1].

This trend towards exploiting the opportunities of technological development and the outcomes of the Fourth Industrial Revolution has affected all aspects of the organization's activity, as chatbot technologies can be a good source for organizations to collect information from current and potential customers. These systems can add value to customer relationship management programs (CRM) by providing valuable insights into consumer behaviors. In addition to that, it will benefit through customer relationship management (CRM) and other automated systems of customer data, including their transaction records, inquiries, and personal preferences…[2], Chatbots are not only a means of communication, but they have also become a tool for contributing to improving marketing communication on the one hand, as well as promoting sustainable efforts on the other hand, by providing information about environmentally friendly practices in the tourism sector, such as sustainable means of transportation, and stay in green housing, in addition to reducing the damage caused by traditional communication processes. Through this study, we will seek to answer an important question:

“ How can a chatbot as an artificial intelligence technology enhance marketing communication and contribute to meeting sustainability challenges in tourism?”

This study is important because it clarifies the fundamental concepts of chatbots, which are considered a modern concept, especially in Algeria, and digital marketing communication in the tourism sector and the extent of their use and benefit from chatbots, which have proven their importance as a strategy followed by the most prosperous countries in the field of tourism. It discusses how chatbots can enhance marketing communication while promoting sustainable tourism development. Additionally, it highlights the importance of international chatbot experiences and the benefits derived from them.

This study aims to achieve the following results: Recognition Of Artificial intelligence and Digital marketing and the aspects that made digital marketing

communication reach great importance in institutions, especially in the sustainable development trends of the tourism sector.

Exposure To some experiences of international institutions Pioneering the use of chatbots in marketing communications in the tourism industry and highlighting Success indicators in exploiting chatbots to improve marketing communication.

Our study included the theoretical background of chatbots as an application of artificial intelligence, their importance in the tourism sector, their contribution to enhancing digital marketing communication, intelligence, and sustainable tourism development, and a presentation of some international companies' experiences.

2 LITERATURE REVIEW

2.1 Digital Marketing Communication

Marketing communication is an important marketing mix element, especially in the service sector. Its importance has increased daily due to its role in all operations and the rapid development of the communication tools that accompany it. It plays a fundamental role in the institution's success, especially with the strength of market competition.

Marketing communication expresses the process of introducing the product, its characteristics, functions, methods of use, and the benefits it provides to the consumer. It also introduces him to the methods of obtaining it and its prices, as well as working to convince and influence him to buy the product. It also represents the organization's methods and tools to promote its products to the target market. In the case of digital marketing communication, the difference from traditional marketing communication is the use of digital media and electronic tools such as computers and the Internet.

2.2 Chatbots and its characteristics:

Chatbot can be defined as "a program that interacts with users using natural language." Currently, chatbots are common in mobile applications and text messaging systems deployed on corporate websites [3].

Chatbots are considered one of the most popular and essential applications. It works to ensure constant contact with customers to meet their growing needs, and it is a program that simulates human conversation; its start was in the search for handling recurring inquiries received by the customer service center. It was then developed to provide more services in the tourism sector, especially reservation and delivery services, cancellation of reservations, and receiving complaints [4].

We can notice that several features characterize chatbot [5], including:

- Their ability to simulate human conversation so that it is difficult to distinguish them from it.
- They are characterized by their ability to learn through the self-learning feature that enables them to learn and develop conversational skills based on their previous experiences and their database of prior conversations.
- They interact with users in the user's natural language, not the machine language, through natural language processes.
- Carrying out various communication processes with users.
- Ability to respond immediately and accurately to user inquiries.
- Interacting with many customers simultaneously and with the same efficiency.

2.3 Sustainable development of tourism:

Sustainable development is a complex and somewhat intertwined concept with many aspects and dimensions. Its definitions are usually divided into four levels: economic, social, environmental, and technological.

- On the economic level, sustainable development for developed countries means reducing energy consumption, while for underdeveloped countries, it means employing resources to raise the standard of living and reduce poverty [5].
- On the social level, it means striving for stable population growth and raising health and educational services, especially in rural areas.
- On the environmental level, it means protecting natural resources and ensuring the optimal use of agricultural land and water resources.
- On the technological level, it means moving society to the era of clean industries, which use environmentally friendly technology, and searching for alternative energy sources such as solar energy and replacing fuel with electrical power. Thus ensuring society's transition to the era of clean industries and technologies that use the least energy and resources and produce the minimum amount of gases, emissions, and pollutants.

The concepts of tourism development referring to the principles of sustainable development began to appear in the international literature on a broader scale in the mid-eighties with the so-called responsible tourism, and it seems that the moment when the discussion about new ways of tourism development began was when the concept of so-called alternative tourism appeared [6].

The World Tourism Organization defines sustainable tourism development as "on the one hand, meeting the current needs of tourists and host areas, and on the other hand, protecting and improving future opportunities. Development requires managing resources to meet economic, social, and aesthetic needs while preserving all cultural features, natural environment features, biodiversity, and life support systems. The guidelines and management practices for sustainable tourism development apply to all forms of tourism in all destinations, including mass tourism and various specialized tourism sectors [1].

According to researchers, the biggest problems facing tourism in achieving sustainability are the instability of customers' needs in the tourism sector and

the continuous development of their preferences. Intelligent technologies can help overcome this problem through their ability to analyze and collect vast amounts of data quickly and efficiently, which has broad implications for other sectors and, thus, sustainable development for all industries. [7].

3 EXAMPLES OF COMPANIES USING CHATBOTS

3.1 Chatbot MC From a hotel chain Marriott:

Marriott's chatbot can search job listings regardless of location, explore available hotels based on specific dates, and present User Suggestions Based on Information from Marriott Jobs, Marriott Careers, Marriott Jobs social media, and Marriott International Hotels. This system helped the Marriott Rewards Program achieve a 97% response rate, earning Facebook's "Highly Responsive" customer service badge.

3.2 Royal Dutch Airlines KLM

KLM Royal Dutch Airlines is an excellent example of how chatbots can be utilized in the hospitality industry. The airline's " BB " chatbot for "BlueBot" streamlines internal operations by providing fast and personalized customer service. BB is available on multilingual Messenger and offers 24/7 real-time assistance for various travel inquiries. Users can book tickets, check baggage information, request refunds, and check flight status.

KLM's chatbot uses conversational AI to improve customer engagement and satisfaction. If needed, it connects users to a live agent and offers emoji routing services for travelers to get directions based on their location via Messenger. Customers can also book flights through Facebook Messenger without agent assistance.

The chatbot allows users to book flights, check statuses, and get personalized travel recommendations on platforms like Facebook Messenger and WhatsApp. It enhances convenience and speed, providing a cost-effective, customized experience. KLM manages bookings more efficiently, and BlueBot has received positive feedback, rating 4.7 out of 5 in the Apple App Store.

3.3 Chatbot of Uber company

Uber is one of the most powerful global companies that has revolutionized the world of transportation. It is an American transportation company that is present on the Internet through its smartphone application. It allows its users to request transportation to any location by directing Uber drivers who use their cars to carry out delivery or trip requests. The services of this company have spread to more than one country around the world, making it the focus of many and a model to be emulated for success in innovative and unprecedented work. Uber has launched an automated chat program to book trips via WhatsApp - the most popular messaging application in the world. Now, you don't have to download the Uber application. Uber will enter your conversations effortlessly and suggest trips and offers to facilitate your movements without hassle. Uber seeks in Horizons 2040 to move hundreds of thousands of driver-partners to use electric transportation through the Green Future program. 80% of Uber Eats restaurant orders in cities across Europe and Asia have been converted from single-use plastics to reusable, recyclable, or compostable packaging options. Additionally, it aims to serve as a zero-emissions transportation platform in the US, Canada, and European cities. By 2040, 100% of Uber Eats restaurant merchants will have moved to global reusable, recyclable, or compostable packaging options and will conduct all rides and deliveries in zero-emission vehicles, micromobility, or public transportation. Uber's chatbot has helped increase sales and improve customer satisfaction.

3.4 Capital One's Eno Chatbot

Banking and financial services are activities that accompany and support the tourism industry. An example is Capital One Financial Corporation, an American banking company and bank specializing in credit cards, car loans, bank accounts, and savings accounts. It was founded in 1994 and is headquartered in McLean, Virginia, USA. It is one of the largest banks in the United States and has a good reputation for focusing on technological development. It was among the top five banks issuing credit cards regarding purchase volume. Capital One launched a chatbot called Eno, which provides customers with real-time information about their account balance, transactions, and credit score. Eno also allows customers to pay bills, check rewards, and monitor their credit usage. Eno uses artificial intelligence to understand customer requests and respond in a conversational tone. The chatbot provides real-time account information, pays bills, and tracks rewards through an AI-powered conversational interface. It also contributes to an improved customer experience, faster problem resolution, and enhanced security with fraud detection. Results of its use:

- Eno is the backbone of Capital One's digital customer interactions.
- Capital One has distributed over $1.2 billion in Paycheck Protection Program loans using digital tools like Eno.

4 RESULTS AND DISCUSSION

Supporting the tourism sector with chatbot technology is considered a priority in formulating its strategies to keep pace with the development of customer needs in line with the digital era and the sustainability of tourism. Everyone agrees that companies should interact with their customers; this is even more important in the tourism industry. Many of these interactions depend on human skills. Still, self-service technologies allow interactions between the company and the customer without human intervention through various modern technological methods, where the customer can obtain services easily and quickly only by using the platforms or

even smart devices available in the institution [8]. These technologies have become capable of simulating human conversations through electronic interfaces on websites or social media messaging applications such as Facebook Messenger or WhatsApp Messenger, enabling them to engage in two-way communications with Internet/mobile users in real-time and with immediate responses. These interactive technologies aim to support customers with their recommendations, assist them with their inquiries, and reduce complaints, as well as provide personal service and improve the quality of electronic service by meeting the customer's expectations of speed of response and efficiency in processing all their requests in real-time, as they can respond to users online. Because they are programmed to recognize texts or data that contain specific keywords and phrases that are usually associated with common consumer issues, and with the current development, they can respond to verbal communication by providing relevant answers and solutions according to the data they receive and also according to the database they own. These chatbots are used to enhance their digital services. They realize that such interactive technologies offer many benefits, including increased efficiency and reduced waiting times for Internet users [2].

Chatbots can communicate with customers by directing their purchasing decisions and improving brand image. In addition, as a quick communication tool between the customer and the brand, chatbots give the organization an advantage over competitors [9], It provides the most enjoyable and interactive way to communicate with customers and thus increases the effectiveness of marketing activities directed directly to them.

A study entitled The Role of Artificial Intelligence on Sustainable Development discussed artificial intelligence's positive and negative effects on sustainable development in its three dimensions: economic, social, and environmental. This study concluded that artificial intelligence helps achieve 79 percent of sustainable development goals through technological improvement. In contrast, some adverse effects are facing the sustainable development goals at a rate of 35 percent from the development of artificial intelligence [10], as shown in figure 1.

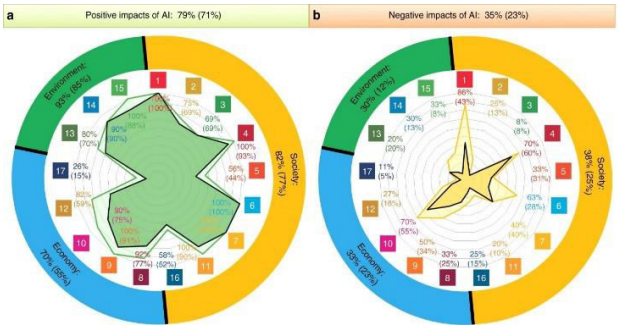

Figure 1: Positive and negative impacts of AI on the Sustainable Development Goals

According to the same study, AI can help achieve sustainable development goals by predicting errors and planning goals more effectively. It can also become a crucial tool for facilitating the circular economy. This economic system aims to eliminate waste, continuously use resources, and build smart cities that use their resources efficiently.

Many researchers have tried to identify successful communication strategies to enhance customers' intention to use tourism services. These and consumer satisfaction can be essential sources in achieving sustainable development. Accordingly, researchers have focused on chatbots, as their characteristics are necessary for estimating customers' tangible value.

There is a study investigating whether the features of service robots can improve customer intentions through perceived benefits, perceived value, and satisfaction. The results of this study suggest that although the restaurant industry is suffering from labor shortages caused by the increase in the minimum wage, in addition to the circumstances accompanying the COVID-19 pandemic, chatbots can be a suitable strategy to gain more customers. Moreover, for the sustainability of the tourism-related service business (the case of restaurants in the study), customers' clear intentions to visit and revisit can be the most critical factor [4].

According to Abd El Kafy et al [11] In their study, most respondents reported several advantages of using AI services, including chatbots, in tourism and hospitality. They found that interacting with AI devices is enjoyable and entertaining. Additionally, AI devices are faster than human employees; provide more accurate services with fewer errors, and offer greater availability and consistency in language diversity compared to human staff. Respondents expressed feelings of satisfaction, hope, and relaxation while using AI devices, and their feedback suggests a strong intention to continue utilizing AI services in the future.

5 CONCLUSION

This study concludes that chatbots are essential in marketing communication, adapting to digital trends and technology as customers' first point of contact. They shape customer perceptions and contribute to resource efficiency, enabling more innovative practices in sustainable tourism. Customers interact with chatbots via various digital platforms to gather information about services, such as hotel room details, pricing, booking methods, and local attractions. Additionally, chatbots promote green initiatives by encouraging environmentally friendly behaviors and guiding customers toward sustainable tourism options. AI-powered chatbots can deliver relevant content and use the right conversational style that makes customers feel listened to and cared for, which in turn can significantly enhance their emotional connection to the brand and create loyalty, which is evident in the immediate response to their inquiries and working to provide everything they need without the need for waiting time, which is one of the most important factors that leads to losing customers to competitors.

Although this technology is still new, it is receiving considerable acceptance from users on the Internet. It improves the user experience, shows high efficiency in improving the user experience and managing orders, and dramatically supports electronic marketing by increasing the number of acquired customers and promoting products and services to target segments.

Chatbots can efficiently collect and analyze customer information during conversations while providing high-quality service, something that's challenging for humans to do simultaneously. By leveraging artificial intelligence, these chatbots enhance their performance in future interactions and better understand customer needs to improve service.

To achieve the Sustainable Development Goals by 2030, a comprehensive change in how governments respond to the growing development challenges is necessary. This requires rethinking the role of governments in the digital age and how they interact with society and the private sector. As developments in artificial intelligence open new horizons in many technologies, AI can improve the achievement of the Sustainable Development Goals. Combining the two can change the way and speed of achieving the Sustainable Development Goals in the shortest possible time.

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The Impact of Data Discretization onAI-Driven Inflation Forecasting: A Case Study of Algeria

CHERFAOUI Yasmine[1] and **FALI Fatima**[2]
University of Sciences and Technology HOUARI BOUMEDIÈNE
([1]*cheryasmine@gmail.com*, [2]*ffali@usthb.dz*)

ABSTRACT

This research investigates the impact of data discretization on the performance of neural network models for inflation forecasting in Algeria. By comparing models trained on discretized monthly data with those using raw data, we explore how data characteristics influence forecasting accuracy. Our findings contribute to the understanding of AI-driven inflation prediction in emerging economies and provide valuable insights for policymakers and researchers in the fields of artificial intelligence and management.

KEYWORDS: Neural network, Inflation, Machine learning, Discretization.

1 INTRODUCTION

1.1 What is inflation?

Inflation is a persistent rise in the general price level of goods and services in an economy. Imagine your favorite basket of groceries costing slightly more each month that's inflation in action. Over time, inflation erodes the purchasing power of money, making it harder to buy the same amountof goods and services with the same amount of money. This can have significant consequences for individuals, businesses, and the overall health of an economy.

1.2 Why is inflation important to predict?

Accurately predicting inflation is crucial for policymakers. Imagine driving a car blindfolded that's akin to formulating economic policies without knowing the future trajectory of inflation. Policymakers rely on inflation forecasts to make informed decisions about interest rates, government spending,and other measures that can influence economic growth and stability.

- **Impact on Individuals:** If inflation is not well-managed, it can disproportionately affect low income households who spend a larger portion of their income on essential goods. Their purchasing power shrinks as prices rise, leading to a decline in living standards.
- **Impact on Businesses:** Businesses need to factor in inflation when making investment decisions and setting prices. Inaccurate forecasts can lead to over investment or under investment, impacting profitability and economic growth.
- **Impact on Government Policies:** Central banks use interest rates asa tool to control inflation. If inflation is underestimated, interest rates might not be raised enough to curb inflation. Conversely, overestimating inflation could lead to unnecessarily high interest rates, slowing economic growth.

Therefore, developing effective methods for inflation forecasting is critical to navigate economic challenges and ensure the well-being of its citizens.

1.3 Why Neural Networks?

In recent years, Recurrent Neural Networks (RNNs) have been widely utilized in various time series analyses, such as predicting stock prices [13], exchange rates [7], and GDP (Gross Domestic Product) [9]. There is also a growing body of work that utilizes neural networks for forecasting inflation. For example, [11] evaluate the effectiveness of neural networks for inflation forecasting using recent U.S. data in a pseudo-out-of-sample forecasting experiment. While, [3] assess the performance of different Artificial Neural Network (ANN) models as forecasting tools for monthly inflation rates in 28 Organization for Economic Cooperation and Development (OECD) countries, showing that neural network models and their combinations outperform the simple AR 1 process in forecasting inflation rates in OECD countries. [6] also explore inflation forecasting in Pakistan using artificial neural networks, and [12] apply two benchmarking methods to model inflation in Russia.

In recent research, [1] demonstrated the effectiveness of a hybrid model combining Autoregressive Fractionally Integrated Moving Average with RNN for accurately modeling inflation rates, highlighting the significance of capturing long-memory patterns in inflation data to enhance forecasting accuracy.

1.4 What are the reasons for discretizing data?

Discretization simplifies complex time series patterns, enabling a more straightforward interpretation of the data. The authors of the paper [10] investigate the relationship between discretization and inflation forecasting, specifically examining howthe contribution of discretization differs between the model state and the forecast-error covariance.

Additionally, the paper [5] focuses on the

implementation of the discretization filter as a simple method for estimating nonlinear state space models. This approach provides valuable insights into the potential benefits and limitations of discretization in modeling and forecasting inflation in the aimto identify unique patterns associated withdifferent economic conditions. Discretization offers several potentialbenefits:

- Improved Model Accuracy: By capturing nonlinear relationships and regime shifts, discretization can enhance the model's ability to accurately predict inflation.
- Enhanced Interpretability: Discretized data can be more interpretable than continuous data, making it easier to understand the model's predictions and the factors influencing inflation.
- Reduced Noise: Discretization can help reduce noise in the data by grouping similar data points together,potentially improving model performance.

This study will investigate the impact of these discretization methods on inflation forecasting using neural networks, comparing their performance to models trained onraw, discretized data.

2 METHODOLOGY

2.1 Data collection and Preprocessing

The dataset utilized in this paper comprises variables sourced from the official web sites of the Algerian national Office of statistics (ONS) and the official web site of Bank of Algeria. The variables selected for analysis in this study are those that do not have any missing values, covering a sample period from January 2002 to mars 2024, consisting of 268 observations.

The main variable used is month-to-month inflation. Month-to-Month Inflation is a key macroeconomic indicator that mea-sures the percentage change in the Consumer Price Index (CPI) from one month to the next. It provides a granular view of price fluctuations, enabling policymakers Disand Analysts to assess the short-term inflationary trends in an economy. It is given by:

$$\pi_t = \frac{CPI_t}{CPI_{t-1}} - 1$$

It provides a snapshot of price changes over a shorter period compared to year-over-year inflation. To ensure compatibility with the neural network model, we proceed with normalizing and scaling the data, taking into account that there are no missing values in our dataset. During the training phase, the neural network learns from the preprocessed data to make accurate predictions. This involves feeding the data into the network, adjusting the model's weights and biases through back-propagation, and optimizing the model's performance using various algorithms such as gradient descent.

2.2 Hyperparameter tuning

Parameter tuning, also known as hyperparameter optimization, is the process of selecting the best values for the hyperparameters of a machine learning algorithm. Hyperparameters are not learned from data, but rather set by the user before training the model. The goal of parameter tuning is to find the optimal combination of hyperparameters that maximizes the performance of the model on unseen data.

The common approach is to split the training data into a training set and a validation set. The training set is used to train the models with different hyperparameter combinations, while the validation set is used to evaluate their performance. By comparing the performance of different models on the validation set, the hyperparameter combination that yields the best performance can be selected. This process helps in improving the accuracy and generalization of the random forest model.

2.3 Neural Networks

RNNs demonstrate exceptional performance in handling historical data over extended periods, making them highly effective in forecasting data from time series (see Figure 1). A comprehensive review and comparison of the different RNN architectures is availablein [4] and [8].

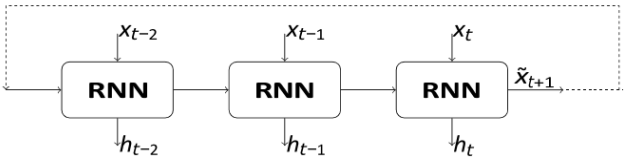

Figure 1: Basic representation of a recurrent neural network.

x_t represents the input vector at time step t, while h_t denotes the hidden state vector at the same time step t.

There are a number of variants of RNNs that have been developed to improve their performance on time series data. These variants include:

a)LSTMs are a type of RNN that have been specifically designed to learn long-term dependencies in data. The Long Short-Term Memory (LSTM) neural network as introduced by [14] is a type of recurrent neural network RNN that is well-suited for modeling sequential data, making it suitable for time series forecasting (see Figure 2). LSTM have a number of features that make them well-suited for time series data, including a gating mechanism that allows them to control the flow of information through the network, a cell state (c_t) that allows them to store long-term information, and output gates (o_t) that allow them to control the output of the network. LSTM networks are trained using back-propagation through time and gradient descent. The weights and biases are

adjusted iteratively to minimize the error between the predicted and actual outputs. The learning process allows the LSTM network to learn the patterns and dependencies in the time series data. LSTM networks are trained to learn the patterns and dependencies in time series data. This allows them to make predictions about future values in the series.

b) GRUs are a simpler variant of LSTMs that have similar performance. A GRU was proposed by [2] to make each recurrent unit to adaptively capture dependencies of different time scales. Similarly to the LSTM unit, the GRU has gating units that modulate the flow of information inside the unit, however, without having a separate memory cells.

The Figure 3 shows the basic structure of a GRU cell. The cell has two main components: a reset gate and an update gate. These gates control the flow of informationinto and out of the hidden state.

- The reset gate r_t determines how much of the previous hidden state h_{t-1} should be forgotten.
- The update gate z_t determines how much of the new information should be added to the hidden state.

GRU cells are also connected in a chain like fashion. thus ,the output of one cell is the input to the next cell. This allows GRU networks to learn long-term dependencies in data.

3 Models

In this paper, multiple models have beenestablished depending on the data used:

- **Model 1**: The first model utilizes only monthly inflation rates;
- **Model 2**: The second model utilizes monthly inflation rates along with the explicative variables (GDP, Government Spending and oil prices);

For the second type of models, the inflation rates were discretized using different methods. Discretization is a process in data analysis and modeling where continuous variables or data are transformed into discrete categories or intervals. It involves dividing the data into distinct groups or bins based on certain criteria or rules. In the context of modeling inflation, discretization is used to categorize the inflation rates into different groups or levels. This allows for the identification of patterns, trends, or specific ranges of inflationwithin the data.

The methods of discretization used include:

- **Binary discretization (Model 1):** In this approach, the inflation rates are categorized as either an increase or a decrease compared to the previous month. Noting π t the month-on-month inflation for the period t and d_t the discretized value associated withthe period t:

$$d_t = \begin{cases} 0 & \text{if } \pi_t > 0 \\ 1 & \text{if } \pi_t \leq 0 \end{cases}$$

- **Standard deviation-based discretization (Model 2):** The infla- tion rates are grouped based on the standard deviation of the series. This method helps identify periods of high or low volatility. Noting σ the standard deviation of the series.

$$d_t = \begin{cases} 0 & \text{if } \pi_t \geq 2\sigma \\ 1 & \text{if } 2\sigma \geq \pi_t > \sigma \\ 2 & \text{if } \sigma \geq \pi_t > 0 \\ 3 & \text{if } 0 \geq \pi_t > -\sigma \\ 4 & \text{if } \pi_t \leq -\sigma \end{cases}$$

- **Mean-based discretization (Model 3):** The inflation rates are categorized based on the mean of the series. This method helps identify periods of above or below average inflation. Noting μ the standard deviation of the series.

$$d_t = \begin{cases} 0 & \text{if } \pi_t \geq 4\mu \\ 1 & \text{if } 4\mu \geq \pi_t > 2\mu \\ 2 & \text{if } 2\mu \geq \pi_t > 0 \\ 3 & \text{if } 0 \geq \pi_t > -2\mu \\ 4 & \text{if } -2\mu \geq \pi_t > -4\mu \\ 5 & \text{if } \pi_t \leq -4\mu \end{cases}$$

- **Quantile-based discretization (Model 4):** The inflation rates are divided into quantiles, allowing for the identification of different ranges or levels of inflation. Noting Q_1 and Q_3 the first and third quantile and M the median of the series.

$$d_t = \begin{cases} 0 & \text{if } \pi_t \geq Q_3 \\ 1 & \text{if } Q_3 \geq \pi_t > M \\ 2 & \text{if } M \geq \pi_t > 0 \\ 3 & \text{if } 0 \geq \pi_t > Q_1 \\ 4 & \text{if } \pi_t \leq Q_1 \end{cases}$$

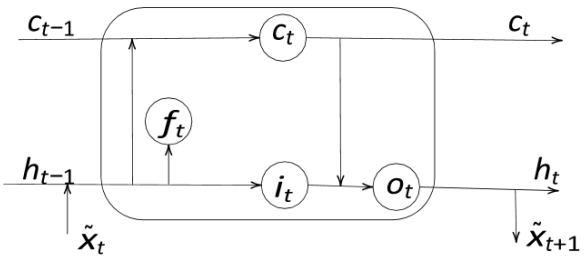

Figure 2: Basic representation of an LSTM cell.

- h_t: is the hidden state at time step t. It contains information from the previous time steps andis used to make predictions or decisions at the current time step.
- c_t: is the cell state at time step t. It acts as a memory that carries information across time steps, allowing the LSTM to maintain long-term dependencies.
- i_t: is the input gate at time step t. It determines how much of the new information from the current input should be added to the cell state.

- o_t: is the output gate at time step t. It controls how much of the cell state should be output as the hidden state for the next time step.
- f_t: is the forget gate at time step t. It decides how much of the previous cell state should beretained or discarded.

4 EVALUATION AND METRICS

Evaluation and metrics are used to assess the performance and quality of machine learning models. The choice of evaluation metric depends on the type of problem being addressed, whether it is a regression (continuous) or classification task. For a regression model, common evaluation metrics include:

- **Mean Absolute Error (MAE):** It measures the average absolute difference between the predicted and actual values. It is less sensitive to outliers compared to MSE.

$$MSE = \frac{1}{n}\sum_{t=1}^{n}(\pi_t - \hat{\pi}_t)^2 \qquad (1)$$

Where

n: Number of observations.

π_t: Actual value for the t-th observation.

$\hat{\pi}_t$: Predicted value for the t-th observation.

- **Mean Squared Error (MSE):** It calculates the average squared differ ence between the predicted and actual values. Smaller values indicate better performance.

$$MAE = \frac{1}{n}\sum_{t=1}^{n}|\pi_i - \hat{\pi}_i| \qquad (2)$$

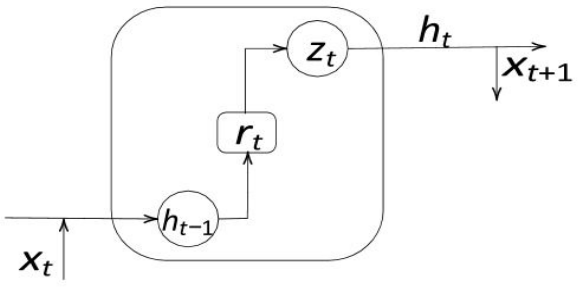

Figure 3: Basic representation of an GRU cell

- x_t: is the input vector at time step t. It contains the features or data that the GRU cell will process at that specific time.
- h_t: is the hidden state vector at time step t. It represents the output of the GRU cell at that time step and carries information from previous time steps, allowing the model to maintain context.
- z_t: is the update gate at time step t. The update gate determines how much of the previous hidden state h_{t-1} should be retained and how much of the new candidate hidden state should be incorporated into the current hidden state h_t.
- r_t: is the reset gate at time step t. The reset gate controls how much of the past information (from the previous hidden state h_{t-1}) should be forgotten when calculating the new candidate hidden state.

- **R-squared (R^2) or Coefficient of Determination:** It indicates the proportion of the variance in the dependent variable that can be explained by the independent variables. A value close to 1 indicates a good fit.

$$R^2 = 1 - \frac{\sum_{t=1}^{n}(\pi_i - \hat{\pi}_t)^2}{\sum_{t=1}^{n}(\pi_i - \bar{\pi})^2} \qquad (3)$$

For classification models, MSE and MAEcan be used along with:

a) Accuracy: It measures the proportion of correctly classified instances out of the total number of instances. It is suitable when the classes are balanced.

$$\frac{TP + TN}{TP + TN + FP + FN} \qquad (4)$$

Where

TP: True Positives (correctly classified positive cases).

TN: True Negatives (correctly classified negative cases).

FP: False Positives (incorrectly classified positive cases).

FN: False Negatives (incorrectly classified negative cases).

b) Precision: It measures the proportion of true positives out of all predicted positives. It focuses on the correctness of positive predictions.

$$\frac{TP}{TP + FP} \qquad (5)$$

c) Recall (Sensitivity or True Positive Rate): It measures the proportion of true positives out of all actual positives. It focuses on capturing all positive instances.

$$\frac{TP}{TP + FN} \qquad (6)$$

d) F1-score: It is the harmonic mean of precision and recall, providing a balanced measure of the model's performance.

$$\frac{Precision \cdot Recall}{Precision + Recall} \qquad (7)$$

When tuning the parameters of a NN model, it is essential to choose an appropriate evaluation metric based on the problem type (regression or classification) and the specific goals of the model. The selection of the evaluation metric guides the optimization process by indicating the direction of improvement and allowing the comparison of different parameter configurations.

5 Results analysis

The results are reported in Table 1:

- **Continuous Models:** These models generally outperform discretized models in terms of accuracy and predictive power, as indicated by lower MSE and MAE values and higher R-squared.
- **Discretized Models:** While less accurate, discretized models can offer valuable insights into the underlying patterns and relationships in the data. The choice of discretization method (e.g., equal-width, equal-frequency, or quantile-based) can significantly im- pact performance.
- **LSTM vs. GRU:** GRU models often outperform LSTM models, especially in terms of computational efficiency. However, LSTM models can be more powerful when dealing with long term dependencies.
- **Impact of Explanatory Variables:** Incorporating additional explanatory variables can improve the performance of both continuous and discretized models, particularly for LSTM models.

Table 1: Comparison of Continuous and Discretized Models (LSTM

Model	Type	Classes	Method	MSE	MAE	R^2	Accuracy	Precision	Recall	F1-score
Continuous Models										
Continuous - LSTM	Cont.	N/A	N/A	0.20	0.15	0.78	-	-	-	-
Continuous - GRU	Cont.	N/A	N/A	0.18	0.14	0.82	-	-	-	-
Discretized Models (Classification)										
Model 1 - LSTM	Discretized	2	Inc/Dec	0.22	0.16	0.75	0.88	0.85	0.87	0.86
Model 1 - GRU	Discretized	2	Inc/Dec	0.20	0.15	0.78	0.90	0.88	0.89	0.88
Model 2 - LSTM	Discretized	5	Std. Dev	0.50	0.35	0.50	0.52	0.50	0.51	0.50
Model 2 - GRU	Discretized	5	Std. Dev	0.48	0.33	0.55	0.55	0.53	0.54	0.53
Model 3 - LSTM	Discretized	6	Mean	0.38	0.28	0.65	0.60	0.58	0.59	0.58
Model 3 - GRU	Discretized	6	Mean	0.36	0.26	0.68	0.62	0.60	0.61	0.60
Model 4 - LSTM	Discretized	5	Quantile	0.55	0.40	0.45	0.48	0.45	0.47	0.46
Model 4 - GRU	Discretized	5	Quantile	0.52	0.38	0.48	0.50	0.48	0.49	0.48

6 CONCLUSION

In conclusion, the choice between classification and continuous variable models ultimately hinges on the specific goals of the task at hand. Incorporating additional relevant features consistently enhances predictive capabilities, while continuous improvement demands exploring further features, refining discretization methods, and venturing into alternative machine learning algorithms.

Overall, discretization offers a promising avenue for improving forecasting by capturing nonlinear relationships and regime shifts. Future research could delve deeper into the impact of explanatory variables on inflation forecasting. Analyzing feature importance, experimenting with different variable combinations, and considering the potential for nonlinear relationships between variables could provide valuable insights. Also, developing customized discretization methods tailored to specific economic contexts and data characteristics could further enhance forecasting accuracy. Exploring techniques that incorporate domain knowledge or utilize advanced clustering algorithms could be fruitful.

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Harnessing artificial intelligence for enhanced digital marketing strategies: A data-driven approach

TIMIZARD Ahmed [1], GACEB Hocine [2], *BENATTALAH Sabrina*[3]
[1] *University of mhamed bougarra, Boumerdes, algeria (h.gaceb@univ-boumerdes.dz)*
[2] *University of mhamed bougarra, Boumerdes, algeria (a.timizard@univ-boumerdes.dz)*
[3] *University algeries3, algeries, algeria (a.timizard@univ-alger3.dz)*

ABSTRACT

The study sheds light on the metamorphic role of artificial intelligence (AI) in the field of digital marketing, addressing its applications in enhancing customer engagement and improving operational efficiency. In order to examine the contemporary trends and challenges in regards to the implementation of AI, a descriptive analytical methodology is employed. The findings showcase that artificial intelligence has the greatly bolsters marketing strategies in that it offers personalized experiences and data-driven insights. It additionally highlights the ethical challenges and data privacy issues that must be taken into consideration to ensure sustainable growth and maintain customer trust.

KEYWORDS: artificial intelligence, digital marketing, data-driven, emerging technologies, personalization

1 INTRODUCTION

The integration of artificial intelligence (AI) has emerged as a transformative force to be reckoned with in the rapidly evolving landscape of digital marketing. As businesses strive to capture the attention of increasingly discerning consumers, traditional marketing strategies are no longer sufficient. AI technologies offer innovative solutions that enhance targeting, personalization, and customer engagement, dramatically altering the connections that brands have with their audiences. This presentation strives to explore the pivotal role of AI in shaping digital marketing strategies, emphasizing the significance of a data-driven approach. By examining current trends, effective tools, and real-world applications, we will highlight how harnessing AI can empower businesses to optimize their marketing efforts and yield successful outcomes in today's competitive environment.

The main problematic of this study focuses on how artificial intelligence can be leveraged to enhance digital marketing strategies through a data-driven approach. The rise of AI technology offers unique opportunities for businesses to personalize their marketing efforts, predict consumer behaviour, and optimize strategies based on data. This study aims to explore these possibilities and provide insight into how AI can revolutionize digital marketing practices.

To break down the main issue, this study explores several sub-questions. First, it seeks to identify the most effective artificial intelligence techniques and tools that can improve digital marketing strategies. Second, the research addresses the ethical and practical challenges associated with using AI in digital marketing, aiming to find solutions for overcoming these hurdles.

The hypotheses of this study suggest that AI can significantly enhance the effectiveness of digital marketing strategies. The first hypothesis posits that the use of AI techniques, such as predictive analytics and personalization, will increase the effectiveness of marketing strategies by improving the customer experience and boosting conversion rates. The second hypothesis acknowledges the ethical and practical challenges that companies face when implementing AI in marketing. It suggests that these challenges can be addressed through responsible practices and ongoing data monitoring, thereby maximizing the benefits of AI for businesses.

The importance of this study lies in its exploration of the transformative potential of artificial intelligence in digital marketing. As businesses strive to stay competitive in an increasingly digital world, AI offers a critical advantage by enabling more personalized, data-driven marketing efforts. This research delves into the opportunities that AI presents, as well as the challenges it brings, providing valuable insights for marketers, businesses, and researchers looking to harness AI for effective marketing strategies.

The objectives of the study are multi-faceted. First, the study aims to analyse the role of AI in digital marketing by examining various AI techniques and tools that businesses can use to improve their marketing efforts. Second, it seeks to evaluate the importance of data-driven decision-making, investigating how AI can optimize data usage to shape better marketing strategies. Third, the study aims to identify the ethical and practical challenges associated with the implementation of AI in digital marketing. Fourth, the research will explore emerging trends in AI and their potential impact on the future of digital marketing. Finally, the study will provide actionable recommendations for businesses looking to integrate AI into their marketing strategies effectively.

To achieve these objectives, a mixed-methods approach is used in this study. A comprehensive literature review is conducted to establish a theoretical framework for AI applications in digital marketing. Quantitative data will be collected through surveys distributed to marketing

professionals to understand the current use of AI, its perceived benefits, and challenges. Case studies will be analyzed to highlight successful implementations of AI-driven marketing strategies. In-depth interviews with industry experts will offer qualitative insights into the practical applications and future directions of AI in digital marketing. Statistical analysis of the survey results will ensure that the study delivers robust and relevant findings for contemporary marketing practices.

The first study, The Impact of Artificial Intelligence on Digital Marketing Strategies [1], aimed to explore the effects of AI technologies on the effectiveness of digital marketing strategies. It examined various AI applications, such as chatbots, predictive analytics, and personalization, and how they enhance customer engagement. The study used a mixed-methods approach, incorporating surveys of marketing professionals and case studies of successful AI implementations. The results demonstrated that AI significantly improved customer engagement and conversion rates, emphasizing the importance of data-driven decision-making in achieving successful marketing outcomes. While this study broadly focuses on AI applications in marketing, the current study offers a more targeted analysis by specifically investigating the role of data-driven AI in enhancing digital marketing strategies.

The second study, Challenges and Opportunities of Artificial Intelligence in Digital Marketing [2], aimed to identify the challenges and opportunities presented by AI in the digital marketing space. It addressed ethical issues, data privacy concerns, and the need for responsible AI usage. This research used qualitative interviews with industry experts and content analysis of existing literature. The findings revealed that while AI offers substantial benefits, significant ethical challenges need to be addressed to ensure its responsible implementation. Unlike this study, which concentrates on the challenges of AI adoption, the current research places more emphasis on the practical applications and benefits of AI in digital marketing, particularly from a data-driven perspective.

The third study, Leveraging Big Data and Artificial Intelligence in Digital Marketing [3], sought to analyse how the combination of big data and AI can transform marketing strategies. It explored several case studies where businesses successfully integrated big data analytics and AI in their marketing campaigns. Using a case study approach, the research concluded that the integration of big data with AI enhances decision-making processes and leads to more effective marketing strategies. In contrast to this study, which focuses on the relationship between big data and AI, the current research specifically highlights how AI, informed by data, can enhance digital marketing strategies, providing a distinct focus on the data-driven aspects of AI.

These previous studies offer valuable insights into the applications and implications of artificial intelligence in digital marketing. However, the current study distinguishes itself by concentrating specifically on the data-driven approach to leveraging AI for enhancing marketing strategies, an area that has not been the primary focus of previous research.

2 THE ROLE OF AI IN DIGITAL MARKETING

In today's fast-paced digital landscape, businesses are increasingly turning to innovative technologies to gain a competitive edge. Artificial Intelligence (AI) has emerged as a transformative force in the marketing sector, enabling companies to analyse vast amounts of data, personalize customer experiences, and automate marketing tasks. As organizations seek to adapt to evolving consumer behaviours and preferences, understanding the role of AI in digital marketing becomes essential for developing effective strategies that enhance engagement and drive growth. This section will define AI and its key components in marketing and explore the current trends and statistics related to its adoption in the industry.

2.1 Definition and Key Components of AI in Marketing

Artificial intelligence (AI) refers to the simulation of human intelligence processes by computer systems, which includes learning, reasoning, and self-correction [4]. In the context of digital marketing, AI encompasses various technologies and tools that automate tasks, analyse consumer data, and enhance decision-making processes. Key components of AI in marketing include machine learning, natural language processing, chatbots, predictive analytics, and personalization algorithms. These components allow businesses to understand consumer behavior better, create targeted marketing campaigns, and improve customer engagement by delivering personalized experiences [2].

2.2 Current Trends and Statistics on AI Adoption in the Marketing Sector

The adoption of AI in marketing is rapidly increasing as businesses recognize its potential to enhance efficiency and effectiveness. According to a report by Sales force (2023), 84% of marketing leaders indicated that AI is essential for their success, with 57% already using AI in their marketing strategies. Furthermore, in 2024, 70% of marketing organizations will leverage AI to enhance customer engagement, improve operational efficiency, and optimize marketing strategies [5].

In terms of financial impact, a study by McKinsey (2021) revealed that companies employing AI in their marketing efforts have seen a 10-20% increase in revenue, highlighting the significant return on investment (ROI) that AI-driven marketing can yield [6]. Additionally, businesses that utilize AI for personalized marketing experiences report 5 to 8 times higher ROI on their marketing expenditures [7].

The integration of artificial intelligence in digital marketing is redefining how businesses operate in an

increasingly competitive environment. With its ability to analyse vast amounts of data, predict consumer behaviour, and automate marketing processes, AI offers a powerful tool for enhancing marketing strategies and achieving higher customer satisfaction. As the adoption of AI continues to rise, businesses that leverage these technologies are likely to see substantial improvements in their marketing effectiveness and overall financial performance.

3 DATA-DRIVEN DECISION MAKING

In the era of digital transformation, data has become a vital asset for businesses seeking to enhance their marketing strategies. Data-driven decision making involves leveraging data analytics and insights to inform and optimize marketing initiatives. This approach allows organizations to understand their customers better, anticipate market trends, and tailor their marketing efforts for maximum impact. This section will discuss the importance of data in shaping marketing strategies, the various types of data utilized in AI-driven marketing, and examples of successful data-driven campaigns.

3.1 Importance of Data in Shaping Marketing Strategies

Data plays a crucial role in shaping effective marketing strategies by providing insights into consumer behaviour, preferences, and trends. Companies that leverage data-driven strategies are six times more likely to be profitable year-over-year compared to those that do not [8]. By analysing data, marketers can identify target audiences, segment their market, and develop personalized campaigns that resonate with customers. Additionally, data helps organizations measure the effectiveness of their marketing efforts, allowing for real-time adjustments and improvements [9].

3.2 Types of Data Utilized in AI-Driven Marketing

AI-driven marketing relies on various types of data to optimize campaigns and enhance customer experiences. Key types of data include:

a) Customer Behaviour Data: This includes data collected from customer interactions with digital platforms, such as website visits, clicks, and purchase history. Analysing this data allows marketers to understand customer preferences and predict future behaviour [10];

b) Market Trends Data: This encompasses information about overall market performance, industry trends, and competitor analysis. By understanding market dynamics, businesses can adjust their marketing strategies to align with current trends and consumer demands [7];

c) Demographic Data: This involves data related to the characteristics of customers, such as age, gender, location, and income levels. Demographic insights help marketers tailor their messaging and target specific audience segments effectively [1] .

3.3 Examples of Successful Data-Driven Campaigns Using AI

Several companies have successfully implemented data-driven campaigns utilizing AI technologies. For instance:

- Netflix: The streaming giant uses AI algorithms to analyse viewer behaviour and preferences. By leveraging this data, Netflix delivers personalized content recommendations, resulting in increased viewer engagement and retention [7];
- Coca-Cola: The company employs AI-driven analytics to track consumer sentiment on social media and adjust its marketing campaigns accordingly. This data-driven approach has allowed Coca-Cola to create targeted advertisements that resonate with their audience, leading to a significant increase in brand engagement [9];
- Amazon: By analysing customer purchasing patterns and browsing history, Amazon uses AI to optimize its product recommendations and marketing strategies. This personalization has contributed to a substantial increase in sales and customer satisfaction [10].

Data-driven decision making is essential for developing effective marketing strategies in today's competitive landscape. By leveraging various types of data, businesses can gain valuable insights into consumer behaviour and market trends, allowing for the creation of tailored marketing campaigns. The successful implementation of data-driven strategies, as demonstrated by leading companies like Netflix, Coca-Cola, and Amazon, underscores the importance of utilizing AI and data analytics to enhance marketing effectiveness and drive business growth.

4 AI TECHNIQUES AND TOOLS IN DIGITAL MARKETING

4.1 Overview of AI Tools and Technologies

a) Chatbots: Chatbots are AI-powered virtual assistants that can interact with customers in real time through messaging platforms. They are designed to answer queries, provide product recommendations, and assist in transactions, thus enhancing customer engagement and satisfaction [2]. Chatbots can operate 24/7, enabling businesses to provide continuous support and streamline communication;

b) Predictive Analytics: Predictive analytics utilizes historical data, statistical algorithms, and machine learning techniques to identify the likelihood of future outcomes. In marketing, this tool helps businesses forecast customer behaviour, optimize marketing campaigns, and improve targeting [7]. By analysing data patterns, marketers can make informed decisions and allocate resources more efficiently;

c) Machine Learning: Machine learning is a subset of AI that focuses on developing algorithms that allow computers to learn from data and improve their performance over time without explicit programming. In

digital marketing, machine learning algorithms can analyze vast datasets to identify trends, optimize ad placements, and enhance personalization [1]. This technology enables marketers to create more relevant and effective marketing strategies.

4.2 Case Studies Demonstrating the Application of These Tools

- Sephora: The beauty retailer utilizes AI-powered chatbots to enhance customer engagement on its website and mobile app. These chatbots provide personalized product recommendations based on customer preferences and past purchases, significantly improving the shopping experience. As a result, Sephora reported a 10% increase in online sales attributed to chatbot interactions [9];
- Netflix: Netflix employs predictive analytics to analyse viewer data and predict what content users are likely to enjoy. By utilizing machine learning algorithms, the platform tailors its recommendations and marketing strategies, leading to a 75% increase in viewer engagement. This data-driven approach has been crucial in retaining subscribers and reducing churn rates [7];
- Coca-Cola: Coca-Cola has implemented machine learning tools to analyse consumer sentiment on social media and optimize its marketing campaigns accordingly. By leveraging predictive analytics, Coca-Cola can anticipate consumer trends and adjust its messaging in real time. This strategy has resulted in a 20% increase in campaign effectiveness and higher brand engagement [2].

AI techniques and tools have become indispensable in the realm of digital marketing, enabling businesses to enhance customer engagement, optimize campaigns, and drive better results. With the implementation of chatbots, predictive analytics, and machine learning, organizations can gain valuable insights into consumer behaviour and preferences, leading to more effective marketing strategies. The success of companies like Sephora, Netflix, and Coca-Cola in leveraging AI technologies demonstrates the potential of these tools to transform marketing efforts and achieve significant business outcomes.

5 CHALLENGES AND ETHICAL CONSIDERATIONS

While the integration of Artificial Intelligence (AI) into digital marketing offers significant advantages, it also presents a range of challenges and ethical considerations that must be addressed. As businesses increasingly rely on AI technologies to optimize their marketing strategies, concerns related to data privacy, algorithmic bias, and responsible AI usage become paramount. This section will discuss the potential challenges of implementing AI in digital marketing and the ethical considerations that necessitate responsible practices.

5.1 Discussion of Potential Challenges in Implementing AI in Digital Marketing

- Data Privacy: One of the most pressing challenges in AI-driven digital marketing is ensuring the privacy and security of customer data. As marketers collect vast amounts of personal information to tailor their campaigns, there is a growing risk of data breaches and misuse of sensitive information. According to a report by the International Association of Privacy Professionals 79% of consumer's express concern over how their data is used by companies [11]. This skepticism can lead to a lack of trust, adversely affecting customer relationships and brand reputation;
- Bias in AI Algorithms: Another significant challenge is the potential for bias in AI algorithms. If the data used to train AI systems is biased, the resulting algorithms may perpetuate existing inequalities or stereotypes in marketing practices. For example, an AI system that learns from historical data may inadvertently favour certain demographics over others, leading to unfair targeting and exclusion [12]. Addressing algorithmic bias is crucial to ensure equitable marketing practices and maintain customer trust.

5.2 Ethical Considerations and the Need for Responsible AI Usage

The ethical implications of AI in digital marketing necessitate a framework for responsible usage. Key ethical considerations include:

- Transparency: Marketers must be transparent about how they use AI technologies and data. Providing customers with clear information about data collection practices and the purpose of AI applications fosters trust and encourages engagement. According to a survey by Accenture 83% of consumers prefer companies that are transparent about their data practices [13];
- Accountability: Organizations must take responsibility for the outcomes of their AI systems. Establishing accountability measures ensures that businesses are held liable for any negative consequences arising from biased algorithms or data breaches. Implementing governance frameworks that outline ethical guidelines for AI usage can help mitigate risks and promote responsible practices [14];
- Fairness: Ensuring fairness in AI-driven marketing involves actively working to eliminate biases in data and algorithms. Businesses should conduct regular audits of their AI systems to identify and address any biases that may arise. Additionally, incorporating diverse perspectives in AI development teams can contribute to more equitable outcomes [15].

The challenges and ethical considerations associated with implementing AI in digital marketing highlight the need for responsible practices. By addressing issues such as data privacy, algorithmic bias, and accountability, businesses can harness the power of AI while fostering customer trust and promoting fairness. Establishing ethical guidelines and transparency in AI

usage will be crucial for ensuring that the benefits of AI in digital marketing are realized without compromising ethical standards.

6 FUTURE TRENDS IN AI AND DIGITAL MARKETING

The landscape of digital marketing is rapidly evolving, driven by advancements in Artificial Intelligence (AI) and emerging technologies. As businesses continue to integrate AI into their marketing strategies, it is essential to explore future trends that will shape the industry. This section will provide predictions for the future integration of AI in marketing strategies and examine emerging technologies that are poised to impact digital marketing significantly.

6.1 Predictions for the Future Integration of AI in Marketing Strategies

1. Increased Personalization: One of the most significant trends in the future of AI in digital marketing is the move toward hyper-personalization. With the growing availability of consumer data, marketers will leverage AI algorithms to create highly tailored marketing experiences for individual customers. By analyzing behavior patterns and preferences, businesses can deliver personalized content, product recommendations, and offers that resonate with consumers on a deeper level [1] . This shift is expected to enhance customer engagement and loyalty;
2. Enhanced Customer Experience through AI: AI will continue to play a crucial role in improving customer experience across various touchpoints. As chatbots and virtual assistants become more sophisticated, they will provide seamless interactions with customers, answering inquiries and resolving issues in real-time. Moreover, AI-driven predictive analytics will enable marketers to anticipate customer needs and preferences, facilitating proactive engagement [10]. This trend will result in higher customer satisfaction and retention rates;
3. Integration of Voice Search and Conversational Marketing: The rise of voice-activated devices and smart speakers is transforming how consumers search for information and interact with brands. Future marketing strategies will increasingly incorporate voice search optimization and conversational marketing, enabling businesses to connect with customers in a more natural and intuitive manner. By utilizing AI-powered voice recognition technology, marketers can engage users through voice-activated content and personalized recommendations [16].

6.2 Emerging Technologies and Their Potential Impact on Digital Marketing

1. Augmented Reality (AR) and Virtual Reality (VR): AR and VR technologies are expected to revolutionize digital marketing by providing immersive and interactive experiences for consumers. Brands can leverage these technologies to create engaging product demonstrations, virtual try-ons, and immersive storytelling that enhances brand perception and drives conversions [17]. As AR and VR become more accessible, marketers will find innovative ways to integrate these tools into their campaigns;
2. Blockchain Technology: Blockchain technology has the potential to transform data security and transparency in digital marketing. By providing a decentralized and tamper-proof record of transactions, blockchain can enhance consumer trust and protect data privacy. Marketers can utilize blockchain to verify the authenticity of customer data, combat ad fraud, and improve the overall transparency of their marketing efforts [18]. This technology will be particularly relevant as consumers become increasingly concerned about data privacy and security;
3. 5G Technology: The rollout of 5G networks will significantly impact digital marketing by enabling faster data transmission and more reliable connectivity. This advancement will facilitate the use of rich media content, such as high-quality videos and live streaming, in marketing campaigns. As a result, businesses will be able to deliver more engaging and dynamic experiences to consumers, enhancing brand interactions and increasing conversion rates [19].

The future of AI in digital marketing is bright, with numerous trends and emerging technologies poised to reshape the industry. The integration of AI will lead to enhanced personalization, improved customer experiences, and innovative marketing strategies that leverage voice search, AR, VR, blockchain, and 5G technologies. By staying ahead of these trends, businesses can position themselves for success in the ever-evolving digital marketing landscape.

7 CONCLUSION

In this discussion, we explored the multifaceted role of Artificial Intelligence (AI) in digital marketing, highlighting several key areas: the definition and components of AI in marketing, the significance of data-driven decision-making, the tools and techniques employed in AI-driven marketing, and the challenges and ethical considerations associated with AI integration. Additionally, we examined future trends, including increased personalization, enhanced customer experiences, and the impact of emerging technologies such as augmented reality, blockchain, and 5G.

AI's ability to analyse vast amounts of data and identify patterns allows marketers to tailor their strategies to meet consumer needs more effectively. This leads to improved customer engagement, loyalty, and satisfaction. However, as we integrate AI into our marketing efforts, it is essential to remain mindful of the ethical implications and potential biases that may arise from AI technologies.

Harnessing AI is not just about adopting new tools; it is about rethinking how we connect with customers and deliver value in a rapidly evolving digital landscape. As businesses continue to innovate and adapt to changing market dynamics, the importance of AI in shaping successful digital marketing strategies will only grow.

Embracing these advancements will be crucial for organizations seeking to thrive in a competitive environment.

The integration of artificial intelligence in digital marketing has yielded several significant results:

- Enhanced Personalization: The integration of AI in digital marketing has significantly improved the ability to create personalized marketing experiences. This has resulted in higher engagement rates and increased customer satisfaction;
- Data-Driven Insights: Utilizing AI for data analysis has enabled marketers to extract valuable insights from large datasets, leading to more informed decision-making and effective marketing strategies;
- Operational Efficiency: AI tools, such as chatbots and predictive analytics, have streamlined marketing operations, reducing manual efforts and allowing for real-time customer interactions;
- Improved Customer Experience: The use of AI-driven technologies has enhanced the overall customer experience by providing timely responses and tailored content, leading to stronger brand loyalty;
- Future Growth Potential: Emerging technologies like augmented reality, blockchain, and 5G present significant opportunities for further innovation in digital marketing, positioning organizations to better meet consumer expectations.

Based on these findings, several recommendations can be made for businesses looking to leverage AI in their digital marketing efforts.

- Invest in AI Technology: Businesses should prioritize investments in AI tools and technologies to stay competitive and leverage the benefits of personalized marketing and data-driven decision-making;
- Focus on Ethical AI Practices: It is essential for organizations to adopt ethical practices in AI implementation, ensuring transparency and fairness to build trust with consumers;
- Continuous Learning and Adaptation: Marketers should stay informed about the latest AI trends and technologies, adapting their strategies to incorporate new developments that enhance customer engagement;
- Enhance Data Security Measures: As data privacy concerns grow, companies must implement robust data protection measures to safeguard customer information and comply with regulations;
- Foster Collaboration Across Teams: Encouraging collaboration between marketing, IT, and data analytics teams can lead to more effective AI strategy development and implementation, maximizing the benefits of AI in digital marketing.

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Human resources recruitment by artificial intelligence cvtheque model

Benchouk Wahiba[1] , Khedir Nassima [2]
[1] *M'hamed Bougara university, Boumerdes, Algeria (w.benchouk@univ-boumerdes.dz)*
[2] *M'hamed Bougara university, Boumerdes, Algeria (n.khedir@univ-boumerdes.dz)*

ABSTRACT

This paper aims to discover the role of artificial intelligence in the HR recruitment process and provides insight about creating a CV library via the Jobaffinity software. This recruitment software enables to manage the entire recruitment process efficiently. Beyond the novel benefits of AI, we show how this innovative technology can be the best way to manage and automate HR recruitment in a secure manner. In other words, AI can screen resumes and job applications quickly, identifying top candidates based on predetermined criteria. A descriptive analysis method is used to analyze the advantages and disadvantages of AI. The findings suggest that by utilizing AI in recruitment, companies can streamline their hiring processes and identify top talent more efficiently. This technology can also help eliminate bias in the selection process by focusing on objective data and qualifications.

KEYWORDS: Human resources, artificial intelligence, recruitment, CVtheque.

1 INTRODUCTION

In the age of fourth industrial revolution, new foundations of competitive advantages have been created: digital inequality, information and communication technologies, artificial intelligence tools. In fact, artificial intelligence (AI) is predicted to significantly transform nearly every industry, including human resources. Many HR and talent acquisition teams have begun incorporating AI into their daily workflows to enhance efficiency and to avoid falling behind competitors who have already adopted AI-technology. 76% of HR leaders believe that by not adopting AI in the next one to two years, they will not be as successful as organizations that have embraced it (n.d, 2024). It's evident that the use of AI in HR is growing fast.

Additionally, according to IDC's Future of Work research, 80% of global 2000 companies will use algorithmic managers for hiring, firing, and training workers by 2024 (Verlinden, n.d.). With these numbers and predictions in mind, this paper explores the ways AI is changing the HR landscape and offers insights on how HR teams can incorporate AI and machine learning into their day-to-day operations.

Furthermore, Human Resource managers can make more mistakes when using traditional HR tools and methods as they act under limited conditions of time and space. But digitalization of management processes and using Artificial Intelligence for performing HR tasks enable managers to process a large amount of information error-free, and expand their abilities and boundaries. (Gigaur, Gulua, & Mushkudiani, 2020, p. 31). In this regard, recruitment and hiring were some of the first areas where AI was applied to improve processes. As such, AI has been incorporated into every single part of the recruitment process.

The recruitment process is about handling supply and demand. Candidates offer their skills to companies, which need to find the most suitable person to join their team. For hundreds of applicants, the challenge relies on selecting the best candidates. But what if companies could rely on an AI solution for recruiting purposes? The goal of this paper is to explore the potential benefits of using artificial intelligence in recruitment and evaluate why adopting this technology can make a difference. Therefore:

What are the advantages of artificial intelligence, and how does it impact on HR recruitment?

To address the research question, the study will delve into the literature review on general AI technologies and AI on HRM, exploring the definition of AI (Section 1) following the Introduction. Based upon the extensive literature review, the study also presents the benefits and disadvantages of AI (Section 2). Further, the study aims to know relationship between HRM and AI in (Section 3), Focusing on the most important AI applications used in recruitment (Section 4).

2 THE DEFINITION OF ARTIFICIAL INTELLIGENCE

With the rise in the use of technologies in the field of human resource management, it is necessary to better understand AI, beginning with defining and classifying it. The technology of artificial intelligence is related to the outputs of the fourth industrial revolution and the transformations of the virtual world based on the use of electronic media, such as computers and the Internet, and the use of regular and big data systems (MECHRI, 2024). Thus, artificial intelligence is one of the branches of computer science, and one of the fundamental pillars that contribute to the industry and the development of technology at the present time. To understand what artificial intelligence is, we must first define what human intelligence means. It is associated with mental abilities such as the capacity to adapt to life circumstances, benefit

from past experiences, think, analyze, plan, solve problems, draw sound conclusions, and empathize with others, in addition to the speed of learning and the ability to use what has been learned in a correct and beneficial manner. Artificial intelligence is a simulation of human intelligence and an understanding of its nature through the development of computer programs capable of mimicking intelligent human behavior. Currently, artificial intelligence is everywhere around us, starting from self-driving cars and drones to translation software, investment tools, and many other applications that are widespread in everyday life.

Therefore, Artificial intelligence (AI) refers to technology used to do a task that requires some level of intelligence to accomplish — in other words, a tool trained to do what a human can do. Why is AI different than ordinary software? Three core components — high-speed computation, a huge amount of quality data and advanced algorithms differentiate AI from ordinary software. Core AI technologies provide better accuracy and stability to everyday processes using an algorithm that connects quality data with fast computation services. AI technologies offer significant opportunities to improve HR functions, such as self-service transactions, recruiting and talent acquisition, payroll, reporting, access policies and procedures. We are living in an era in which AI capabilities are reaching new heights and have a major impact on how we operate our business. Human resources executives have faith that merging AI into HR administration functions will benefit and improve the overall employee experience. This will provide more capacity, more time and budget, and more accurate information for decisive people management. (n.d, 2018).

Overall, AI is defined as: Digital machines and devices perform many tasks performed by humans, for example learning and thinking, and other processes that need quick intellectual thinking, in artificial intelligence that seeks to achieve intelligence systems that perform all the actions of a natural individual.

3 THE ADVANTAGES AND DISADVANTAGES OF AI

Artificial intelligence offers numerous benefits across various fields and industries. Here are some key advantages. (Arkadiusz, 2024):

- **Increased efficiency:** AI can automate repetitive tasks, freeing up human resources for more complex work.
- **Enhanced accuracy:** AI systems can process data with high precision, reducing human error.
- **24/7 availability:** Unlike humans, AI systems can work continuously without fatigue.
- **Faster decision-making:** AI can analyze large amounts of data quickly, enabling rapid insights and decisions.
- **Improved customer service:** AI-powered chatbots and virtual assistants can provide round-the-clock customer support.
- **Advanced analytics:** AI can uncover patterns and insights in complex datasets that humans might miss.
- **Personalization:** AI enables tailored experiences in areas like marketing, entertainment, and education.
- **Medical advancements:** AI assists in disease diagnosis, drug discovery, and personalized treatment plans.
- **Enhanced safety:** AI can be used in dangerous environments, reducing risks to human workers.
- **Innovation acceleration:** AI can speed up research and development processes across various fields.
- **Cost reduction:** By automating processes and optimizing operations, AI can lead to significant cost savings.
- **Improved accessibility:** AI-powered technologies can assist people with disabilities, enhancing their quality of life.

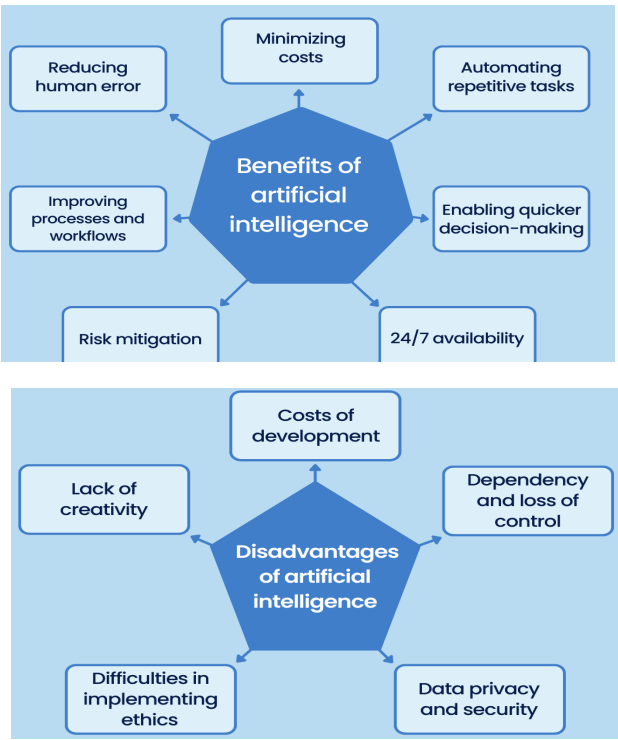

Figure 1: The benefits and disadvantages of artificial intelligence

Otherwise, not everything is straightforward, and even the most advanced technologies may cause some problems along the way. Here are five typical challenges that modern businesses need to be cautious of when utilizing AI-based solutions (Arkadiusz, 2024):

- **Costs of development**: It is crucial to have adequate expertise and knowledge when developing AI-based solutions. Companies seeking to implement AI and ML solutions in their daily operations should consider seeking help from **custom software development companies that specialize in developing AI-based software products.**

- **Dependency and loss of control**: If AI systems fail or behave unexpectedly, companies may face difficulty functioning properly, which can result in financial losses, customer dissatisfaction, or regulatory compliance issues.
- **Data privacy and security:** The use of AI frequently involves gathering and analyzing vast amounts of sensitive data, which presents a substantial risk to data privacy and security.
- **Difficulties in implementing ethics:** Integrating ethical considerations into AI systems can be complex, **as machines lack moral judgment** and can unintentionally perpetuate biases present in data.
- **Lack of creativity:** AI may struggle with creative tasks that require intuition, imagination, and human emotion**.** The potential lack of creative thinking could impede certain aspects of business innovation and problem-solving. Figure 1 illustrate the benefits and disadvantages of artificial intelligence

4 THE IMPACT OF AI ON HUMAN RESOURCES RECRUITMENT

The use of artificial intelligence in human resources, particularly in recruitment processes, is a growing trend with significant implications, that's through.

4.1 Recruitment and hiring

- AI can screen resumes and job applications quickly, identifying top candidates based on predetermined criteria.
- Chatbots can handle initial candidate interactions, answering questions and scheduling interviews.
- AI-powered video interviews can analyze candidate responses, facial expressions, and tone of voice.

4.2 Employee engagement and retention

- AI can analyze employee data to predict turnover risks and suggest retention strategies.
- Sentiment analysis can gauge employee morale through surveys and communication patterns.

4.3 Performance management

- AI can provide real-time feedback and performance tracking.
- It can identify patterns in employee performance and suggest areas for improvement or training.

4.4 Training and development

- AI can personalize learning experiences based on individual employee needs and learning styles.
- It can recommend relevant training programs based on an employee's career path and skill gaps.

4.5 WORKFORCE PLANNING

- AI can analyze trends and predict future staffing needs.
- It can help optimize workforce allocation based on skills and project requirements.

4.6 BIAS REDUCTION

- Properly designed AI systems can help reduce human biases in hiring and promotion decisions.
- However, it's crucial to ensure that AI systems themselves are not perpetuating existing biases.

4.7 HR ANALYTICS

AI can process vast amounts of HR data to provide insights on workforce trends, productivity, and organizational health.

4.8 Onboarding

- AI can automate parts of the onboarding process, providing new hires with necessary information and guiding them through paperwork.
- Virtual assistants can answer common questions, reducing the workload on HR staff.

4.9 COMPLIANCE

AI can help ensure compliance with labor laws and regulations by monitoring HR processes and flagging potential issues.

4.10 EMPLOYEE EXPERIENCE:

AI-powered tools can enhance the overall employee experience by providing personalized support and streamlining HR processes.

AI offers unprecedented opportunities to optimize HR processes and support decision-making. However, it also poses considerable challenges, particularly in terms of ethics, bias, and the protection of personal data. It's important to consider potential challenges (Alsaif & Aksoy, 2023, p. 1):

- Ensuring data privacy and security.
- Maintaining a human touch in HR processes.
- Addressing potential biases in AI algorithms.
- Managing the transition for HR professionals as their roles evolve.

Furthermore, there are also challenges and concerns that need to be addressed. One of the main concerns is the potential for job displacement due to automation. As AI takes over more HR functions, there is a risk that some HR professionals may lose their jobs (Umasankar et al , 2023). Another One of the challenges of AI-enabled recruiting is simply the cost of creating the tools and systems. (Stewart Black & Patrick, 2020).

5 CURRENT APPLICATIONS OF AI IN RECRUITMENT: CV LIBRARY MODEL OF AI IN RECRUITMENT

Recruitment time can be reduced by 75% when using AI-based candidate screening tool in order to attract talents while ameliorating accuracy (Heric, 2018, p. 2) . Since artificial intelligence can provide new capabilities that traditional technologies cannot. Such as filtering for candidates with the right skills more efficiently and effectively and helping identify future talent needs earlier. There are several AI tools on the market that are embedded in HR recruitment processes; most of these tools evaluate CVs or applications and are built and operationalized through machine learning techniques such as Natural Language Processing or neural networks, among others (Gasana, 2024). For instance, The CVthèque is a collection of online CVs or profiles that modern recruiters can use to aid in their hiring process and more quickly identify applicants who meet the job requirements. It is one of their most important tools. Many manual stages are eliminated by the program, which saves time and effort while looking for new hires.

- **What is a CV library? Definition :**

A CV library (or candidate pool) is a collection of online CVs or profiles that recruiters can browse to find qualified candidates for vacancies quickly and easily. It contains detailed information on each candidate, such as qualifications, experience and other relevant data. Thus, A CV library is a very practical tool for recruiters, allowing them to dip into their bank of CVs to find the ideal profile for the position or responsibilities required. It can also be used to post job offers directly on the site for more targeted recruitment (n.d, 2023).

- **What are the advantages of a CV library?**

CV libraries are designed to save recruiters time, so they don't have to examine hundreds of unqualified applications. With a CV library, it will be much easier to locate, filter or even comparing different candidates, making the hiring process faster and more efficient.

By setting up this up-to-date CV database, recruiters will be able to (n.d, 2023) :

- Locate the best candidates quickly and accurately,
- Targeting passive candidates,
- Filter and compare the data for each candidate,
- Make the hiring process faster and more efficient,
- Improve the candidate experience,
- Reduce recruitment costs.

5.1 Locate the best candidates quickly and accurately.

When you add up all the CVs you receive (unsolicited applications) or have acquired (via social networks, for example), you can end up with hundreds of different CVs that are neither sorted nor classified. To help you get organized, and save you from sourcing and review hundreds of unqualified applications, digital CV libraries are ideal, allowing quick access to all candidate profiles and information.

5.2 Targeting passive candidates

According to LinkedIn, 70% of the global workforces are passive profiles. people who already have a job or who are not actively looking for one. Yet many employees would be prepared to take the plunge and be dismissed for a more interesting position. you can easily reach candidates without going through a headhunter, if they have already applied for a job with you, or if you have retained their CV in your database at some point (after spotting their profile on social networks, for example).

5.3 Filter and compare data for each candidate

As well as being a storage place, a CV library is a true search engine. With this tool, via cross-searches, semantic searches or via resume parsing, you'll be able to extract profiles that match the positions you're looking to fill in just a few clicks. By using our Jobaffinity recruitment software, you ensure that only relevant CVs are displayed in your database, by defining your filters: skills, location, level of education, distance from the workplace, results of recruitment questionnaires, etc.

5.4 Make the hiring process faster and more efficient

A well-designed and structured CV library gives you rapid access to the best candidates for a given position. You can determine in just a few clicks: whether you need to publish a job offer, make multibroadcast on several jobboards or if using the range of profiles available in your CV library is enough. This way, you can organize interviews more easily, without going through a job advertisement (and therefore avoiding the risk of irrelevant applications), thus reducing the length of the hiring process, as well as abandonment rate.

5.5 Improving the candidate experience

CV libraries also offer advantages for candidates, enabling them to position themselves in jobs that match their skills and receive offers that are relevant to their profiles. Candidates can also be recontacted by different companies without having to go through multiple application processes.

5.5 Reduce recruitment costs

By having a good stock of talented professionals in your CV library, it will be easier and cheaper to fill positions quickly with less action than a complete recruitment process.

e.g. Create a CV library easily with Jobaffinity (n.d, 2023) **:**

Jobaffinity is the recruitment software that saves time Published by Intuition Software, Jobaffinity is a complete recruitment software that allows pleasant and intuitive management of advertisements and applications. A tool developed by recruitment professionals.

To create your own CV library quickly and easily, you can use Jobaffinity software. this recruitment software enables you to manage the entire recruitment process efficiently. From creating vacancies and publishing them on job boards, to monitoring candidates, rating them and working with recruiters or human resources professionals. With Jobaffinity you can create candidate pools in just a few clicks, assign profiles from different sources (job platforms, LinkedIn, unsolicited applications, etc) and Access the best candidates for a given position.

Simply create a category and rename it according to the job type, department, or area to begin building your CV lirary with Job affinity. The only thing left to do is click " add to pool " on the profile you want to include in the category after it has been created. To discover a profie, check their resume, message them, or up a meeting, you may then filter and search by keyword (n. d, 2023).

6 CONCLUSION

The rapid advancement of technology, especially the implementation of AI in HR, has brought about significant changes in HR processes and practices. In this context, the concept of AI has become a key component of the recruitment process. It excels in resume screening and candidate matching, reducing time-to-hire and elevating the quality of hires. Beyond efficiency, AI plays a pivotal role in promoting diversity and minimizing biases in recruitment processes by focusing on objective criteria. For instance, the CVthèque tool often includes features that allow recruiters to track the progress of each candidate, schedule interviews, and communicate with potential hires directly through the platform.

Furthermore, the ability to create a CV library can help recruiters quickly identify top candidates based on specific criteria. This streamlined approach can lead to faster hiring decisions and better-quality hires for organizations. This level of organization and accessibility can significantly improve the overall recruitment experience for both parties involved.

Overall, by analyzing the adopting of AI in the human resource management, especially in the recruitment process, we can summarize some results as follow:

- The integration of AI in HR can lead to a more efficient and effective recruitment process, benefiting both employers and job seekers.

- AI can analyze large amounts of data quickly, enabling rapid insights and decisions. This technology eliminates many manual steps, saving time and effort in the search for new employees.

- The CVthéque is a valuable tool for storing and managing candidate resumes, making the recruitment process more efficient. By utilizing this tool recruiters can identify top talent more effectively and make informed hiring decisions.

- It's important to use AI responsibly to avoid the risks of over-reliance on algorithms, and to ensure that it complements, rather than replaces, human judgment in the hiring process.

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Leveraging Artificial Intelligence to Boost Customer Loyalty

Saida Ishak Boushaki[1], Selma Abdelhakk[2], Abdelwahab Belhimer [2], Omar Bendjeghaba[3]
[1] *Computer science department, LIMOSE laboratory, University M'Hamed Bougara Boumerdes, Boumerdes, Boumerdes, 35000, Algeria (s.boushaki@univ-boumerdes.dz)*
[2] *Computer science department, University M'Hamed Bougara Boumerdes, Boumerdes, Boumerdes, 35000, Algeria (selmaabdelhakk@gmail.com, wowfury11@gmail.com)*
[3] *(LREEI), University M'Hamed Bougara Boumerdes,Boumerdes, 35000, Algeria.*
(bendjeghaba@univ-boumerdes.dz)

ABSTRACT

In today's competitive landscape, where market offerings are increasingly diverse, companies are prioritizing customer satisfaction as a cornerstone of their strategy to build long-term relationships. Djezzy, Algeria's leading mobile telecommunications provider leverages the Net Promoter Score (NPS) to gauge subscriber loyalty as part of its customer satisfaction management system. However, the system encounters a significant challenge: the response rate to distributed surveys is often much lower than anticipated, complicating efforts to predict missing responses. This study aims to develop a predictive system using machine-learning algorithms to estimate NPS scores for the segment of the customer base that does not respond to surveys. In this paper, seven machine-learning algorithms are implemented to predict NPS scores for customers who do not respond to surveys. These algorithms include Logistic Regression, Decision Tree, Random Forest, K-Nearest Neighbors (KNN), Gradient Boosting, XGBoost, and AdaBoost. Experimental results on a prepared questionnaire dataset containing 261,445 rows and 16 attributes demonstrate that Gradient Boosting is the most effective model among those evaluated. It achieves the highest precision, recall, and F-measure, indicating strong overall performance on our dataset.

KEYWORDS: Net Promoter Score (NPS), Machine Learning, Artificial Intelligence, Classification, Prediction, Logistic Regression, Decision Tree, Random Forest, K-Nearest Neighbors (KNN), Gradient Boosting, XGBoost, AdaBoost.

1 INTRODUCTION

Today, companies prioritize customer satisfaction as a core element of their strategy to build enduring relationships. A single instance of dissatisfaction can tarnish a company's reputation and drive customers to seek alternatives. The advancement of communication technology, particularly the Internet, has facilitated rapid data acquisition and the development of new marketing strategies to manage it. Consequently, a novel approach to gauging consumer perception has emerged, centered around communication. Among various metrics established to measure customer satisfaction, the Net Promoter Score (NPS) is widely recognized. Introduced by Reichheld in 2003 [1], NPS is based on questionnaires and is valued for its simplicity and its reliance on word-of-mouth (WOM). Loyal customers demonstrate their allegiance by recommending the company, intending to continue business, and viewing it as their top choice [2].
In 2021, Dyah Puspitasari Srirahayu and colleagues investigated the NPS of state academic library users in Indonesia. They found that while satisfaction influences loyalty, it does not directly impact NPS; however, loyalty significantly affects NPS. The study suggests that enhancing library services can improve both user satisfaction and NPS [3].

In the same year, Sven Baehre and colleagues revisited NPS as a predictor of sales growth by analyzing data from seven U.S. sportswear brands over five years. While NPS remains popular among managers, the study validates academic concerns about its methodology. It finds that only the newer brand health NPS, which includes non-customers, effectively predicts future sales growth [4].

In 2022, Matus Barath explored trends in measuring customer satisfaction and loyalty, highlighting their importance in successful business models and product development. His study, based on 1,050 customer responses, emphasizes the role of NPS in understanding customer loyalty and its impact on growth, focusing on brand loyalty in the food industry, specifically in the A La Carte category [5].

In the same year, Asier Baquero examined the relationship between NPS and customer satisfaction in the hotel industry. Focusing on reception, cleanliness, room comfort, and gastronomy, and using fuzzy set qualitative comparative analysis (fsQCA) on surveys from six hotels in the Balearic Islands, the research identified gastronomy as the key factor for a high NPS in 2021, while cleanliness and room comfort were crucial in 2020, influenced by the COVID-19 pandemic. These insights are valuable for hotel managers and academics [6].

In 2023, Manuela Cazzaro and Paola Maddalena Chiodini addressed NPS limitations by proposing a statistical method to determine whether identical NPS values accurately reflect similar levels of customer loyalty. They introduced an algorithm based on cumulative marginal logit models, providing a statistical test to enhance decision-making by identifying differences in customer base compositions over time. This method offers a practical tool for improving NPS reliability in evaluating customer satisfaction [7].

With growing competition and diverse market offerings, customer retention has become essential. Djezzy, the leading mobile telephony provider in Algeria, utilizes NPS to gauge subscriber loyalty within its customer satisfaction management system. This score categorizes subscribers as promoters, passives, or detractors, providing an overall view of customer satisfaction. However, a significant challenge arises from the lower response rate to distributed questionnaires compared to their distribution rate, complicating the prediction of missing responses. This study aims to develop a predictive system using artificial intelligence [8], specifically machine learning algorithms [9], to forecast NPS scores for the segment of the customer base that does not respond to questionnaires.

The remainder of this paper is organized as follows: Section 2 provides an overview of the Net Promoter Score (NPS) and its definition. Section 3 details the machine learning algorithms employed to predict NPS scores. Section 4 describes the design of the proposed solution, including an overview of the dataset used and the experimental results obtained. Finally, Section 5 presents the conclusions and outlines directions for future work.

1. ESSENTIAL CONCEPTS OF NPS

The Net Promoter Score (NPS) is an index ranging from -100 to 100 that gauges customers' willingness to recommend a company's products or services to others. It serves as an indicator of overall customer satisfaction with the company's offerings and their loyalty to the brand.To calculate the NPS, customers are asked a single question: on an 11-point scale, how likely are they to recommend the company or brand to a friend or colleague? Based on their responses, customers are categorized into three groups: detractors, passives, and promoters. The overall NPS is calculated by subtracting the percentage of detractors from the percentage of promoters, yielding a score between -100 and +100, as illustrated in Figure 1.

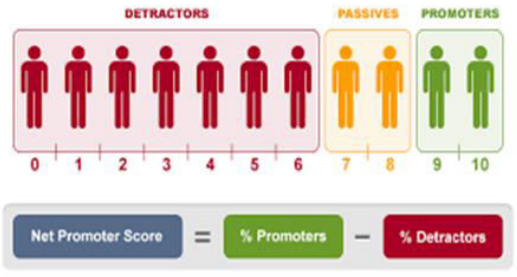

Figure 1. Net Promoter Score (NPS)

Customers can be classified into three main categories based on their ratings, as detailed in Fig. 1:

- Detractors: Ratings between 0 and 6.
- Passives: Ratings between 7 and 8.
- Promoters: Ratings between 9 and 10.

2 MACHINE LEARNING ALGORITHMS

Our technical challenge involves developing a tool that leverages machine-learning algorithms [9] to predict the Net Promoter Score (NPS) based on various variables. This problem is framed as a classification task within the realm of supervised learning. The following supervised machine learning algorithms are used.

2.1 Logistic Regression

Logistic Regression is a statistical model employed for binary classification tasks. It estimates the probability of a binary outcome based on one or more predictor variables, using a logistic function to map predicted values between 0 and 1. This model is valued for its simplicity and effectiveness in tasks such as spam detection and disease prediction. Logistic Regression also provides interpretable coefficients that illustrate the influence of each predictor on the outcome.

2.2 Decision Trees

Decision Trees are a type of supervised learning model used for classification and regression tasks. They partition data into subsets based on the values of input features, creating a tree-like structure of decisions. Each node in the tree represents a decision based on a feature, while branches represent the possible outcomes. Decision Trees are easy to interpret and visualize, making them useful for understanding the decision-making process. However, they can be prone to overfitting, particularly with very deep trees.

2.3 Random Forest

Random Forest is an ensemble learning method for classification and regression. It constructs multiple decision trees during training and aggregates their predictions to produce a final result. For classification, it outputs the mode of the classes, while for regression, it calculates the mean prediction of the individual trees. By using a random subset of data and features for each tree, Random Forest helps reduce overfitting and enhances model robustness. It is effective and versatile, requiring minimal tuning, and provides feature importance metrics for interpreting model decisions.

2.4 K-Nearest Neighbors (KNN)

K-Nearest Neighbors (KNN) is a simple, instance-based machine learning algorithm used for classification and regression. It works by identifying the 'k' nearest training examples to a given data point and making predictions based on the majority class (for classification) or the average value (for regression) of these neighbors. KNN is easy to implement and adaptable to changes in data. However, it can be computationally expensive and less effective with high-dimensional data or when 'k' is not optimally chosen.

2.5 Gradient Boosting

Gradient Boosting is an ensemble learning technique used for classification and regression tasks. It builds a series of weak learners, typically decision trees, where each new model corrects the errors made by the previous ones. These models are trained sequentially, with each tree focusing on the residuals of the preceding trees. Gradient Boosting enhances prediction accuracy by combining multiple weak models into a robust overall model. While effective, it can be sensitive to hyperparameters and prone to overfitting if not properly tuned.

2.6 XGBoost (Extreme Gradient Boosting)

XGBoost is an advanced implementation of gradient boosting designed for high efficiency and scalability. It builds an ensemble of decision trees sequentially, with each new tree aiming to correct the errors of the previous ones. XGBoost incorporates regularization to prevent overfitting and uses advanced optimization techniques to enhance performance and reduce computational costs. It also supports parallel processing and handles missing data. XGBoost is widely used in machine learning competitions and real-world applications due to its accuracy and speed.

2.7 AdaBoost (Adaptive Boosting)

AdaBoost is an ensemble learning technique that enhances the performance of weak classifiers by combining them into a strong classifier. It works by sequentially training weak models, such as simple decision trees, where each model focuses on the errors made by the previous ones. AdaBoost adjusts the weights of incorrectly classified examples so that subsequent models pay more attention to these challenging cases. The final model is a weighted combination of all weak classifiers. AdaBoost is effective in improving prediction accuracy and reducing bias but can be sensitive to noisy data and outliers.

3 EXPERIMENTAL RESULTS

In this section, we first provide an overview of the primary characteristics of the dataset used. Following this, we present the results obtained from implementing the various models.

3.1 Data Description

We have two main files: "responses" and "survey_base," each containing distinct attributes essential for our analysis. The "responses" file includes subscribers' answers to the NPS questionnaires, while the "survey_base" file contains basic information about the customers and surveys. We utilized Apache NiFi [10] to streamline the initial data transformation process for these files. This process addresses anomalies, missing values, and irrelevant variables to ensure the creation of a clean, high-quality database suitable for detailed analysis and machine learning. Ultimately, we obtained a dataset consisting of 261,445 rows organized into 16 columns, each representing different variables.

3.2 Implementation and results

Predictive models for forecasting NPS scores were developed using seven well-known machine learning algorithms: Logistic Regression, Decision Tree, Random Forest, K-Nearest Neighbors (KNN), Gradient Boosting, XGBoost, and AdaBoost. All algorithms were implemented using the Python programming language, with individual parameters configured according to the recommendations from the original literature. Three external quality metrics are utilized to assess the quality of the classification results: F1-score (F-measure), precision, and recall [11].

3.2.1 Logistic Regression

The classification results of the logistic regression model are presented in Figure 2.

Classification Report:

	precision	recall	f1-score	support
0	0.58	0.95	0.72	13481
1	0.00	0.00	0.00	1780
2	0.00	0.00	0.00	1518
3	0.00	0.00	0.00	1124
4	0.00	0.00	0.00	957
5	0.27	0.12	0.17	3559
6	0.50	0.00	0.00	1482
7	0.33	0.02	0.04	2319
8	0.57	0.94	0.71	3396
9	0.00	0.00	0.00	2304
10	0.87	1.00	0.93	14874
accuracy			0.67	46794
macro avg	0.28	0.28	0.23	46794
weighted avg	0.54	0.67	0.57	46794

Figure 2. Classification Report of the "Logistic Regression" Model.

The model performs well for classes 0 and 10, but struggles significantly with classes 1 through 9. The overall accuracy is just 0.28, meaning only 28% of the data points are correctly predicted. The weighted metrics (precision = 0.54, recall = 0.67, and F1-score = 0.57) suggest a moderate performance, reflecting a trade-off between precision and recall.

3.2.2 Decision Tree

The classification results of the decision tree model are presented in Figure 3. The model performs well for classes 0, 7, 8, and 10, but the results are less accurate for classes 1, 2, 3, 4, 5, and 6. The overall accuracy of the model is 0.74, meaning that about 74% of the data points are correctly predicted. The weighted metrics (precision = 0.73, recall = 0.74, and F1-score = 0.72) indicate an average performance.

Classification Report:

	precision	recall	f1-score	support
0	0.67	0.91	0.77	13481
1	0.63	0.25	0.36	1780
2	0.63	0.25	0.36	1518
3	0.65	0.24	0.35	1124
4	0.59	0.22	0.32	957
5	0.47	0.38	0.42	3559
6	0.59	0.26	0.36	1482
7	0.69	0.68	0.68	2319
8	0.77	0.79	0.78	3396
9	0.75	0.30	0.43	2304
10	0.90	0.98	0.94	14874
accuracy			0.74	46794
macro avg	0.67	0.48	0.52	46794
weighted avg	0.73	0.74	0.72	46794

Figure 3. Classification Report of the " Decision Tree " Model.

3.2.3 *Random Forest*

The classification results of the random forests model are presented in Figure 4. The model's results are satisfactory for classes 0, 7, 8, and 10, but poor for classes 1, 2, 3, 4, 5, and 6. The overall accuracy of the model is 0.78, indicating that about 78% of the data points are correctly predicted. The weighted performance metrics (precision = 0.78, recall = 0.78, and F1-score = 0.76) suggest a satisfactory performance with a reasonable balance between precision and recall, though there is stillroom for improvement.

Classification Report:

	precision	recall	f1-score	support
0	0.71	0.93	0.81	13481
1	0.67	0.33	0.44	1780
2	0.64	0.35	0.45	1518
3	0.58	0.30	0.40	1124
4	0.60	0.27	0.38	957
5	0.65	0.46	0.54	3559
6	0.63	0.35	0.45	1482
7	0.81	0.68	0.74	2319
8	0.80	0.89	0.84	3396
9	0.87	0.36	0.51	2304
10	0.91	0.99	0.95	14874
accuracy			0.78	46794
macro avg	0.72	0.54	0.59	46794
weighted avg	0.78	0.78	0.76	46794

Figure 4. Classification Report of the " Random Forest " Model.

3.2.4 *KNN*

The classification results of the KNN model are presented in Figure 5. Classes 0, 8, and 10 achieved satisfactory results, while classes 1, 2, 3, 4, 5, 6, and 7 performed poorly. The overall accuracy of the model is 0.65, indicating that about 65% of the data points are correctly predicted. The weighted metrics (precision = 0.63, recall = 0.65, and F1-score = 0.64) are fairly satisfactory, showing a reasonable balance between precision and recall.

Classification Report:

	precision	recall	f1-score	support
0	0.68	0.76	0.72	13481
1	0.23	0.18	0.20	1780
2	0.27	0.23	0.24	1518
3	0.25	0.21	0.23	1124
4	0.20	0.16	0.18	957
5	0.38	0.36	0.37	3559
6	0.27	0.21	0.24	1482
7	0.50	0.45	0.47	2319
8	0.64	0.66	0.65	3396
9	0.32	0.19	0.24	2304
10	0.87	0.94	0.90	14874
accuracy			0.65	46794
macro avg	0.42	0.39	0.40	46794
weighted avg	0.63	0.65	0.64	46794

Figure 5. Classification Report of the " KNN" Model.

3.2.5 *Gradient Boosting*

The classification results of the Gradient Boosting model are presented in Figure 6. The model produces satisfactory results for classes 0, 2, 5, 7, 8, 9, and 10, while the results for classes 1, 3, 4, and 6 are poor. The overall accuracy of the model is 0.80, indicating that about 80% of the data points are correctly predicted. The weighted metrics (precision = 0.82, recall = 0.80, and F1-score = 0.78) suggest that the model has satisfactory precision, with slightly lower recall, resulting in a moderate F1-score. This indicates generally strong performance, though there is room for improvement in recall.

Classification Report:

	precision	recall	f1-score	support
0	0.68	0.98	0.81	12807
1	0.83	0.33	0.47	1780
2	0.86	0.36	0.51	1518
3	0.79	0.33	0.46	1124
4	0.77	0.34	0.47	957
5	0.83	0.52	0.63	4233
6	0.78	0.34	0.48	1482
7	0.88	0.70	0.78	2319
8	0.81	0.94	0.87	3396
9	0.95	0.36	0.52	2304
10	0.91	1.00	0.95	14874
accuracy			0.80	46794
macro avg	0.83	0.56	0.63	46794
weighted avg	0.82	0.80	0.78	46794

Figure 6. Classification Report of the "Gradient Boosting" Model.

3.2.6 *XGBoost*

The classification results of the XGBoost model are presented in Figure 7. The model's results are satisfactory for classes 0, 8, and 10, but poor for classes 1, 2, 3, 4, 5, 6, and 7. The overall accuracy of the model is 0.75, indicating that about 75% of the data points are correctly predicted. The weighted performance metrics (precision = 0.78, recall = 0.75, and F1-score = 0.71) suggest that while the model is generally accurate in its positive predictions, it may miss some true positive samples, slightly lowering the overall F1-score.

Classification Report:	precision	recall	f1-score	support
0	0.65	0.97	0.78	13481
1	0.83	0.25	0.38	1780
2	0.83	0.25	0.39	1518
3	0.78	0.24	0.36	1124
4	0.62	0.23	0.34	957
5	0.71	0.28	0.41	3559
6	0.86	0.24	0.37	1482
7	0.83	0.34	0.49	2319
8	0.67	0.96	0.79	3396
9	0.93	0.27	0.42	2304
10	0.90	1.00	0.95	14874
accuracy			0.75	46794
macro avg	0.78	0.46	0.51	46794
weighted avg	0.78	0.75	0.71	46794

Figure 7. Classification Report of the " XGBoost " Model.

3.2.7 AdaBoost

The classification results of the AdaBoost model are presented in Figure 8.

Classification Report:	precision	recall	f1-score	support
0	0.59	0.93	0.72	13481
1	0.42	0.01	0.02	1780
2	0.57	0.05	0.09	1518
3	0.45	0.04	0.08	1124
4	0.31	0.01	0.02	957
5	0.59	0.26	0.36	3559
6	0.50	0.23	0.31	1482
7	0.76	0.25	0.37	2319
8	0.60	0.92	0.73	3396
9	0.86	0.25	0.39	2304
10	0.90	0.99	0.94	14874
accuracy			0.70	46794
macro avg	0.59	0.36	0.37	46794
weighted avg	0.69	0.70	0.64	46794

Figure 8. Classification Report of the " AdaBoost " Model.

The model produces satisfactory results for classes 0, 8, and 10, while the results for classes 1, 2, 3, 4, 5, 6, and 7 are poor. The overall accuracy of the model is 0.70, indicating that about 70% of the data points are correctly predicted. The weighted performance metrics (precision = 0.69, recall = 0.70, and F1-score = 0.64) suggest that the model is generally accurate in its positive predictions.

3.2.8 Evaluation

We can compare the performance of the different models, as summarized in Table 1, which presents their various performance metrics. This comparison will help us select the best-performing model. A comparison of the performance of the different models is shown in Fig. 9. It is important to note that the selection of the best model is based on the weighted F1 score, considering the imbalanced class situation. According to the metrics presented in the table, Gradient Boosting stands out as the most effective model among those evaluated in our strategy. It demonstrates the best results in terms of precision, recall, and F1 score, indicating a strong overall performance on our dataset.

Table 1. Metrics of the Different Models

Model	Precision	Recall	F1-score
Logistic Regression	0.54	0.67	0.57
Decision Tree	0.73	0.74	0.72
Random Forest	0.78	0.78	0.76
KNN	0.63	0.65	0.64
Gradient Boosting	**0.82**	**0.80**	**0.78**
XGBoost	0.78	0.75	0.71
AdaBoost	0.69	0.70	0.64

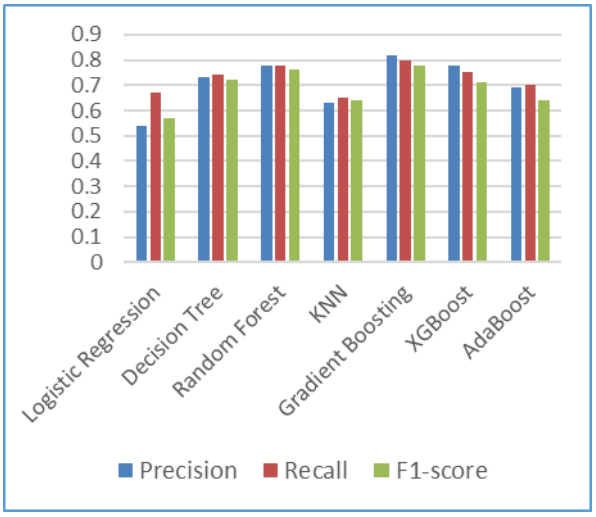

Figure 9. Comparison of the performance of the different models.

4 CONCLUSION

In this study, artificial intelligence is harnessed to enhance decision-making within the Data Value Management department at Djezzy. We developed a range of predictive models to forecast Net Promoter Scores (NPS) for customers who do not respond to surveys, employing machine learning algorithms such as Logistic Regression, Decision Tree, Random Forest, K-Nearest Neighbors (KNN), Gradient Boosting, XGBoost, and AdaBoost.

The process began with data collection from files containing subscribers' responses to NPS questionnaires, as well as basic information about customers and surveys. This data was then processed and prepared, resulting in a final dataset with 261,445 rows and 16 attributes.

Our results show that Gradient Boosting outperformed the other models, achieving the highest precision, recall, and F1 score. Conversely, the Logistic Regression model exhibited the least effectiveness. Looking ahead, we plan to enhance customer segmentation by utilizing advanced clustering methods to enable more precise and personalized interventions.

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