

The Impact of AI, Machine Learning, and Big Data on Customer Satisfaction and Loyalty

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ABSTRACT

This research aims to investigate the impact of artificial intelligence, machine learning, and big data analytics on customer satisfaction and loyalty. The main objective is to measure how these technologies collectively effects positively on enhancing tourism companies' ability to respond effectively for changing based on customer needs and market conditions. The study was conducted by distributing a questionnaire through google forms, which was sent by email to tourism offices in Jordan, yielding 234 valid responses for statistical analysis. The dimensions used to measure ai included model accuracy, prediction speed, and algorithm complexity; for machine learning, dimensions were training duration, hyper parameter tuning, and model robustness; and for big data analytics, dimensions were data volume, query latency, and parallel processing. The research main objective represented by the result that indicate that the application of these technologies positively and significantly affect customer satisfaction and loyalty in the tourism sector. Finally, the study arrived to the fact that applying artificial intelligence, machine learning, and big data analytics is considered important key for tourism companies to efficiently process huge amounts of data, adapt to rapidly changing conditions, and maintain a competitive edge in a dynamic market.

Keywords: Artificial Intelligence (AI), Machine Learning (ML), Big Data Analytics (BDA), Customer Satisfaction (CS), Customer Loyalty (CL)

INTRODUCTION

Artificial intelligence (AI), machine learning, and big data analytics have become essential tools for organizations in the tourism sector, enabling them to organize, analyze, and extract valuable insights from large amounts of data collected through various processes. They provide significant advantages over traditional systems by offering advanced capabilities to process massive datasets, respond quickly to dynamic market environments, and deliver personalized services to tourists. Many tourism companies have increasingly adopted these technologies to enhance operational efficiency, improve service delivery, and strengthen their competitive advantage (Jamil et al., 2023). The application of AI, machine learning, and big data analytics has become a key driver for improving organizational competitiveness, flexibility, and adaptability in a rapidly changing tourism

environment (Zagheer et al., 2024). At the same time, organizations have recognized that successfully adopting these technologies requires continuous development of employees' skills and knowledge to keep pace with technological advancements. Providing proper training and developing employee competencies is essential for leveraging the full potential of these technologies and delivering personalized services to tourists (Rahmani et al., 2025).

The rapid wave of digital transformation has further increased reliance on data-driven tools and advanced analytics, pushing tourism firms to adopt innovative solutions that enhance operational processes and improve customer satisfaction. AI tools enable organizations to better understand customer behavior, predict future demands, and deliver highly tailored services. They also support innovation by helping businesses execute tasks more efficiently and effectively. Similarly, big data analytics plays a critical role in supporting managers' decision-making by uncovering hidden insights and patterns that guide strategic planning and enable organizations to respond quickly to evolving market trends (Huang et al., 2023; Singh & Verma, 2024).

In the tourism sector, most organizations face significant challenges due to intense environmental pressures such as globalization, growing customer demands, and strong competition in both local and international markets. Additionally, the transition toward a knowledge-based economy requires companies to adopt innovative solutions to remain competitive and sustainable. Digital tools such as artificial intelligence and big data analytics provide organizations with powerful support by leveraging stored data to develop solutions, overcome operational challenges, improve internal processes, and better understand customer needs, ultimately enhancing customer satisfaction and loyalty (Chen et al., 2024; Al-Mutairi et al., 2025).

Additionally, companies have recognized the necessity of integrating these advanced technologies to improve operational processes, respond effectively to market developments, and resolve problems promptly, which directly contributes to customer satisfaction and loyalty. These technologies also enhance organizational flexibility, enabling firms to adapt quickly to changing conditions and evolving customer preferences, thereby strengthening their competitiveness in a dynamic industry (Kim & Lee, 2022; Patel et al., 2025). However, while the application of artificial intelligence, machine learning, and big data analytics shows great potential, there remains a need for more empirical studies to explore their combined impact on customer satisfaction and loyalty in the tourism sector. Therefore, this research aims to fill this gap by investigating and evaluating the influence of these technologies and their specific dimensions—model accuracy, prediction speed, and algorithm complexity for AI; training duration, hyperparameter tuning, and model robustness for machine learning; and data volume, query latency, and parallel processing for big data analytics—on customer satisfaction and loyalty in Jordan's tourism sector.

LITERATURE REVIEW

Artificial Intelligence (AI)

Artificial Intelligence (AI) is a controlling technology that organizations have started to leverage to handle vast amounts of data, solve complex difficulties, and respond quickly to changing market conditions (Singh & Gupta, 2024; Al-Khasawneh et al., 2024). Currently, tourism companies are using artificial intelligence (AI) to streamline operations, customize services, and improve decision-making, which directly impacts increased customer satisfaction and loyalty. The tools of artificial intelligence are used for performing routine operations and tasks from the operational level tasks till the executive level tasks because of its capabilities on developing services quality and competitive advantages (Jamil et al., 2023). What's more, artificial intelligence helps organizations to face and solve complicated problems and issues and enhancing tasks based on customers' demands (Patel et al., 2025). Applying artificial intelligence lies on improving internal work environment, enhancing customer's loyalty and satisfaction, and strengthen employees skills and knowledge to create greater competitive advantages in the tourism sector.

Machine Learning (ML)

Machine learning systems help organizations and institutions define hidden meanings and relationships within large, complex data sets, which require valuable predictive capabilities to lead decisions in efficient way. Machine learning technologies also help organizations and companies build strategic plans that rely more heavily on customer preferences, tourism trends, and competitive market indicators (Rahmani et al., 2025). These technologies also assist organizations and companies in product marketing operations by designing promotional offers and setting product prices in line with customer needs and preferences (Kim & Lee, 2022). The importance of machine learning lies in its ability to read and absorb massive amounts of customer and operational data, analyze it, and then transform it into innovative, applicable knowledge and unique, new ideas resulting from building hidden relationships within the data, which helps improve customer service and increase

loyalty rates (Jamil et al., 2023). The adoption of machine learning in dealing with historical data and information helps organizations provide distinguished services and improve the performance of future operations. It makes most of the organization's operations, from routine operations to decision-making and strategic planning, largely dependent on data received from customers, which gives organizations the ability to achieve long-term interactions within the tourism sector (Patel et al., 2025).

Big Data Analytics (BDA)

Analyzing complex, big data is a fundamental pillar for organizations that aspire to maximize and increase the added value of their stored data and extract practical insights from the analysis of highly complex big data (Zhang et al., 2024). Big data from customers, such as data related to reservations, ratings, preferences, transactions, and complaints, is efficiently processed and analyzed through big data analytics to uncover hidden patterns and relationships (Al-Khasawneh et al., 2024). Through the use of complex big data analytics, tourism companies have been able to better understand and segment tourism markets, identify customer pain points, and quickly regain competitiveness in the face of changing economic and political conditions (Singh & Gupta, 2024). Big data analytics techniques have also helped the government sector improve pricing strategies, design promotional offers, and enhance service delivery based on actionable big data analytics (Patel et al., 2025). Using advanced digital tools to communicate with huge amount of data is considered privileges for organization and main pillars for competing, enhancing products quality, and having new knowledge added values on their products and services.

Customer Satisfaction (CS)

In tourism field the customer satisfaction dimension is considered important and primary for most of organizations to know if their products and services which provided are unique, special and different or they are full of low quality and mistakes (Jamil et al., 2023). Adopting advanced digital tools such as artificial intelligence, machine learning, and big data analysis give organizations ability to understand how customers are thinking, and what they want exactly to be provided (Singh & Gupta, 2024). Moreover, using these technologies give speed in responding for organizations to any current issues or risks, decrease the percentages of customer complaints, finding solutions for problems quickly, and focusing on satisfying all types of customers. Customer satisfaction is connected with the electronic word of mouth in our days, feedback from customers after the end of travel effects on others and most of organizations started already in enhancing their provided services, opinions and expectations of their customers, and focusing to make all power between customers hands in the gol of meeting this dynamic changes (Jamil et al., 2023). This enables tourism organizations to offer unique products and services, reducing weaknesses and increasing satisfaction rates (Singh & Gupta, 2024). These digital technologies enable tourism organizations to respond quickly and timely to customer complaints, solve problems, and offer unique that increase percentages of satisfying (Al-Khasawneh et al., 2024).

Customer Loyalty (CL)

Customer Loyalty is a key self-regulating for tourism organizations and directly replicates their capability to remember and attract duplication tourists (Jamil et al., 2023; Patel et al., 2025). The grouping of Artificial Intelligence, Machine Learning, and Big Data Analytics benefits companies to advance approaches for loyalty by detecting high-value segments, thoughtful their preferences, and delivering personalized facility (Singh & Gupta, 2024; Al-Khasawneh et al., 2024). Additionally, these technologies enable companies to expect future actions and proactively return to customer requests, strengthening loyalty and decreasing churn. y using advanced technologies to support their operations with customer expectations, tourism organizations foster loyalty, loyalty programs become more current, and repeat business increases. Loyalty, in turn, contributes directly to sustained competitiveness and returns growth in a dynamic and interesting tourism market.

The following research proposals are derived from prior investigations and analysis, and they are as follows:

- H1:** AI have a strong and positive impact on improving customer Satisfaction.
- H2:** AI have a strong and positive impact on improving customer Loyalty.
- H3:** ML have a strong and positive impact on improving customer Satisfaction.
- H4:** ML have a strong and positive impact on improving customer Loyalty.
- H5:** BDA have a strong and positive impact on improving customer Satisfaction.
- H6:** BDA have a strong and positive impact on improving customer Loyalty.
- H7:** Customer Satisfaction have a strong and positive impact on improving customer Loyalty.

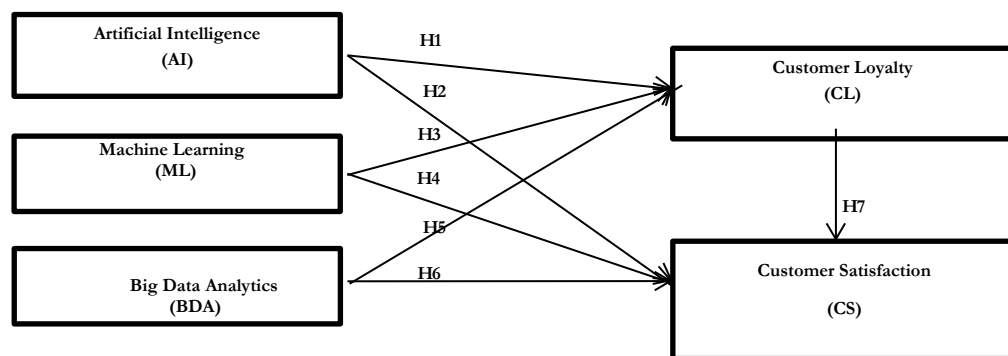


Figure 1. Research Model

RESEARCH METHODOLOGY

This research purposes to investigate the effect of Artificial Intelligence (AI), Machine Learning, and Big Data Analytics on Customer Satisfaction and Loyalty in Jordan's tourism sector. The research study design digital survey consists of 15 main questions divided in 5 main categories based on the research hypotheses, and then, distributed online through using google form link which has been sent to all respondents through their emails, then the researcher received after sending more than 290 emails 234 valid for analysis. The research used for studying the impact of artificial intelligence the following measures model accuracy, prediction speed, and algorithm complexity, and for machine learning the training duration, hyper parameter tuning, and model robustness; and for big data analytics data volume, query latency, and parallel processing. The results of applying artificial intelligence, machine learning and big data analysis tools clearly show a significant improvement in customer satisfaction and increased loyalty rates, especially in the tourism sector. The study indicated that the activation of these digital technologies and tools is considered one of the essential elements for tourism companies to process and analyze large and massive amounts of complex data, with high efficiency and speed, adapt to market changes and maintain competitive advantages in a highly competitive and dynamic environment that is constantly changing.

Research Design

A research questionnaire was developed and distributed digitally to tourism offices to verify the impact of the primary and independent study variables on the dependent variables. This study aimed to measure the impact of using artificial intelligence, machine learning, and big data analysis tools and techniques on customer satisfaction and loyalty. The study questionnaire was designed and consisted of five main parts, with a total of 15 questions and three questions for each variable. These questions focused on variables related to artificial intelligence, measured through the dimensions of model accuracy, prediction speed, and algorithm complexity; machine learning, measured through training duration, high-performance process tuning, and model robustness; and big data analysis, measured through data volume, query response time, and parallel processing. For the dependent variables, the analysis was designed to present participants' experiences, expectations, and roles related to the implementation of these advanced technologies and their impact on institutions, tourism offices, and companies in Jordan. A five-point Likert scale with five response options was used to enable participants to indicate their levels of agreement, ranging from strongly disagree, disagree, neutral, agree, and strongly agree, providing a comprehensive measure of the impact of each item on customer satisfaction and loyalty. Data was analyzed using 234 quantifiable responses retrieved using SMART PLS 3.3.9 to test the theoretical model and study hypotheses. This statistical analysis confirmed the impact of the dimensions of the independent and dependent variables and provided a comprehensive understanding of the impact of model accuracy, prediction speed, and algorithm complexity in artificial intelligence. The training duration, high-performance process tuning, and model placement for machine learning also influence the impact of data size, query response time, and parallel processing in big data analytics on customer satisfaction and loyalty.

Research Analysis

Smart PLS 3.3.9 was used to transform the collected data into understandable and analyzable information to discuss the main study hypotheses. All data was entered and checked with high accuracy, correcting any input errors. All responses underwent a comprehensive review process to ensure completeness, consistency, and accuracy, to maintain the study's credibility. The analysis focused on evaluating the measurement model and assessing the reliability and validity of components related to the artificial intelligence dimensions: model accuracy, prediction speed, algorithm complexity; and machine learning dimensions: training time, high-performance process tuning, model robustness; and big data analysis: data size, query response time, and parallel processing. Composite reliability, average variance extracted (AVE), and factor likelihood were used secondarily to confirm component validity. Two main steps were used for the analysis: first, to confirm the convergent strength of the measurement model; and second, to evaluate the structural model to test the relationship between the independent and dependent study variables. The SPSS program has been used to analyze data and to approve the accuracy of data. The chi-square test (χ^2) was used to assure that the significance levels below 0.001 to support the strength and consistency of the research study model. The threshold value was determined at 14.36. After reviewing and correcting the data, 234 valid questionnaires were retrieved and used for the final analysis. The standard model demonstrated strong internal consistency and reliability, which supported the theoretical framework of the study. The statistical procedures used and the sound theoretical foundation supported the validity and reliability of the research findings, as they provided valuable insights into how artificial intelligence and machine learning can guide big data analysis to customer satisfaction and loyalty rates in the Jordanian tourism sector.

Measurement Model Assessment

A 15-question questionnaire was used to examine the importance and impact of independent variables, namely artificial intelligence (AI), with its dimensions of model accuracy, prediction speed, and algorithm complexity; machine learning (ML), with its dimensions of training duration, high-performance process tuning, and model robustness; and big data analysis (Data volume, query waiting time, and parallel processing), on the dependent variables, namely customer satisfaction and loyalty. Before beginning the theoretical analysis, the consistency and validity of the measurement model were carefully assessed to confirm the robustness and basis of the research. The consistency and reliability of the items were evaluated by investigating the external loadings of each variable on its separate construct. In this research two main statistical tools have been used the average variance extracted and the composite reliability. AVE values for all variables exceeded (0.5) which indicate that more than 50% of variables explained by the whole and separate components, confirming that the components share a strong correlation with the items used for measurement and linking convergent validity (Hair et al., 2021). CR has been calculated to determine the internal consistency of the research study variables, and all CR values were more than (0.70) that indicates reliable measurement consistency. This procedure demonstrated that the measurement items used to represent the main study variables are statistically sound and theoretically valid. The results confirmed that the events are well-constructed and accurately represent the intended concepts, which further confirms the reliability and validity of the measurement model used in this study.

Table 1. Reliability and Validity Test

Variable	Factor's Loading	VIF	Cronbach's Alpha	CR	AVE
Artificial Intelligence (AI)			0.61	0.42	0.50
Model Accuracy	0.46	0.54			
Prediction Speed	0.30	0.64			
Algorithm Complexity	0.45	0.40			
Machine Learning (ML)			0.65	0.43	0.53
Training Duration	0.45	0.31			
Hyper parameter Tuning	0.30	0.35			
Model Robustness	0.46	0.38			
Big Data Analytics (BDA)			0.63	0.44	0.52
Data Volume	0.30	0.46			
Query Latency	0.45	0.51			
Parallel Processing	0.40	0.66			
Customer Loyalty			0.62	0.40	0.50
Repeat Purchase Rate	0.43	0.52			
Brand Advocacy	0.45	0.65			
Customer Retention	0.36	0.62			
Customer Satisfaction			0.64	0.40	0.49
Service Quality	0.35	0.52			

Responsiveness	0.40	0.55			
Overall Experience	0.46	0.61			

Research Hypotheses Test

The second phase of the study, following approval of the research model's reliability and validity, involved testing the research hypotheses to assess the contacts between the independent and dependent variables. This phase focused on evaluating how the key independent variables SCM systems, member skills, and project agility directly affect the dependent variables, namely project efficiency and overall business concert. The table below presents the results of the structural model, highlighting the direct effects and statistical meaning of all hypothesized relationships supported by the study.

Table 2. Path Coefficient Test Results

	Research Hypotheses Test	P Value	Results
H1	Artificial Intelligence (AI) → Customer Loyalty (CL)	0.001	Supported
H2	Artificial Intelligence (AI) → Customer Satisfaction (CS)	0.001	Supported
H3	Machine Learning (ML) → Customer Loyalty (CL)	0.001	Supported
H4	Machine Learning (ML) → Customer Satisfaction (CS)	0.002	Supported
H5	Big Data Analytics (BDA) → Customer Loyalty (CL)	0.001	Supported
H6	Big Data Analytics (BDA) → Customer Satisfaction (CS)	0.001	Supported
H7	Customer Loyalty (CL) → Customer Satisfaction (CS)	0.000	Supported

The figure illustrates the PLS-SEM analysis results for the constructs considered. The Artificial Intelligence construct was represented by three indicators Model Accurateness, Prediction Speed, and Algorithm Complexity with factor loadings ranging from 0.28 to 0.45, indicating a moderate level of consistency. Among these, Model Accuracy had the highest loading of 0.64, reflecting its significant contribution to improving Customer Satisfaction and Customer Loyalty. The Machine Learning construct included three indicators Training Time, Hyper parameter Tuning, and Model Robustness with factor loadings varying between 0.30 and 0.50. Hyper parameter Tuning displayed the strongest loading at 0.62, highlighting its important role in driving positive customer products. The Big Data Analytics hypothesis, measured by Data Volume, Query Latency, and Parallel Processing, showed factor loadings between 0.27 and 0.47, with Data Volume taking the highest loading at 0.61, underscoring its influence in assistant effective data handling that leads to customer satisfaction and loyalty. The analysis further revealed that Customer Satisfaction and Customer Loyalty are statistically major dependent variables, as indicated by probability principles well below 0.01 (e.g., 0.001, 0.002), authorizing the meaningful impact of these technologies.

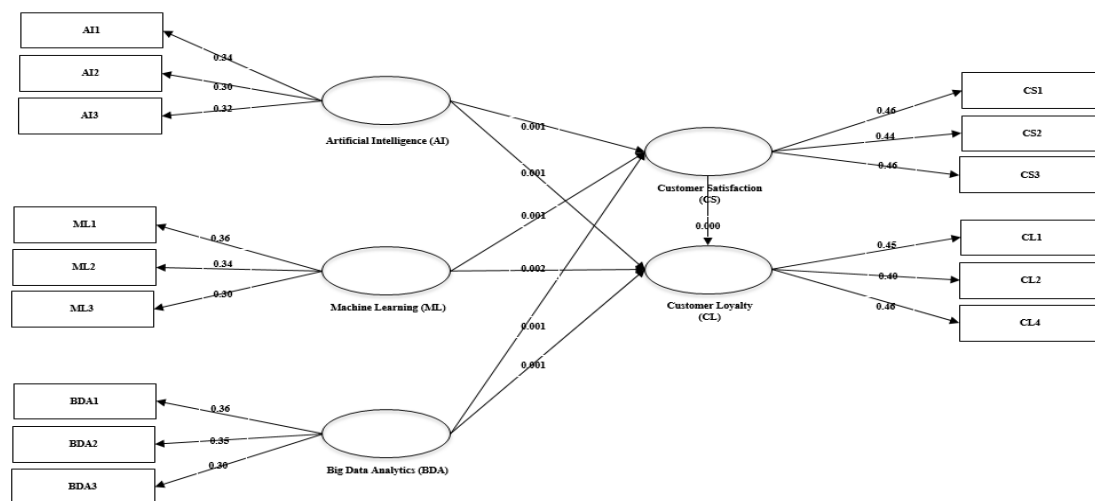


Fig.9. PLS-SEM Path Analysis Result

RESEARCH DISCUSSIONS

The research was conducted in the tourism sector in Jordan to study the impact of artificial intelligence, machine learning, and big data analytics on customer satisfaction and loyalty. Because tourism companies operate in a highly dynamic and competitive environment, it is essential for tourism organizations and institutions to determine how these digital technologies can contribute to meeting changing and evolving customer demands, improving tourism service delivery, and enhancing loyalty rates. In light of rapid technological developments and

digital transformation, companies must leverage digital technologies and ensure their employees possess the technical skills capable of adapting and using these technologies and digital tools to increase and maximize the benefits of these technologies in raising and improving tacit knowledge levels, innovation and creativity rates, and improving products by relying on new and creative ideas. The primary objective of this research is to estimate how the operation of Artificial Intelligence, alongside Machine Learning and Big Data Analytics, can enhance service operations, growth Customer Satisfaction, and improve loyalty and retention. Artificial Intelligence, through Model Accuracy, Prediction Speed, and Algorithm Complexity, provides actionable and precise insight into customer likings; Machine Learning, supported by Training Duration, Hyper parameter Tuning, and Model Robustness, assists companies in improving service delivery; and Big Data Analytics, through Data Volume, Query Latency, and Parallel Processing, enables companies to lever large amounts of customer data efficiently and respond promptly to changing market conditions. The outcomes of the research confirmation that the synergy between these technologies contributes significantly to improving Customer Approval and Loyalty. Artificial Intelligence strengthens service personalization and decision accuracy, Machine Learning helps to fine-tune strategies and respond quickly to customer needs, and Big Data Analytics assists in finding hidden patterns and trends. Together, these components create a more adaptive, data-centric, and competitive tourism enterprise. Besides, the research suggests that tourism companies can develop performance indicators such as facility delivery time, personalization accuracy, customer retention rate, and satisfaction scores to measure and track advancement in operational and strategic initiatives. These metrics can provide valuable insight into how effectively companies control technology and expertise to enhance their service delivery and maximize Customer Loyalty.

RESEARCH LIMITATIONS

Many studies and researches have been focused on the impact of artificial intelligence, machine learning, and big data analytics on customer satisfaction and loyalty. The novelty of this study lies on the field that the research study has been conducted in. These differences have impacted customer opportunities, technology adoption, and customer reactions to the services provided, making it a top priority to review and reassess these variables in light of the difference conditions of tourism operations. Key internal factors, such as service experience, digital skills, and adaptability, must be considered to achieve a comprehensive and integrated understanding of service development and loyalty. This research provides valuable insights into the role of artificial intelligence, machine learning, and data analytics in the tourism sector. It also emphasizes the importance of a research framework, which calls for a broader approach that encompasses different sectors, such as the public sector, to develop a robust knowledge base that guides the practical use of these technologies, which have tangible results, across all other sectors.

FUTURE RESEARCH RECOMMENDATIONS

Future research should focus on the impact of AI on tourist's satisfaction and place of travelling, Comparing local and foreign travelers and different types of tourism businesses may reveal technology adoption tendencies. Understanding AI-driven tourist customer behavior would also need evaluating trust, valuation, and privacy issues as mediators. Furthermore, studying and focusing on technologies like real-time predictive analytics, and emotional AI further enhance customer satisfaction and loyalty in different segments of Jordan's tourism sector. Finally, future research also should focuses more on entrepreneurship variables and their impact on tourism filed and taking some unique variables such as innovativeness, risk taking and how those skills can affect on the internal environment with the organizations especially on workers skills and way of conducting tasks and thinking.

RESEARCH CONCLUSIONS

This study focused on studying the main impact and effects of using digital and advanced tools such as artificial intelligence (AI), machine learning (ML), and big data analytics (BDA) on customer satisfaction and customer loyalty in tourism sector field in Jordan. The research defined and discussed seven main hypotheses in order to measure the impact of independent variables which represented through artificial intelligence, machine learning, and big data analysis on the dependent variables which represented through customer satisfaction and customer loyalty. The results are consistent with previous studies, as Al-Hayari et al. (2023) found that AI-powered personalized service retained positive customer loyalty impacts in luxury hotels in Jordan. Additionally, another research emphasized how big data initiatives can support tourism companies in improving service

delivery and customer loyalty by offering personalized promotions (Al-Nawasah, 2023). More and more, the machine learning technologies have proven effective in identifying customer preferences, improving service delivery, and enhancing customer loyalty (Kharoush et al., 2024). This study approves the important influence of the study variables and that the request of digital skills has allowed organizations to professionally lever large volumes of data, learn from customer requests, and react quickly to variations. This study also provides organizations with the skill to decrease decision-making costs. This study highpoints the fundamental role of artificial intelligence, machine learning, and big data analytics in influential customer loyalty and satisfaction. The results arrived to summarize that companies can use these technologies to improve more their main operation, services which provided to customers, and having more efficient and competitive advantages.

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