# The Role of Artificial Intelligence in Enhancing Digital Entrepreneurship: A Proposed Model for Developing Business Organizations Management – Private Banks in Baghdad


## Abstract

This research aims to examine the role of artificial intelligence (AI) in enhancing digital entrepreneurship through proposing a model for developing the management of business organizations in the digital environment. The research reviews the most significant AI techniques utilized in the digital business environment, with a focus on their impact in improving digital transformation decision-making, fostering innovation, and enhancing utilization efficiency. The research problem centers on how AI techniques can be employed to promote digital entrepreneurship and the extent to which they contribute to improving the management of business organizations, with specific reference to a group of private Iraqi banks in Baghdad. A questionnaire was used to gather the opinions of a sample comprising 98 specialists from the private banking sector.The results revealed the impact of artificial intelligence on digital entrepreneurship, and manual labor was identified in the research areas.



**Keywords:** Artificial Intelligence, Digital Entrepreneurship, Digital Transformation, Innovation, Business Organizations, Private Banks.


## 1. Introduction

The world has witnessed tremendous advancements in digital technology, leading to a significant transformation in business management approaches. AI has emerged as one of the most crucial factors in enhancing the efficiency of business organizations and enabling them to achieve competitive advantages in digital markets. It has now become a fundamental component of digital transformation, applied in data analysis, process automation, and supporting top management decision-making. This research seeks to present a comprehensive model illustrating how AI techniques can be effectively used in managing digital business organizations to achieve their strategic objectives.

## Research Methodology

## 2.1 Research Problem

### First: Problem Statement

In light of the rapid technological changes in the business world, artificial intelligence (AI) has emerged as one of the most influential factors in enhancing the competitiveness of business organizations, especially in the fields of production and operations. This technology has become capable of supporting decision-making, improving process quality, and increasing efficiency, which can contribute to strengthening organizational entrepreneurship and achieving strategic distinction.

Despite these capabilities, many business organizations particularly within the Iraqi context still face challenges in adopting AI technologies and utilizing them in ways that serve their entrepreneurial objectives.Accordingly, the research problem stems from attempting to answer the following central question:**"What is the impact of artificial intelligence on enhancing the entrepreneurship of business organizations?"**

**Second: Research Questions**

Based on the research problem, the following questions are formulated:

**1.** What is the level of adoption of AI technologies in Iraqi business organizations?

**2.** Which dimensions of business organization entrepreneurship can be influenced by AI technologies?

**3.** To what extent does AI enhance innovation within business organizations?

**4.** What is the relationship between the use of AI technologies and achieving a competitive entrepreneurial advantage for organizations?

**5.** Are there statistically significant differences in AI’s impact on business organization entrepreneurship attributable to organizational characteristics (such as size, industry type, and years of operation)?

## 2.2 Research Significance

The world is currently witnessing profound transformations in business due to the rapid advancement of AI technologies and the expanding use of digital platforms in creating and developing entrepreneurial ventures. This research is a scientific contribution that sheds light on the role of AI as a decisive factor in supporting digital entrepreneurship not only in terms of process automation and enhancing user experience, but also in creating a qualitative leap in decision-making, resource allocation, and the design of smart products and services.

The significance of this study also lies in presenting a proposed model for developing the management of business organizations within a dynamic digital environment, thereby enriching both theoretical understanding and practical applications of how AI technologies can be leveraged to enhance the competitiveness of digital enterprises.

Furthermore, the research helps bridge the knowledge gap between theory and practice by linking AI tools such as machine learning, predictive analytics, recommender systems, and robotic process automation to modern digital entrepreneurship applications. The importance of this study is underscored by its provision of scientifically based recommendations supported by a practical, implementable model, thus strengthening digital transformation efforts, particularly in economies seeking to improve their standing in global innovation and entrepreneurship indices.

## 2.3 Research Objectives

This study aims to achieve the following objectives:

1. Determine the level of AI application in the companies within the research domain.
2. Diagnose the level of entrepreneurship in the companies under study.
3. Measure the impact of AI and its dimensions on entrepreneurship.

## 2.4 Research Model

Based on the conceptual frameworks of the literature and research variables, and in accordance with the research problem and objectives, the hypothetical research model was designed to illustrate the variables and the relationships among them, as shown in Figure (1).

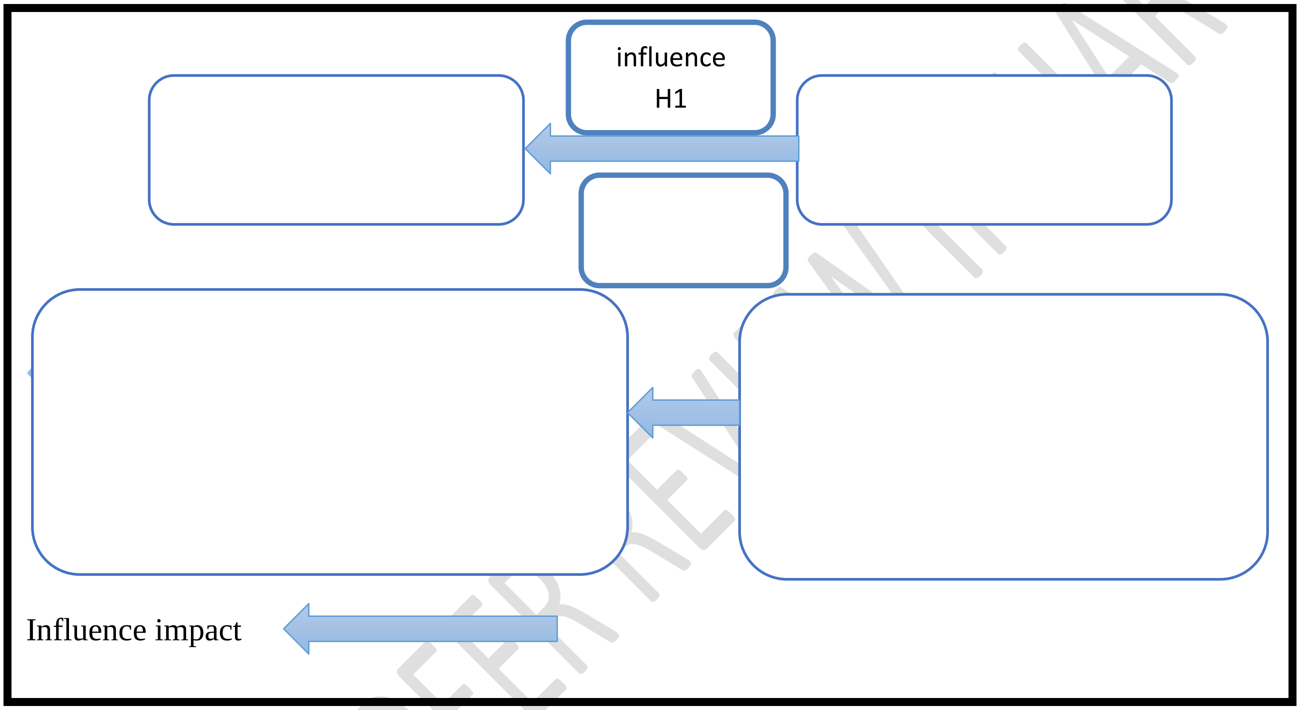



Figure (1) proposal research model

## 2.5 Research Hypotheses

**Main Hypothesis 1:** There is a statistically significant impact of artificial intelligence on digital entrepreneurship in the private banks within the research domain.

**Sub-Hypotheses:**

- There is a statistically significant impact of the machine learning dimension on digital entrepreneurship.
- There is a statistically significant impact of the recommender systems dimension on digital entrepreneurship.
- There is a statistically significant impact of the predictive analytics dimension on digital entrepreneurship.

- There is a statistically significant impact of the robotic process automation dimension on digital entrepreneurship.

**Main Hypothesis 2:**There is a statistically significant collective impact of all AI dimensions on digital entrepreneurship in the private banks within the research domain.

## 2.6 Research Population and Sample

**Research Environment and Population:**

A group of private Iraqi banks was selected as the research environment. The sample was drawn from senior management in the Iraqi banking sector, as shown in Table (1).

Table (1) Research Population

| No. | Banking Sector | Population Size | No. | Banking Sector | Population Size |
|---|---|---|---|---|---|
| 1 | Bank 1 | 45 | 3 | Bank 3 | 27 |
| 2 | Bank 2 | 40 | 4 | Bank 4 | 20 |
| **Total** | | **132** | | | |

**Research Sample:**

For quantitative analysis, a purposive random sample of specialists in the private banking sector was selected. The final sample size was 98 valid questionnaires out of a total of 113 distributed, calculated using the Thompson equation (Thompson, 2012: 59), as shown below:

$$\mathbf{n=n*p\ (1-p)/\ (n-1(d^2/z^2)\ +p\ (1-p))}$$

Where:

n = Sample size

p = Probability = 0.05

d = Margin of error = 0.05

z = Standard score = 1.96 for a 95% confidence level

The 98 symbol was distributed on the research companies according to the equation below:

**“Company symbol size = (company society size/ all companiessocietysizes) *total symbol size”**

The sample was distributed across the banks as shown in Table (2).

Table (2) Research Sample

| No. | Banking Sector | Sample Size | No. | Sample Sector | Population Size |
|---|---|---|---|---|---|
| 1 | Bank 1 | 33 | 3 | Bank 3 | 20 |
| 2 | Bank 2 | 30 | 4 | Bank 4 | 15 |
| **Total** | | **98** | | | |

## 3. Artificial Intelligence

## 3.1 Concept of Artificial Intelligence

Artificial intelligence (AI) is a branch of computer science that focuses on designing intelligent systems capable of simulating human mental abilities such as learning, thinking, decision-making, and problem-solving (**Russell & Norvig, 2021: 1**). It includes a set of advanced technologies, most notably: Machine Learning, Deep Learning, Natural Language Processing, and Computer Vision. These technologies have become strategic tools in supporting operational processes and improving organizational performance across various sectors (**Davenport & Ronanki, 2018: 110**). It is worth noting that the integration of artificial intelligence with the digital environment contributes to enhancing efficiency, increasing productivity, and strengthening competitiveness in the context of digital entrepreneurship.

The intellectual beginnings of artificial intelligence date back to philosophy and logic among the ancient Greeks (**Singh, 2019: 566**). However, its scientific origins trace back to the post-World War II period. In 1956, researchers from various fields gathered to formulate the concept of "intelligent machines," among whom was the British scientist Alan Turing (**Simpson, 2024: 4**), who contributed to developing the idea of machines capable of "thinking." Initially, the focus was on programming computers to perform specific tasks such as playing chess. With the advancement of computing capabilities, learning systems emerged, opening the door to modern artificial intelligence, culminating in generative artificial intelligence, which represents an advanced stage in machines' ability to create and adapt (**Manning, 2020: 1**). Figure (2) illustrates the stages of artificial intelligence development.

| | |
|---|---|
| Beginnings<br>1940-1950 | - Neural cell model 1943<br>- Turing test 1950 |
| Symbolic AI<br>1956-1970 | - Dartmouth Conference 1956<br>- Chess programs |
| First AI Winter<br>1970-1990 | - Cancellation of government projects and university funding due to disappointing results |
| Machine Learning<br>1990-2010 | - Neural networks<br>- Commercial applications |
| Deep Learning & Generative AI<br>2010-present | - Self-driving cars<br>- ChatGPT & AlphaGo |

Figure (2) Stages of Artificial Intelligence Development

Reference: Russell, S., & Norvig, (2020)

## 3.2 Importance of Artificial Intelligence

The importance of artificial intelligence lies in being one of the most crucial tools for digital transformation in the modern era, due to its ability to analyze big data, make intelligent decisions, and personalize experiences, thereby contributing to accelerating innovation and developing new business models. AI provides practical solutions to complex challenges and is a key factor in supporting digital entrepreneurship and enhancing the competitive ability of organizations in a changing environment. The importance of artificial intelligence can be summarized in the following factors:

1. Personalization: Enhances user experiences through personalized recommendations. By analyzing user data, products, services, or customized content can be suggested, leading to increased engagement and thus higher customer loyalty. This personalization creates a strong connection between businesses and consumers, which is critical for success in digital content (**Chaffey, 2019:220**).
2. Data Analysis and Decision Making: Enables companies to make decisions by analyzing large datasets in real time. This capability improves decision-making processes, allowing companies to understand market trends, customer behavior, and effectively enhance their strategies. AI has the ability to process vast amounts of data rapidly, giving digital startups a competitive advantage (**Brynjolfsson & McAfee, 2014:115**).
3. Cost Efficiency: Supports cost efficiency through automating routine tasks such as customer service, inventory management, and marketing. Automation reduces the need for human intervention, lowers operational costs, and allows companies to allocate resources more strategically. This is especially beneficial for startups needing to minimize costs during expansion (**Zhang et al., 2023**).
4. Innovation: Empowers companies to offer new solutions, products, or services. Through product development, customer engagement, and process improvements, entrepreneurs can introduce innovative concepts that differentiate them in the market by developing new business models (**Bughin et al., 2019:12**).
5. Task Automation: Allows companies to streamline operations and focus on growth, such as data entry, content creation, and customer interactions. It reduces manual workload and boosts productivity, freeing up time for more strategic business activities (**Topol, 2019:102**).

## 3.3 Objectives of Artificial Intelligence

AI aims to develop systems capable of simulating human behavior through learning, reasoning, and decision-making. These objectives are essential to supporting innovation and competitiveness, especially in digital entrepreneurship:

**1.** Automating repetitive tasks to improve productivity (**Chui et al., 2018:14**).
**2.** Enhancing decision-making with advanced analytics (**Davenport & Ronanki, 2018:9**).
**3.** Solving complex problems and optimizing processes (**Russell & Norvig, 2021:230**).
**4.** Learning and adapting over time to improve performance (**Goodfellow et al., 2016:342**).
**5.** Creating intelligent systems capable of replicating cognitive functions such as reasoning and problem-solving (**Russell & Norvig, 2021:418**).

## 3.4 Dimensions of Artificial Intelligence

The multiple dimensions of AI reflect its diverse applications and wide-ranging impact on the digital business environment. These dimensions are key enablers of digital entrepreneurship:

1. Machine Learning (ML): Enables systems to learn from data and make predictions, supporting decision-making through valuable insights (**Jordan & Mitchell, 2015:265**).
2. Recommender Systems (RS): Personalize user experiences by analyzing user behavior and preferences to suggest relevant products, services, or content (**Ricci et al., 2015:12**).
3. Predictive Analytics (PA): Forecasts future trends and behaviors based on historical data, crucial for digital marketing and strategic planning (**Davenport & Ronanki, 2018:24**).
4. Robotic Process Automation (RPA): Uses AI to automate repetitive, rule-based tasks, improving efficiency and resource utilization (**Willcocks et al., 2017:45**).

# 4. Digital Entrepreneurship

## 4.1 The Concept of Digital Entrepreneurship

In an era characterized by rapid technological advancement and the integration of traditional and digital economic concepts, digital entrepreneurship has emerged as a cornerstone of the future economy and a promising field attracting the attention of youth, investors, and policymakers alike (**Kraus et al., 2019:354**). The continuous development of information and communication technologies, coupled with the central role of the internet in communication and commerce, has created an entirely new business environment (**Nambisan, 2017:1030**).

It is now possible to establish and manage entrepreneurial ventures using purely digital tools without the need for physical premises or large capital investments, as was required in traditional business models. Digital entrepreneurship reflects a fundamental shift in entrepreneurial thinking, extending innovation beyond the product or service itself to include delivery methods, user experience, and continuous market engagement through digital platforms and social media (**Sussan & Acs, 2017:56**).

This digital environment offers equal opportunities to individuals worldwide, enabling anyone with a novel idea, a clear business plan, and adequate digital skills to launch a venture from home and access global markets. Furthermore, digital entrepreneurship extends beyond economic aspects to influence social and cultural dimensions, promoting independent work culture, empowering women and youth, and creating innovative solutions to societal problems through smart applications and services (**UNCTAD, 2022:7**).

It also serves as a core pillar of national digital transformation strategies adopted by many governments and organizations in pursuit of their future visions. Digital entrepreneurship can be defined as “the process of creating and developing new ventures using digital tools and modern technologies, thereby offering more flexible and scalable opportunities in global markets” (**Nambisan, 2017:1030**).

## 4.2 The Importance of Digital Entrepreneurship

Digital entrepreneurship has become increasingly significant in the modern world, driven by the rapid technological, economic, and social changes of the 21st century. With the rise of the digital economy and the migration of many business activities and services to online spaces, digital entrepreneurship is no longer viewed merely as an alternative to traditional models—it has become a necessity to meet evolving global market demands and changing consumer behaviors (**Brettel et al., 2015:314**).Key points highlighting its importance include:

1. Job Creation: Generates diverse and accessible employment opportunities, particularly for young graduates facing unemployment, enabling them to start businesses with relatively low costs (**Sorgner et al., 2017:8**).
2. Innovation Driver: Encourages creative thinking to develop smart products and services addressing societal needs such as education, healthcare, transportation, and entertainment (**Giones & Brem, 2017:53**).
3. Economic Inclusion: Enables marginalized groups—such as persons with disabilities and rural populations—to participate in the digital economy via accessible online platforms (**UNCTAD, 2022:8**).
4. Strategic Enabler for Digital Transformation: Supports national strategies like Saudi Vision 2030 through data-driven business ecosystems, e-commerce, and emerging technologies such as AI and blockchain (**OECD, 2023:12**).
5. Global Competitiveness: Enhances international expansion for innovative startups, boosts digital exports, and improves national rankings in global innovation and entrepreneurship indices (**World Economic Forum, 2023:17**).

## 4.3 Objectives of Digital Entrepreneurship

The objectives of digital entrepreneurship revolve around leveraging modern technologies to create innovative ventures that generate economic and social value. They include:

1. Contributing to the growth of the digital economy across sectors such as e-commerce, digital services, fintech, e-learning, and digital health (**OECD, 2022:22**).
2. Identifying factors that influence digital venture success, including technology readiness, funding access, government support, and regulatory frameworks (**Giones & Brem, 2021:210**).
3. Addressing challenges such as cybersecurity, data privacy, market competitiveness, and access to venture capital (**Nambisan et al., 2019:224**).
4. Examining the impact on labor markets by creating new job opportunities and promoting digital skills-based employment(**OECD, 2022:12**).
5. Studying innovative business models that effectively leverage digital technology for sustainable growth (**Autio et al., 2018:22**).

6. Offering policy and strategic recommendations for governments, educational institutions, and the private sector to foster digital entrepreneurship (**World Economic Forum, 2023:38**).

## 4.4 Dimensions of Digital Entrepreneurship

Digital entrepreneurship comprises several core dimensions that reflect its scope and impact in the digital environment:

1. Decision-Making: AI enhances decision-making by providing data-driven insights, reducing uncertainty, and improving strategic planning (**Kraus et al., 2022:90**).
2. Digital Marketing and Targeting: AI-powered analysis of social media, web interactions, and customer history enables precise audience targeting, improving conversion rates and marketing efficiency (**Duan et al., 2019:65; Mariani & Borghi, 2021:850**).
3. Product and Service Innovation: AI facilitates the creation of smart product prototypes and predictive analytics to anticipate market trends, accelerating development cycles and boosting market success rates (**Chatterjee et al., 2021:12; Dwivedi et al., 2021**).
4. User Experience Enhancement: AI technologies, such as chatbots, computer vision, and personalization algorithms, enable adaptive, engaging, and emotionally intelligent digital interfaces that improve customer satisfaction and loyalty (**Pillai et al., 2020:1374**).

## 5.1 Coding the Research Scale

To ensure data integrity and facilitate processing in statistical analysis software, all indicators, dimensions, and variables used in the study were coded. This coding process aimed to convert the data into a format that could be efficiently and accurately interpreted by statistical software. Table (3) presents the coding of the research variables.

Table (3) Coding of Research Variables

| Variables | Dimensions | Code | No. of Items |
|---|---|---|---|
| Artificial Intelligence (AI) | Machine Learning | ML | 5 |
| | Recommender Systems | RS | 5 |
| | Predictive Analytics | PA | 5 |
| | Robotic Process Automation | RPA | 5 |
| Digital Entrepreneurship (DE) | Decision-Making | DM | 5 |
| | Digital Marketing & Targeting | DMAT | 5 |
| | Product and Service Innovation | PASI | 5 |
| | User Optimization (Experience) | UO | 5 |

Source: Prepared by the researchers

## 5.2 Confirmatory Factor Analysis for Artificial Intelligence

The AI construct, as the independent variable, consists of four core dimensions: **Machine Learning, Recommender Systems, Predictive Analytics, and Robotic Process Automation** comprising a total of 20 items, as shown in Figure (3). Table (4) displays the model fit indices, all of which met the required thresholds for model acceptance.

The Composite Reliability (CR) values for AI dimensions ranged from 0.847 to 0.882, all above the acceptable threshold of 0.70, indicating high reliability. Cronbach's Alpha values ranged from 0.852 to 0.881, also exceeding 0.70, confirming strong internal consistency. The Average Variance Extracted (AVE) values ranged from 0.542 to 0.600, surpassing the 0.50 criterion, suggesting that the sub-dimensions substantially contribute to explaining the total variance of the AI construct.

Table (4) model fit indices for Artificial intelligence

| Dimensions | Cronbach's alpha (standardized) | Cronbach's alpha (unstandardized) | Composite reliability (rho_c) | Average variance extracted (AVE) |
|---|---|---|---|---|
| ML | 0.881 | 0.881 | 0.882 | 0.600 |
| PA | 0.872 | 0.871 | 0.874 | 0.580 |
| RPA | 0.852 | 0.851 | 0.847 | 0.542 |
| RS | 0.861 | 0.861 | 0.871 | 0.580 |

Source: Outputs of Smart Pls v.4 program

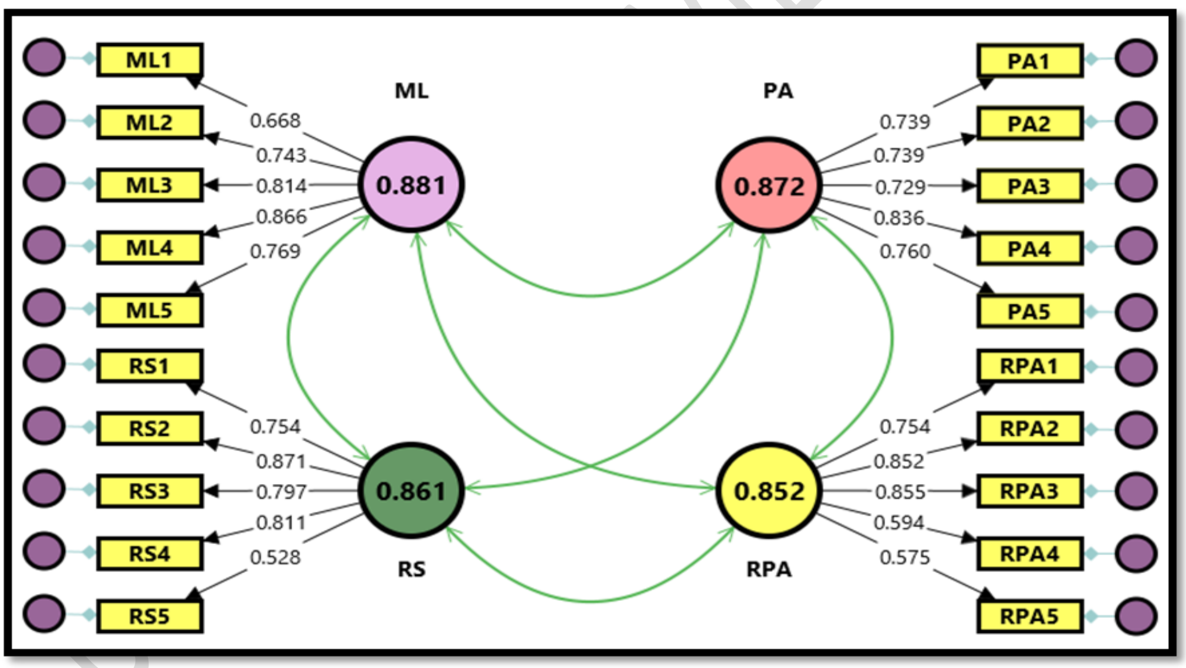



Figure (3) Confirmatory Factor Analysis for Artificial Intelligence

Source: Outputs of Smart Pls v.4 program

Table (5) shows the estimated values, which ranged between (0.528-0.871), as all the questions were interesting. It is also evident from the (T) values, which reached values between (5.127-8.886), which are also greater than the (table value) (1.984), which is sufficient to adopt the model in its final form in subsequent integrations.

Table (5) Dimensional Estimates for the Dimensions of Artificial Intelligence

| Items | Parameter estimates (standardized) | Parameter estimates | Standard errors | T values | P values |
|---|---|---|---|---|---|
| ML1 <- ML | 0.668 | 1.000 | n/a | n/a | n/a |
| ML2 <- ML | 0.743 | 1.072 | 0.166 | 6.456 | 0.000 |
| ML3 <- ML | 0.814 | 1.238 | 0.178 | 6.976 | 0.000 |
| ML4 <- ML | 0.866 | 1.263 | 0.171 | 7.397 | 0.000 |
| ML5 <- ML | 0.769 | 1.100 | 0.163 | 6.760 | 0.000 |
| PA1 <- PA | 0.739 | 1.000 | n/a | n/a | n/a |
| PA2 <- PA | 0.739 | 0.998 | 0.142 | 7.013 | 0.000 |
| PA3 <- PA | 0.729 | 0.902 | 0.127 | 7.084 | 0.000 |
| PA4 <- PA | 0.836 | 1.136 | 0.138 | 8.209 | 0.000 |
| PA5 <- PA | 0.760 | 1.037 | 0.141 | 7.372 | 0.000 |
| RPA1 <- RPA | 0.754 | 1.000 | n/a | n/a | n/a |
| RPA2 <- RPA | 0.852 | 1.122 | 0.129 | 8.674 | 0.000 |
| RPA3 <- RPA | 0.855 | 1.080 | 0.131 | 8.241 | 0.000 |
| RPA4 <- RPA | 0.594 | 0.845 | 0.150 | 5.645 | 0.000 |
| RPA5 <- RPA | 0.575 | 0.793 | 0.148 | 5.367 | 0.000 |
| RS1 <- RS | 0.754 | 1.000 | n/a | n/a | n/a |
| RS2 <- RS | 0.871 | 1.237 | 0.139 | 8.886 | 0.000 |
| RS3 <- RS | 0.797 | 1.124 | 0.137 | 8.204 | 0.000 |
| RS4 <- RS | 0.811 | 1.167 | 0.145 | 8.058 | 0.000 |
| RS5 <- RS | 0.528 | 0.740 | 0.144 | 5.127 | 0.000 |

Source: Outputs of Smart Pls v.4 program

## 5.3 Confirmatory Factor Analysis for Digital Entrepreneurship

The Digital Entrepreneurship construct, as the dependent variable, comprises four dimensions: Decision-Making, Digital Marketing and Targeting, Product and Service Innovation, and User Optimization. Table (6) shows that CR values ranged from 0.878 to 0.893, and Cronbach's Alpha ranged from 0.875 to 0.891 both exceeding 0.70, indicating strong reliability. The AVE values ranged from 0.597 to 0.631, meeting the 0.50 standard, thus confirming that the dimensions significantly explain the overall variance of the construct.

Table (6) model fit indices for Digital Entrepreneurship

| Dimensions | Cronbach's alpha (standardized) | Cronbach's alpha (unstandardized) | Composite reliability (rho_c) | Average variance extracted (AVE) |
|---|---|---|---|---|
| DM | 0.891 | 0.890 | 0.892 | 0.631 |
| DMAT | 0.891 | 0.891 | 0.893 | 0.624 |
| PASI | 0.875 | 0.875 | 0.878 | 0.597 |
| UO | 0.887 | 0.886 | 0.883 | 0.598 |

Source: Outputs of Smart Pls v.4 program

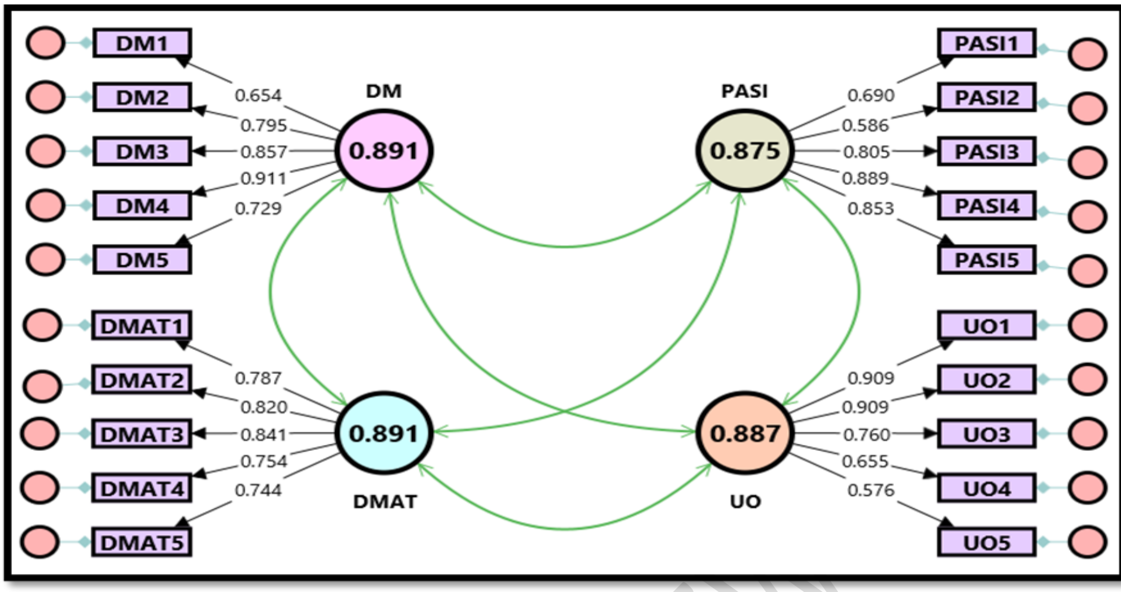



Figure (4) Confirmatory Factor Analysis for Digital entrepreneurship

Source: Outputs of Smart Pls v.4 program

Table (7) presents the estimated values, which ranged between (0.576–0.911), indicating that all questions are influential. Furthermore, the T-values, ranging between (5.561–14.352), are all greater than the tabulated value of (1.984), which is a sufficient indicator for adopting the model in its final form for the subsequent analyses.

Table (7) Dimensional Estimates for the Dimensions of Digital Entrepreneurship

| Items | Parameter estimates (standardized) | Parameter estimates | Standard errors | T values | P values |
|---|---|---|---|---|---|
| DM1 <- DM | 0.654 | 1.000 | n/a | n/a | n/a |
| DM2 <- DM | 0.795 | 1.216 | 0.176 | 6.895 | 0.000 |
| DM3 <- DM | 0.857 | 1.256 | 0.177 | 7.103 | 0.000 |
| DM4 <- DM | 0.911 | 1.272 | 0.171 | 7.448 | 0.000 |
| DM5 <- DM | 0.729 | 1.062 | 0.166 | 6.379 | 0.000 |
| DMAT1 <- DMAT | 0.787 | 1.000 | n/a | n/a | n/a |
| DMAT2 <- DMAT | 0.820 | 1.045 | 0.117 | 8.947 | 0.000 |
| DMAT3 <- DMAT | 0.841 | 1.227 | 0.134 | 9.164 | 0.000 |
| DMAT4 <- DMAT | 0.754 | 1.053 | 0.137 | 7.701 | 0.000 |
| DMAT5 <- DMAT | 0.744 | 0.985 | 0.126 | 7.814 | 0.000 |
| PASI1 <- PASI | 0.690 | 1.000 | n/a | n/a | n/a |
| PASI2 <- PASI | 0.586 | 0.899 | 0.162 | 5.561 | 0.000 |
| PASI3 <- PASI | 0.805 | 1.219 | 0.163 | 7.470 | 0.000 |
| PASI4 <- PASI | 0.889 | 1.284 | 0.156 | 8.213 | 0.000 |

| | | | | | |
|---|---|---|---|---|---|
| PASI5 <- PASI | 0.853 | 1.333 | 0.169 | 7.867 | 0.000 |
| UO1 <- UO | 0.909 | 1.000 | n/a | n/a | n/a |
| UO2 <- UO | 0.909 | 0.982 | 0.068 | 14.352 | 0.000 |
| UO3 <- UO | 0.760 | 0.789 | 0.082 | 9.575 | 0.000 |
| UO4 <- UO | 0.655 | 0.580 | 0.077 | 7.507 | 0.000 |
| UO5 <- UO | 0.576 | 0.614 | 0.099 | 6.225 | 0.000 |

Source: Outputs of Smart Pls v.4 program

## 5.4 Statistical Analysis of the Research Variables

**1. Independent Variable – Artificial Intelligence**

The results shown in Table (8) indicate that the artificial intelligence variable ranked first in terms of relative importance, with an overall mean of 2.939, a standard deviation of 0.865, and a coefficient of variation of 29.45%. This reflects a good level of attention toward applying AI technologies within the digital entrepreneurship environment. However, the overall mean does not indicate strong adoption, but rather a moderate level leaning toward positivity—possibly linked to barriers related to technological resources or organizational understanding of these applications.

- Analysis of the AI dimensions revealed that **Predictive Analytics** ranked first with a mean of 2.929, reflecting a clear reliance on data analysis and forecasting tools. Nevertheless, sustaining this reliance may be limited by a shortage of skilled personnel or weak analytical infrastructure in some organizations, particularly given the coefficient of variation of 32.62%, which indicates inconsistency in practice.
- **Recommender Systems** ranked second with a mean of 2.847, reflecting a relative interest in service personalization; however, this level also indicates a lack of full practical adoption of these systems, potentially due to their limited integration into digital operations or insufficient awareness of their marketing importance.
- **Machine Learning** recorded a mean of 2.867 and ranked third, indicating initial tendencies toward using this technology, though still within a limited or experimental scope. This may be attributed to challenges related to cost or inadequate infrastructure, especially given the high coefficient of variation of 35.64%.
- Although **Robotic Process Automation** recorded the highest mean of 3.174, it ranked last among AI dimensions due to the high coefficient of variation (36.49%), reflecting considerable disparity in application levels across organizations. This likely points to challenges in technical readiness, organizational resistance to change, and weak institutional culture regarding full digital transformation.

**2. Dependent Variable – Digital Entrepreneurship**

The results in Table (8) show that the digital entrepreneurship variable ranked second, with an overall mean of 2.934, a standard deviation of 0.970, and a coefficient of variation of 33.07%. This reflects a moderate level of adoption of digital entrepreneurial practices—indicating tangible efforts in some areas alongside clear weaknesses in others, suggesting gaps in fully integrated activation of digital tools and methodologies within these environments.

- **Decision-Making** ranked first with a mean of 3.000, reflecting a reasonable awareness of the importance of using data and analytics to support decisions. However, this does not imply full digital maturity, as the mean still suggests challenges in speed, accuracy, or the deployment of advanced analytical tools.
- **User Experience Enhancement** ranked second with a mean of 3.010, indicating a willingness to improve the digital user experience. Nonetheless, the high coefficient of variation (36.48%) may suggest instability in policies aimed at improving this experience or gaps in platform design and content personalization.
- **Digital Marketing and Targeting** ranked third with a mean of 2.725, reflecting relative weaknesses in the effectiveness of digital marketing campaigns or limited utilization of precise targeting and analytics tools. The variability in practices may be due to underinvestment in this area or the absence of clear digital strategies.
- Finally, **Product and Service Innovation** ranked fourth with a mean of 2.898 and a high coefficient of variation (39.48%), indicating clear shortcomings in organizations' ability to deliver innovative digital solutions or continuously update products and services. This reflects gaps in innovation culture or limitations in allocating resources for experimentation and development.

Table (8) Descriptive Statistics of the Research Variables and Dimensions

| Research variables & dimensions | M | S | CV | Rank |
|---|---|---|---|---|
| Machine Learning | 2.867 | 1.022 | 35.64 | **3** |
| Recommender Systems | 2.847 | 0.978 | 34.34 | **2** |
| Predictive Analytics | 2.929 | 0.955 | 32.62 | **1** |
| Robotic Process Automation | 3.174 | 1.158 | 36.49 | **4** |
| **Artificial Intelligence** | **2.939** | **0.865** | **29.45** | **First** |
| Decision-Making | 3.000 | 1.035 | 34.52 | **1** |
| Digital Marketing & Targeting | 2.725 | 1.023 | 37.56 | **3** |
| Product and Service Innovation | 2.898 | 1.144 | 39.48 | **4** |
| User Optimization (Experience) | 3.010 | 1.098 | 36.48 | **2** |
| **Digital Entrepreneurship** | **2.934** | **0.970** | **33.07** | **Second** |

Source: SPSS v.28 program

## 5.5 Statistical Analysis and Hypothesis Testing

The statistical analysis was conducted using Structural Equation Modeling (SEM) via the AMOS software to assess the relationships between Artificial Intelligence (AI) dimensions and Digital Entrepreneurship (DE). The analysis included the evaluation of path coefficients, model fit indices, and significance levels for each hypothesis.

- **Testing the First Main Hypothesis:** "There is a statistically significant impact of artificial intelligence on digital entrepreneurship in the private banks within the research domain."

As shown in **Table (9)** and **Figure (5)**, the extracted F-value between artificial intelligence and digital entrepreneurship was **209.018**, which is greater than the tabulated F-value of **3.94** at a significance level of **0.05**. This result provides sufficient evidence to accept the alternative hypothesis, which states that there is a statistically significant effect of artificial intelligence on digital entrepreneurship.This indicates that artificial intelligence has a significant impact on digital entrepreneurship, explaining **68%** of the variance in digital entrepreneurship variables. Furthermore, the extracted t-value for the artificial intelligence variable was **14.457**, which is greater than the tabulated t-value of **1.984** at the **0.05** significance level. This confirms the statistical significance of the β coefficient for the artificial intelligence variable, indicating that a one-unit increase in artificial intelligence would lead to an **85%** increase in digital entrepreneurship.

Table (9) Analysis of the Impact of Artificial Intelligence Dimensions on Digital Entrepreneurship

| **Artificial Intelligence Dimensions** | | | **(t)** | **(R)** | **($R^2$)** | **($R^2$) Adj** | **(F)** | **Sig** | **Dependent Variable** |
|---|---|---|---|---|---|---|---|---|---|
| Learning machine | **(α)** | 1.261 | 6.391 | 0.661 | 0.437 | 0.431 | **74.481** | **0.000** | Digital entrepreneurship |
| | **(β)** | 0.559 | 8.630 | | | | | | |
| Recommender systems | **(α)** | 0.973 | 4.858 | 0.712 | 0.507 | 0.502 | **98.660** | **0.000** | |
| | **(β)** | 0.656 | 9.933 | | | | | | |
| Predictive analytics | **(α)** | 0.688 | 3.724 | 0.783 | 0.613 | 0.609 | **151.973** | **0.000** | |
| | **(β)** | 0.739 | 12.328 | | | | | | |
| Robotic Process Automation | **(α)** | 1.021 | 5.096 | 0.703 | 0.494 | 0.489 | **93.858** | **0.000** | |
| | **(β)** | 0.603 | 9.688 | | | | | | |
| Artificial intelligence | **(α)** | 0.346 | 1.910 | 0.828 | 0.685 | 0.682 | **209.018** | **0.000** | |
| | **(β)** | 0.856 | 14.457 | | | | | | |

Source: SPSS v.28 program

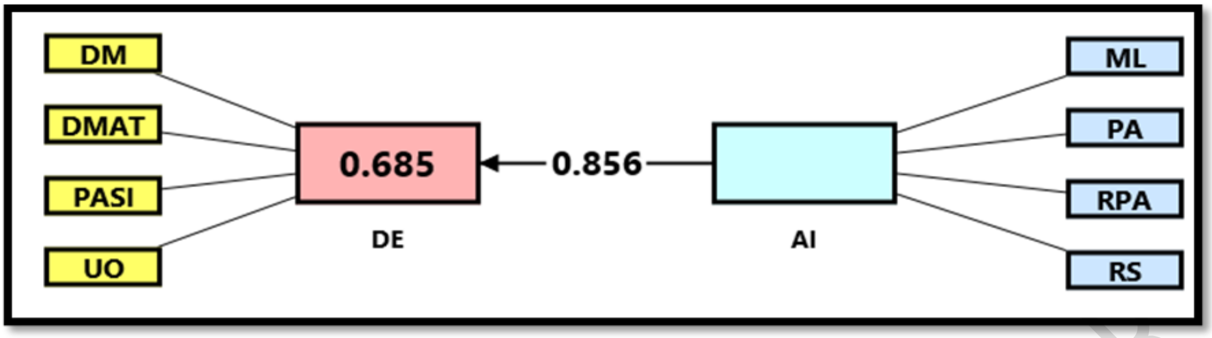



Figure (5) Analysis of the Impact of Artificial Intelligence on Digital Entrepreneurship
Source: Outputs of Smart Pls v.4 program

1. **Sub-Hypothesis 1**: There is a statistically significant effect of the Machine Learning dimension on digital entrepreneurship.

As shown in **Table (9)** and **Figure (6)**, the extracted F-value between the Machine Learning dimension and digital entrepreneurship was **74.481**, which is greater than the tabulated F-value of **3.94** at a significance level of **0.05**. This result provides sufficient evidence to accept the alternative hypothesis, which states that there is a statistically significant effect of the Machine Learning dimension on digital entrepreneurship.

This indicates that the Machine Learning dimension has a significant impact on digital entrepreneurship, explaining **43%** of the variance in digital entrepreneurship variables. Furthermore, the extracted t-value for the Machine Learning dimension was **8.630**, which is greater than the tabulated t-value of **1.984** at the **0.05** significance level. This confirms the statistical significance of the β coefficient for the Machine Learning dimension, indicating that a one-unit increase in Machine Learning would lead to a **55%** increase in digital entrepreneurship.

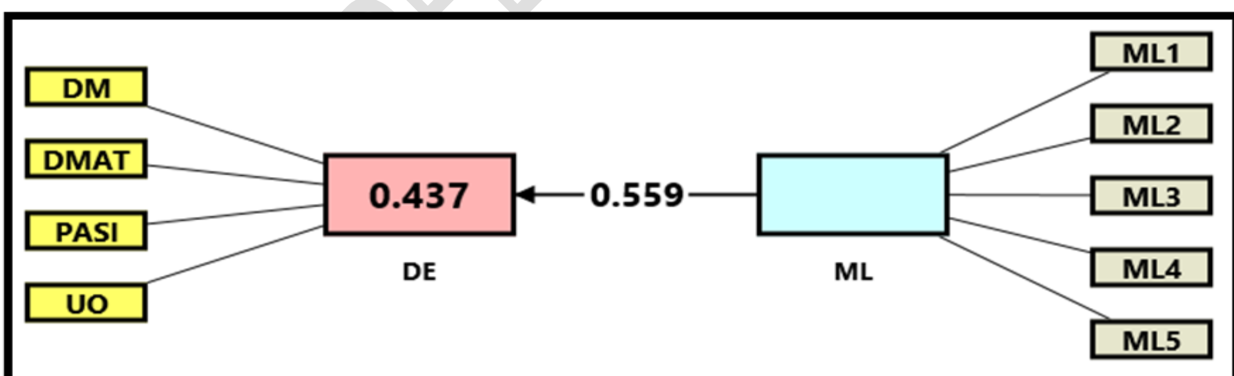



Figure (6) Analysis of the Impact of the Machine Learning Dimension on Digital Entrepreneurship
Source: Outputs of Smart Pls v.4 program

2. **Sub-Hypothesis 2:**There is a statistically significant effect of the Recommender Systems dimension on digital entrepreneurship.

As shown in **Table (9)** and **Figure (7)**, the extracted **F-value** between the Recommender Systems dimension and digital entrepreneurship was **98.660**, which is greater than the tabulated F-value of **3.94** at a significance level of **0.05**. This result provides sufficient evidence to accept the alternative hypothesis, which states that there is a statistically significant effect of the Recommender Systems dimension on digital entrepreneurship.

This indicates that the Recommender Systems dimension has a significant impact on digital entrepreneurship, explaining **50%** of the variance in digital entrepreneurship variables. Furthermore, the **extracted** t-value for the Recommender Systems dimension was **9.933**, which is greater than the tabulated t-value of **1.984** at the 0.05 significance level. This confirms the statistical significance of the β coefficient for the Recommender Systems dimension, indicating that a one-unit increase in Recommender Systems would lead to a **65%** increase in digital entrepreneurship.

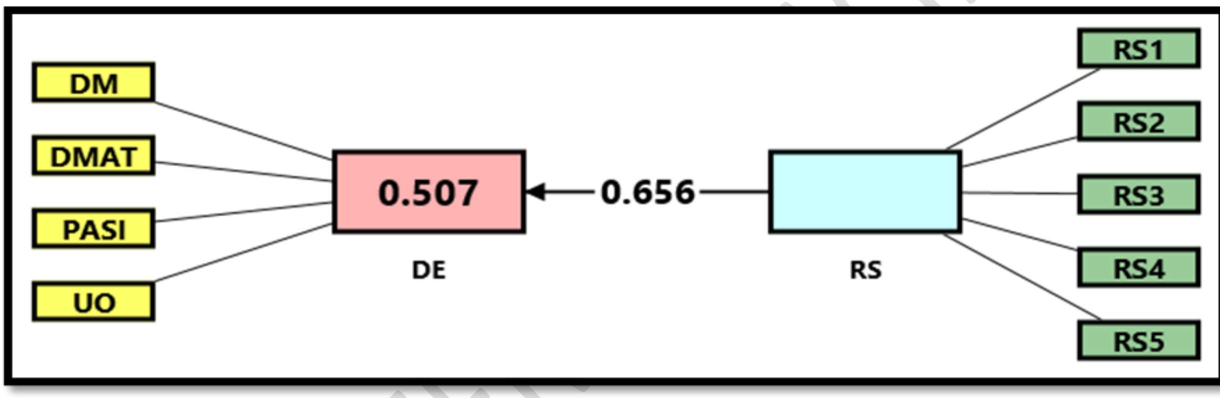


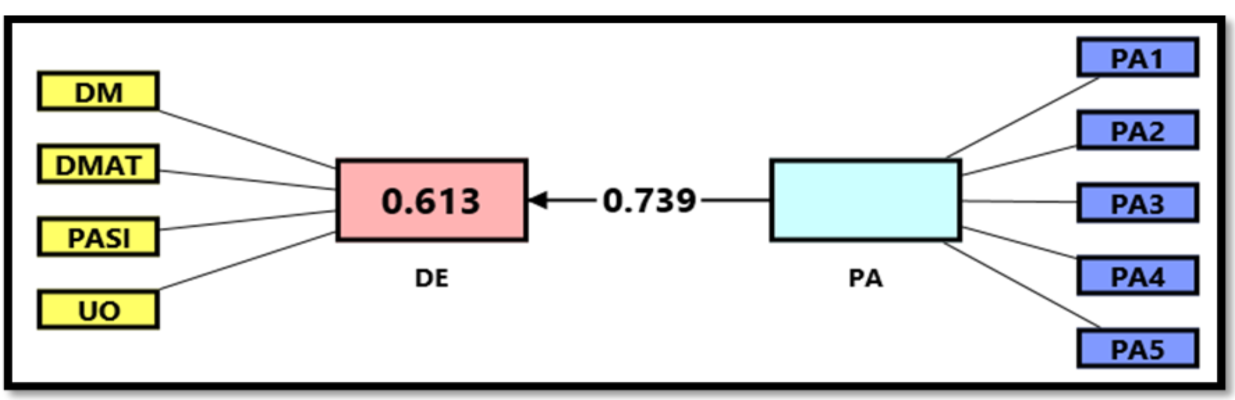

Figure (7) Analysis of the Impact of the Recommender Systems Dimension on Digital Entrepreneurship

Source: Outputs of Smart Pls v.4 program

3. **Sub-Hypothesis 3:**There is a statistically significant effect of the Predictive Analytics dimension on digital entrepreneurship.

As shown in **Table (9)** and **Figure (8)**, the extracted F-value between the Predictive Analytics dimension and digital entrepreneurship was **151.973**, which is greater than the tabulated F-value of **3.94** at a significance level of **0.05**. This result provides sufficient evidence to accept the alternative hypothesis, which states that there is a statistically significant effect of the Predictive Analytics dimension on digital entrepreneurship.

This indicates that the Predictive Analytics dimension has a significant impact on digital



entrepreneurship, explaining **61%** of the variance in digital entrepreneurship variables. Furthermore, the extracted **t-value** for the Predictive Analytics dimension was **12.328**, which is greater than the tabulated t-value of **1.984** at the 0.05 significance level. This confirms the statistical significance of the **β coefficient** for the Predictive Analytics dimension, indicating that a one-unit increase in Predictive Analytics would lead to a **73%** increase in digital entrepreneurship.

Figure (8) Analysis of the Impact of the Predictive Analytics Dimension on Digital Entrepreneurship

Source: Outputs of Smart Pls v.4 program

4. **Sub-Hypothesis 4:**There is a statistically significant effect of the Robotic Process Automation dimension on digital entrepreneurship.

As shown in **Table (9)** and **Figure (9)**, the extracted F-value between the Robotic Process Automation (RPA) dimension and digital entrepreneurship was **93.858**, which is greater than the tabulated F-value of **3.94** at a significance level of **0.05**. This result provides sufficient evidence to accept the alternative hypothesis, which states that there is a statistically significant effect of the Robotic Process Automation dimension on digital entrepreneurship.

This indicates that the Robotic Process Automation dimension has a significant impact on digital entrepreneurship, explaining **49%** of the variance in digital entrepreneurship variables. Furthermore, the extracted **t-value** for the Robotic Process Automation dimension was **9.688**, which is greater than the tabulated t-value of **1.984** at the 0.05 significance level. This confirms the statistical significance of the **β coefficient** for the RPA dimension, indicating that a one-unit increase in Robotic Process Automation would lead to a **60%** increase in digital entrepreneurship.

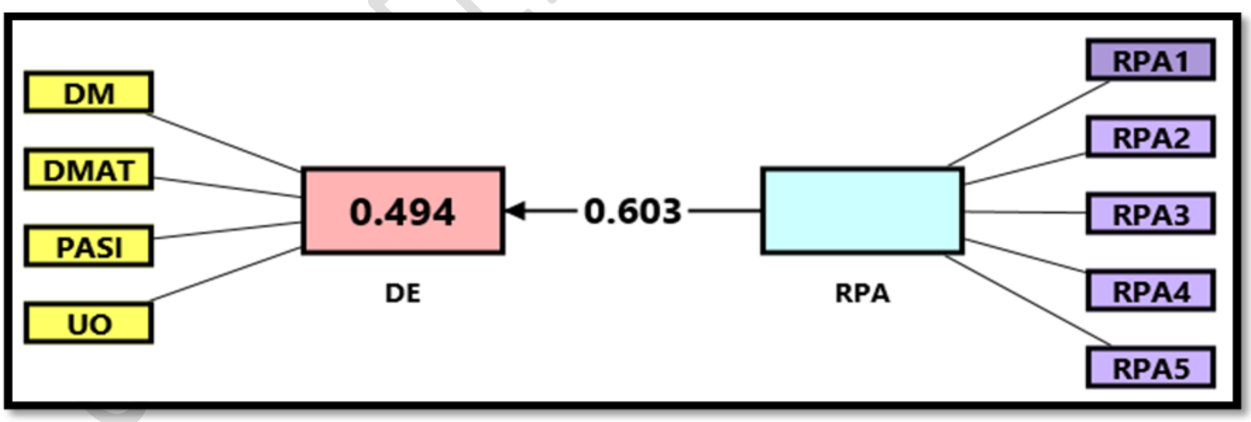



Figure (9) Analysis of the Impact of the Robotic Process Automation Dimension on Digital Entrepreneurship

Source: Outputs of Smart Pls v.4 program

- **Main Hypothesis 2:**There is a statistically significant effect of all Artificial Intelligence dimensions collectively on digital entrepreneurship.

**Table (10)** and **Figure (10)** present the results of the impact analysis between all AI dimensions collectively and digital entrepreneurship. The extracted F-value was **55.089**, indicating a statistically significant effect of AI dimensions collectively on digital entrepreneurship. This supports the acceptance of the alternative hypothesis stating that *there* is a statistically significant effect of all AI dimensions collectively on digital entrepreneurship.

The multicollinearity test results show no issue, as the **Tolerance** values were greater than **0.10**, and the **Variance Inflation Factor (VIF)** values were less than **5**. This generally indicates the absence of multicollinearity among the independent dimensions. The **$R^2$** value indicates that the AI dimensions collectively explained **70%** of the variance in digital entrepreneurship. Moreover, the extracted **t-values** of **2.869**, **4.565**, and **2.961**, respectively, were all greater than the tabulated t-value of **1.984**, confirming the statistical significance of the **β coefficients** for the dimensions of Machine Learning, Predictive Analytics, andRobotic Process Automation.

This means that a one-unit increase in these dimensions would lead to an increase in digital entrepreneurship by **19%**, **40%**, and **20%**, respectively. However, the results showed that the *Recommender Systems* dimension did not have a notable effect in the model.

Table (10) Analysis of the Collective Impact of Artificial Intelligence Dimensions on Digital Entrepreneurship

| VIF | Tolerance | Sig | F | $(R^2)$ Adj | $R^2$ | R | Sig | t | (β) | (α) | AI dimensions |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.986 | 0.503 | 0.000 | 55.089 | 0.690 | 0.703 | 0.839 | 0.005 | 2.869 | 0.193 | 0.307 | Learning machine |
| 3.202 | 0.312 | | | | | | 0.541 | 0.614 | 0.057 | | Recommender systems |
| 2.778 | 0.360 | | | | | | 0.000 | 4.565 | 0.406 | | Predictive analytics |
| 2.129 | 0.470 | | | | | | 0.004 | 2.961 | 0.209 | | Robotic process automation |
| **2.46** | | | | | | | **(F) standard** | | | | |

| | |
|---|---|
| **1.984** | **(t) standard** |

Source: Outputs of Smart Pls v.4, SPSS V.28 programs

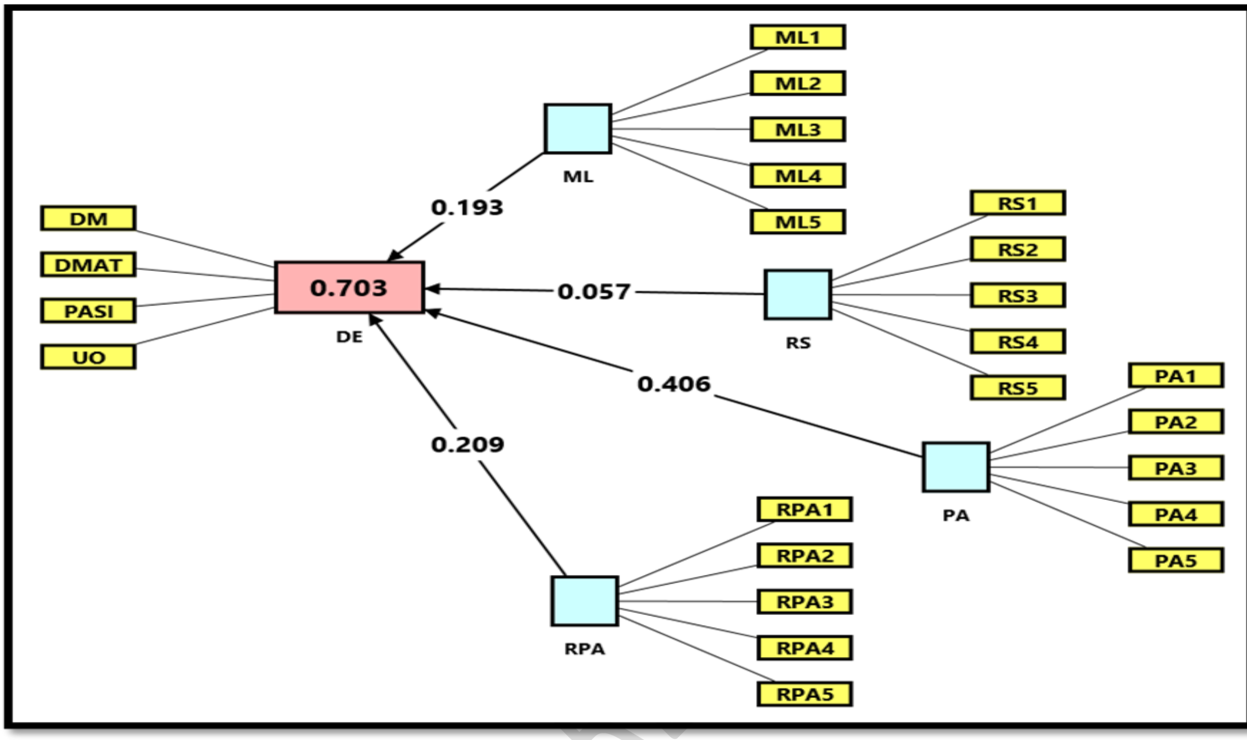



Figure (10) Analysis of the Collective Impact of Artificial Intelligence Dimensions on Digital Entrepreneurship

Source: Outputs of Smart Pls v.4

## 6. Conclusions and Recommendations

### 6.1 Conclusions

The main conclusions drawn from the study are as follows:

1. The values of the **Average Variance Extracted (AVE)** for the artificial intelligence variable ranged between **0.58–0.600**, which is higher than the threshold value of **0.50**. This indicates that the dimensions **(Machine Learning, Recommender Systems, Predictive Analytics, Robotic Process Automation)** significantly contribute to explaining the total variance of the artificial intelligence variable, suggesting that the proposed model is more reliable in explaining the relationships between its dimensions.
2. The **Cronbach's Alpha** values for the artificial intelligence variable ranged between **0.852–0.881**, exceeding the minimum threshold of **0.70**. This reflects a high level of reliability for the dimensions (**Machine Learning, Recommender Systems, Predictive Analytics, Robotic Process Automation**), further supporting the model's credibility in explaining interrelationships.

3. The **Composite Reliability (CR)** values for the artificial intelligence variable ranged between **0.847–0.882**, also exceeding the threshold of **0.70**, confirming high internal consistency for the dimensions and reinforcing the model's reliability in interpreting the relationships between them.
4. The **AVE** values for the digital entrepreneurship variable ranged between **0.597–0.631**, which is greater than **0.50**. This means that the dimensions (**Decision-Making, Digital Marketing and Targeting, Product and Service Innovation, User Experience Enhancement**) make a substantial contribution to explaining the total variance of digital entrepreneurship, reflecting the model's strong explanatory power.
5. The **Cronbach's Alpha** values for the digital entrepreneurship variable ranged between **0.875–0.891**, which are above **0.70**, indicating high reliability for the dimensions (**Decision-Making, Digital Marketing and Targeting, Product and Service Innovation, User Experience Enhancement**).
6. The **CR** values for the digital entrepreneurship variable ranged between **0.878–0.893**, exceeding **0.70**, which confirms the high reliability of its dimensions, suggesting that the proposed model is robust in explaining the relationships between these dimensions.
7. The results showed that artificial intelligence ranked **first** in relative importance (**29.45%**), indicating a good level of interest in adopting AI technologies. However, the overall mean score of **2.939** does not reflect strong adoption but rather a moderate, slightly positive level—likely due to barriers related to technical resources or institutional understanding of these applications.
8. Digital entrepreneurship ranked **second** in relative importance (**33.07%**), indicating a moderate level of adoption of digital entrepreneurial practices, which points to shortcomings in the comprehensive integration of digital tools and methodologies within these environments.
9. Analysis of the AI dimensions revealed that **Predictive Analytics** ranked first in relative importance (**32.62%**), reflecting a clear reliance on data analysis and forecasting tools. **Recommender Systems** and **Machine Learning** ranked second and third, respectively, while **Robotic Process Automation** ranked fourth (**35.64% CV**), indicating high variability in application levels across organizations—likely due to readiness challenges and weak digital transformation culture.
10. Analysis of digital entrepreneurship dimensions showed that **Decision-Making** ranked first in relative importance (**34.52%**), reflecting an acceptable awareness of the importance of data-driven decision-making. **User Experience Enhancement** and **Digital Marketing and Targeting** ranked second and third, respectively, while **Product and Service Innovation** ranked fourth (**39.48% CV**), indicating significant limitations in organizations' ability to offer innovative digital solutions or continuously update products and services.
11. The extracted **F-value** between artificial intelligence and digital entrepreneurship was **209.018**, greater than the tabulated value (**3.94**), providing strong evidence to accept the hypothesis that there is a statistically significant effect of AI on digital entrepreneurship.

12. The extracted **F-value** for the Machine Learning dimension was **74.481**, exceeding the tabulated value (**3.94**), confirming a statistically significant effect of Machine Learning on digital entrepreneurship.
13. The extracted **F-value** for the Recommender Systems dimension was **98.66**, exceeding the tabulated value (**3.94**), confirming a statistically significant effect of Recommender Systems on digital entrepreneurship.
14. The extracted **F-value** for the Predictive Analytics dimension was **151.973**, exceeding the tabulated value (**3.94**), confirming a statistically significant effect of Predictive Analytics on digital entrepreneurship.
15. The extracted **F-value** for the Robotic Process Automation dimension was **93.858**, exceeding the tabulated value (**3.94**), confirming a statistically significant effect of Robotic Process Automation on digital entrepreneurship.
16. The results indicated that the extracted **F-value** for all AI dimensions collectively on digital entrepreneurship was **55.089**, providing sufficient evidence to accept the hypothesis that **there is a statistically significant effect of all AI dimensions collectively on digital entrepreneurship**. Moreover, the extracted **t-values** of **2.869**, **4.565**, and **2.961**, respectively, were all greater than the tabulated t-value (**1.984**), confirming that the **β coefficients** for the dimensions of Machine Learning, Predictive Analytics, and Robotic Process Automation represent real effects. A one-unit increase in these dimensions would lead to increases in digital entrepreneurship by **19%**, **40%**, and **20%**, respectively. However, the **Recommender Systems** dimension was found to have no notable effect in the model.

## 6.2 Recommendations

Based on the conclusions reached, the researchers recommend the following:

1. **Enhance the adoption of AI applications** and encourage scientific competencies in the banking sector by organizing training courses and scientific seminars focusing on their importance, with the aim of increasing expertise, as these applications effectively contribute to the development of products and services.
2. **Prioritize protection and personalization of services** through the full practical adoption of Recommender Systems by integrating them with digital operations and raising awareness of their marketing significance to improve customer experience and satisfaction.
3. **Support the implementation of Machine Learning** by providing the necessary financial resources and infrastructure to develop intelligent systems and foster innovation.
4. **Strengthen the readiness of technical staff** through continuous training and reduce resistance to organizational change via awareness campaigns that highlight the importance of full digital transformation and its benefits for institutional performance.
5. **Focus on delivering innovative digital solutions** by allocating sufficient resources to research and development, which supports innovation and contributes to improving the quality of products and services.

6. **Encourage investment in digital technologies** while establishing clear organizational strategies in digital marketing and targeting to maximize returns and achieve sustainable growth.
7. **Reduce gaps in digital platform design** and tailor content to meet user needs, with the goal of improving the digital user experience and increasing engagement.
8. **Provide advanced analytical tools** to help reduce errors and improve response speed, thereby supporting data-driven decision-making based on accurate and reliable information.

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