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DIGITAL TRANSFORMATION AND ARTIFICIAL INTELLIGENCE AND THEIR IMPACT ON HUMAN CAPITAL EFFICIENCY

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ABSTRACT

The study aimed to identify the Digital transformation and Artificial Intelligence and their Impact on Human Capital Efficiency, the descriptive correlational approach was used to suite the purpose of the study, Sample of the consisted of 380 employees working in various sectors of Jordanian institutions and companies which chosen randomly. These institutions and companies are registered with the Jordanian Ministry of Industry and Trade. Data was collected by the questionnaire, the validity and reliability of which were confirmed. The study results showed that the level of digital transformation, with its dimensions (digital technologies used, digital systems integration, and digital efficiency), was of a medium level. The level of artificial intelligence (AI) use, with its dimensions (user behavior, training and development, and availability of experts), was also of a medium level. Furthermore, the human capital efficiency was found to be at a medium level in the institutions included in the study sample. The study results demonstrated a statistically significant impact of digital transformation, with its dimensions (digital technologies used, digital systems integration, and digital efficiency), on human capital efficiency. Similarly, the results showed a statistically significant impact of AI, with its dimensions (user behavior, training and development, and availability of experts), on human capital efficiency in institutions and companies operating in Jordan. The study recommended the continued implementation of digital transformation and artificial intelligence in Jordanian institutions.

1. INTRODUCTION

In recent decades, the world has witnessed an unprecedented acceleration in the pace of technological development, as digital transformation has become an indispensable strategic option for institutions seeking to survive and compete. Digital transformation is no longer just about introducing modern technological tools into the work environment, but has turned into a comprehensive reformulation of processes, organizational structures, and business models, ensuring that technology is employed to improve performance and raise the level of efficiency. At the heart of this transformation, artificial intelligence stands out as one of the most important main drivers of change, given its ability to analyze big data, automate processes, and support decision-making with accuracy and speed that exceeds traditional human capabilities.

The relationship between digital transformation and artificial intelligence, on the one hand, and the efficiency of human capital, on the other, is complementary. It is based on redefining the role of human beings within organizations. Technology does not aim to eliminate people, but rather to empower them and enhance their productivity by reducing routine tasks, providing advanced analytical tools, and offering opportunities for continuous learning and the development of digital skills. With the increasing reliance on intelligent systems, competencies related to digital analysis, data management, critical thinking, and the ability to adapt to technological changes have become essential elements in building human capital capable of keeping pace with these transformations.

On the other hand, digital transformation contributes to improving the work environment by enhancing internal communication, accelerating information flow, and increasing transparency, which positively impacts employee performance and motivation. Artificial intelligence also provides organizations with advanced human resource management tools, such as performance analysis, training needs forecasting, and career path planning, thus contributing to the optimal utilization of human capital.

Studying the impact of digital transformation and artificial intelligence on human capital efficiency is an important entry point for understanding how to build more resilient and sustainable organizations capable of achieving excellence in a rapidly changing and increasingly competitive environment.

1.1. Study Problem

With the accelerating adoption of digital transformation and artificial intelligence applications across various sectors, organizations face a fundamental challenge: their ability to leverage these technologies to positively impact the efficiency of their human capital. Despite significant investments in digital infrastructure and smart systems, many organizations still struggle to bridge the gap between possessing the technology and realizing the expected return on investment in performance and productivity. This problem becomes even more pronounced when technological transformation is not accompanied by the development of human skills or the redesign of administrative and organizational processes to align with the new digital environment.

The problem of the study is that there is a central question about the nature of the relationship between digital transformation and artificial intelligence on the one hand, and the efficiency of human capital on the other; does the integration of smart technologies lead to raising the productivity of workers and improving the quality of performance, or does it create new challenges such as resistance to change, the digital skills gap, and job anxiety? This issue also raises questions about the extent to which institutions are ready to qualify their human resources, adopt sustainable training policies, and build an organizational culture that supports innovation.

The current study seeks to answer the main research question, which states: "Does digital transformation and artificial intelligence have an impact on human capital efficiency indicators, thus contributing to providing practical recommendations to maximize the return on investment in both technology and human resources?" The following research questions can also be answered:

1.2. Research Questions:

This study will answer the following questions:
- To what extent are digital transformation and artificial intelligence implemented in organizations operating in Jordan?
- What is the level of human capital efficiency indicators in organizations operating in Jordan?
- Does digital transformation have an impact on human capital efficiency in organizations operating in Jordan?
- Does artificial intelligence have an impact on human capital efficiency in organizations operating in Jordan?

1.3. Significance of the Study

The importance of this study lies in two aspects: theoretical and practical, as follows:

1.4. Theoretical Importance:

It is hoped that this study will contribute to building a theoretical framework rich in variables

related to digital transformation, artificial intelligence, and human capital efficiency. It will also enrich the Arabic library with a rare study—to the best of the researcher's knowledge—that has not yet utilized all three variables together. Furthermore, this study can serve as a reference and a precedent that researchers and students in the economic field can utilize, and the study's developed measures can be used in their own research. It is also hoped that this study will contribute to building a proposed model for the relationship between digital transformation, artificial intelligence, and human capital efficiency.

1.5. Practical Importance:

The importance of the study lies in the fact that it benefits officials and decision-makers in institutions operating in Jordan, regardless of their specialization, in developing work strategies to invest in digital transformation and artificial intelligence in order to reach the efficiency of human capital suitable for engaging in work, which enhances the efficiency of those institutions, development and innovation. The results of the study can also be used to guide economic policies within Jordanian institutions and encourage the adoption of technological methods that positively affect the efficiency of human capital.

1.6. Study Objectives:

This study aims to:
- Identify the extent of digital transformation and artificial intelligence implementation in Jordanian organizations.
- Investigate the level of human capital efficiency indicators in Jordanian organizations.
- Identify the impact of digital transformation on human capital efficiency in Jordanian organizations.
- Identify the impact of artificial intelligence on human capital efficiency in Jordanian organizations.

1.7. Study Terms and Their Operational Definitions:

The current study includes several terms, and the following are the terminological and operational definitions for each:
- **Digital transformation:** Digital transformation is defined as the use of digital technology to improve the performance of organizations, and it requires redesigning businesses to make the most of the digital reality, by changing the business strategy and not the data (Tantawi, 2023).

Grab et al. (2019) define digital transformation as a phenomenon that transcends borders and impacts the business activities of companies worldwide. While borders do not entirely limit the power of

change, it is important to note that the effects of digital transformation are not evenly distributed across countries and regions, as the overall state of economic development significantly influences a country's ability to deepen its digital transformation.

Al-Hawari and Marzouq (2023) defined digital transformation as the conversion of traditional operational processes and business activities to digital technologies and an integrated digital environment. Digital transformation involves adopting modern information and communication technologies, developing business applications and software, improving processes, and integrating data across the company. Digital transformation is essential for modern businesses to adapt to technological advancements and remain competitive in the market.
- **Digital transformation is operationally defined**: the score obtained by the study sample on the digital transformation scale, which includes the digital technologies used, digital systems integration and digital efficiency.
- **Artificial Intelligence (AI):** As defined by Siu, Wang, and Ibrahim (2025), AI is a branch of computer science concerned with designing systems and software that enable machines to think in a way that mimics human behavior. This allows computers to possess capabilities similar to the human mind, exhibiting specific behaviors and characteristics that distinguish computer programs. AI is defined as a system's ability to operate flexibly and purposefully in a complex and partially unpredictable environment (Rousku, 2019). Operationally, it is defined as a field of science and technology concerned with developing computer systems capable of simulating human intelligence. These systems are capable of learning, reasoning, making decisions, and even recognizing patterns and trends. AI is measured by the score achieved by the study participants on an AI scale.

1.8. Human Capital Efficiency:

Human Capital Efficiency is the extent to which an organization's human resources can utilize their knowledge, skills, experience, and behavioral abilities to achieve organizational goals with the highest levels of productivity and quality, at the lowest possible cost and in the shortest possible time. It reflects the added value that employees achieve through their effective performance, their ability to innovate, adapt to changes, and contribute to process improvement and decision-making (Hamadi, 2018), Operationally, it is defined as the score obtained by the study sample on the human capital efficiency scale.

1.9. Study Limitations

The study limitations were as follows:
- **Human Limitations:** The study was limited to employees in institutions across all specializations.
- **Geographical Limitations:** This study was conducted in institutions registered with the Jordanian Ministry of Industry and Trade.
- **Temporal Limitations:** The current study was conducted during the first quarter of 2026.

- **Thematic Limitations:** The study topics were limited to digital transformation, artificial intelligence, and human capital efficiency.

1.10. Study Model

The researcher developed a specific model for this study to achieve the defined objectives and fulfill its purpose of examining the impact of the independent variables on the dependent variable. The study model and its variables are illustrated in Figure (1).
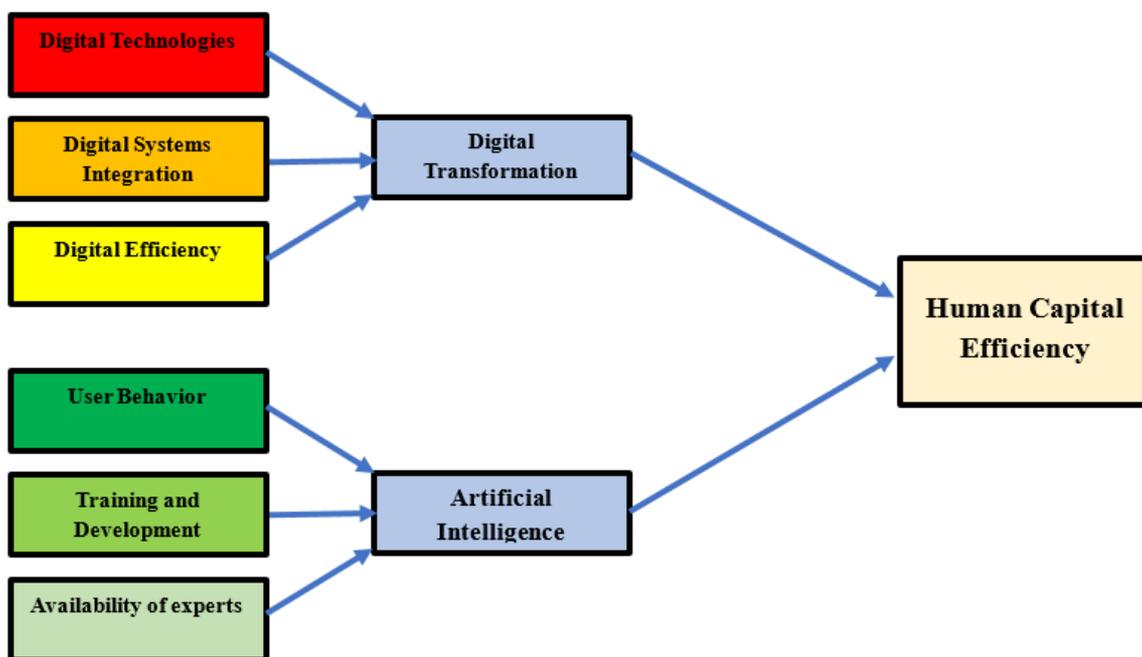

Figure 1:

2. THEORETICAL FRAMEWORK

2.1. First Dimension: Digital Transformation

Digital transformation is considered one of the most prominent changes witnessed in the contemporary world, as it has become a fundamental element in developing institutions and improving their performance across various sectors. Digital transformation refers to the process of employing digital technologies to redesign processes, services, and business models, thereby contributing to increased efficiency, enhanced quality, and the achievement of sustainable competitive advantage. This transformation is not limited to the use of technology alone but also encompasses changes in organizational culture and work practices to align with the requirements of the digital environment (Rustum, 2024).

The rapid development of information and communication technologies has accelerated the pace of digital transformation, enabling institutions to improve data management, facilitate communication, and provide faster and more accurate services. Digital transformation also helps enhance transparency, supports data-driven decision-making, and improves the user experience. With increasing competition and rapid changes in the business environment, adopting digital transformation has become a strategic necessity to ensure continuity and growth, rather than merely a technical option that can be postponed (Al-Sulami, 2021).

2.1.1. Dimensions of Digital Transformation

2.1.2. Digital Technologies Used

The digital technologies used in institutions are considered one of the fundamental pillars of digital transformation, as they represent the means through which the work environment is modernized, and management and operational practices are developed to align with the requirements of the digital age. This process is not limited to introducing modern technological tools; it extends to restructuring internal processes, simplifying procedures, and enhancing integration across different departments through interconnected digital systems. Among the

most prominent of these technologies are Enterprise Resource Planning (ERP) systems, which integrate financial operations, human resources, and supply chains into a unified platform, thereby improving accuracy and transparency and accelerating data-driven decision-making (Al-Shammari, 2025).

Cloud computing is also a crucial component in supporting the digital infrastructure of institutions, providing flexibility in data storage and management, secure access from multiple locations, and reducing costs associated with hardware and maintenance. Additionally, Internet of Things (IoT) technologies play an important role in tracking assets and monitoring operations in real time, thereby improving operational efficiency and reducing errors and waste. Document management and electronic archiving systems further contribute to speeding up transactions, enhancing governance, and minimizing reliance on paper. The integration of these technologies within a clear strategic vision reflects the maturity of digital transformation in the institution and strengthens its ability to achieve efficiency, sustainability, and competitive excellence (Abdul-Mu'min Wahdu & Mohamed, 2024).

2.1.3. Digital Systems Integration

Digital systems integration is considered a fundamental element in the path of digital transformation within institutions. It refers to linking various systems and technical applications so that they operate within a coherent environment that allows data to be exchanged instantly and securely. Instead of each system operating in isolation, integration enables the creation of an interconnected framework that unifies information sources and prevents duplicate entries and repeated errors. This contributes to improving the efficiency of administrative and operational processes, accelerating transaction completion, and enhancing report accuracy, which positively reflects on institutional performance and data-driven decision-making (Al-Hawari & Marzouq, 2023).

System integration is achieved through tools and technologies such as application programming interfaces (APIs), middleware platforms, shared databases, and cloud solutions that facilitate interconnection between different applications. However, such integration requires clear strategic planning, standardized data management protocols, and ensuring the highest levels of information security to protect exchanged data. It also necessitates administrative support and continuous employee training to ensure optimal use of integrated systems. Therefore, digital systems integration represents a crucial step toward building a more efficient, flexible institution capable of responding to rapid changes in the work environment (Al-Farsi & Khan, 2020).

2.1.4. Digital efficiency

Digital efficiency is a modern concept that has emerged with the acceleration of digital transformation across various sectors. It refers to the ability of individuals or institutions to use digital technologies effectively and safely to achieve desired goals with maximum productivity and quality. Digital efficiency is not limited to possessing basic technical skills; it also includes a deep understanding of digital tools, the ability to use them strategically, handling and analyzing data, and adhering to ethical standards and information security (Didenko, Skripnuk, Kikkas, Kalinina & Kosinski, 2021).

At the individual level, Digital efficiency is reflected in the ability to use computers, applications, and electronic systems efficiently, interact with digital platforms, solve basic technical problems, and adapt to continuous updates in the digital work environment. At the institutional level, it is evident in the ability to integrate technology into daily operations, develop services, enhance user experience, and make data-driven decisions (Ferreira, Fernandes & Ferreira, 2019).

Digital efficiency is also linked to continuous learning due to rapid technological developments, requiring investment in training and fostering an organizational culture that supports innovation. In an increasingly competitive environment, Digital efficiency has become a critical factor for achieving competitive advantage and ensuring sustainability, enabling institutions to respond quickly to changes, enhance performance, and support growth in a rapidly evolving digital landscape (Didenko et al., 2021).

2.1.5. The Relationship Between Digital Transformation and Human Capital Efficiency

The relationship between digital transformation and human capital efficiency in institutions is considered strategic and pivotal, as each serves as a fundamental pillar for enhancing institutional performance and achieving competitive advantage. Digital transformation in institutions is not limited to the introduction of new technologies; it also involves redesigning operational and administrative processes, improving the flow of information between departments, and implementing intelligent systems that support data-driven decision-making. To maximize the benefits of these systems, the success of digital transformation heavily depends on the efficiency of human capital—that is, the extent to which employees are able to interact with digital technologies, use them effectively to complete tasks, analyze information, and provide innovative solutions (Rodchenko et al., 2021).

Furthermore, digital transformation contributes to the development of human capital efficiency by

providing tools and technologies that support continuous learning, enhance performance, and reduce routine tasks. This allows employees to focus more on strategic activities and make analytical, data-driven decisions. Integrating digital technology also improves communication among teams, increases collaboration and creativity, and strengthens employees' ability to adapt to continuous changes in the work environment (Purwanto et al., 2023).

Thus, a reciprocal relationship is formed between digital transformation and human capital efficiency: as employees' Digital efficiency increases, the institution's ability to effectively apply digital transformation tools grows, enhancing productivity, quality, and innovation. Conversely, digital transformation supports the development of employee skills and raises overall competence, making this relationship one of the key elements of institutional success in the modern era, ensuring sustainability and the capacity to face rapid changes in the business environment (Thien, 2024).

2.2. Second Dimension: Artificial Intelligence

Artificial intelligence (AI) is considered one of the most prominent technological developments of the modern era, having brought about a radical transformation in the way institutions operate and in daily life practices. AI refers to the ability of computer systems to simulate human cognitive capabilities, such as learning, reasoning, data analysis, and decision-making. This field has developed rapidly due to advances in computing power, the availability of big data, and the evolution of algorithms, making it a pivotal element across various sectors (Awasthi, 2024).

AI is no longer a theoretical concept or a future technology; it has become a tangible reality applied across multiple domains, including healthcare, education, finance, industry, and e-commerce. It contributes to improving operational efficiency by automating routine processes, reducing human errors, and providing accurate analytics that support decision-making. AI also enables forecasting of future trends through the rapid analysis of massive amounts of data (Di Vaio, Gupta & D'Adamo, 2024).

However, AI also raises challenges related to data security, privacy, ethical use, and its impact on the labor market. Therefore, its effective deployment requires clear regulatory frameworks and well-designed strategies to maximize benefits while minimizing risks. In this regard, AI represents a foundational pillar for building a knowledge- and innovation-based digital economy (Al-Otaibi, 2017).

2.2.1. Dimensions of Artificial Intelligence

2.2.2. User Behavior

User behavior in artificial intelligence refers to the way individuals interact with intelligent systems and applications, and how they utilize this technology to achieve their daily objectives. This behavior reflects the user's understanding of technical functionalities, their trust in the results provided by the systems, their ability to adapt to new tools, and their effectiveness in leveraging the available capabilities. Analyzing user behavior is a key factor in improving the performance of intelligent systems, designing more user-friendly interfaces, and ensuring a positive user experience (Fleck, 2018).

User behavior is influenced by multiple factors, including the level of technical knowledge, awareness of AI benefits, and the sense of security and privacy when handling data. Previous experiences and expectations with technology also play a significant role in the user's acceptance of intelligent systems. On the other hand, user behavior can manifest in various forms, such as full reliance on AI recommendations or resistance to using systems due to fears of losing control or difficulty in interaction (Zharkimbekova et al., 2026).

Understanding user behavior helps institutions design AI solutions that are better aligned with user needs, improve human–machine interaction, and enhance overall effectiveness and efficiency. It also allows for predicting future requirements and supports the system's ability to provide personalized services that match diverse usage patterns. Therefore, investing in the study of user behavior represents a strategic step to ensure the successful implementation of AI applications (Acemoglu, Autor, Hazell & Restrepo, 2022).

2.2.3. Training and Development

Training and development in the field of artificial intelligence (AI) are considered pivotal elements for ensuring the effective utilization of this technology, both at the individual and institutional levels. The rapid advancement of AI technologies requires advanced skills, including understanding algorithms, data analysis, machine learning, and natural language processing, as well as the ability to integrate these tools into diverse work environments. Specialized training programs enable individuals to acquire essential technical skills and develop the capacity to solve complex problems using intelligent systems, thereby enhancing efficiency and productivity (Maity, 2019).

At the institutional level, training and development contribute to building teams capable of effectively managing and implementing AI projects, ensuring the integration of this technology with existing operational processes. Continuous development allows institutions to update knowledge and keep pace with rapid changes in the field, including the latest tools and intelligent

platforms. Furthermore, training helps raise awareness about AI ethics and data security, which is crucial for mitigating risks associated with the use of intelligent systems. Therefore, investing in training and development becomes a necessary strategy to build institutions capable of maximizing AI benefits, achieving sustainable competitive advantage, and empowering individuals to grow professionally in a constantly evolving digital environment (Dixit & Jatav, 2024).

2.2.4. Availability of Experts

The availability of experts in artificial intelligence (AI) is a key factor that determines an institution's ability to adopt this technology and maximize its benefits. AI experts possess advanced skills, including designing and developing algorithms, analyzing big data, machine learning, and natural language processing, as well as the ability to effectively integrate these tools into diverse work environments. A lack of specialized expertise is considered one of the major challenges facing institutions, as it can hinder the implementation of AI projects or reduce the quality of expected outcomes, thereby affecting operational efficiency and competitive capability (Grace et al., 2018).

The importance of having AI experts lies in their ability to guide digital transformation strategies, design intelligent solutions tailored to the institution's needs, ensure data security and privacy protection, and minimize risks associated with the misuse of technology. Additionally, the presence of experts fosters a culture of innovation within the institution by training internal teams and facilitating knowledge and experience sharing, which supports the development of digital competencies among other employees. From this perspective, investing in attracting experts and enhancing their skills becomes an essential part of institutional strategy to ensure the success of AI projects and achieve sustainable competitive advantage in a rapidly evolving digital environment (Agarwal, Moehring, Rajpurkar & Salz, 2023).

2.2.5. Challenges of Artificial Intelligence

With the rapid expansion and spread of technological development worldwide, futurists continue to emphasize the emergence of direct and indirect impacts resulting from the proliferation of artificial intelligence software and applications, including:
- The difficulty of ensuring the creation of safe and reliable machines and robots.
- The dominance of large corporations over medium and small enterprises in terms of productivity.
- The potential for the alteration or disappearance of some human values.
- The replacement of human labor by artificial intelligence applications.
- The rise of online platforms and marketplaces, which are disrupting the world of work.
- A shift in employment towards employing only creative, innovative, and productive human capital.
- The difficulty of creating effective interaction among the artificial intelligence applications themselves.

2.2.6. The relationship between artificial intelligence and human capital efficiency

There is no doubt that artificial intelligence, with its advancements in automation and robotics, has a positive impact on productivity, as it seeks to creatively re-engineer human capital. However, its impact will require the development of laws, the readiness of capital, changes in the labor market, job losses, and an increase in unemployment rates.

It must be acknowledged that the success of performance in any organization or institution must be based on the efficiency of human capital through continuous training, expansion in the business sector and development, and building a knowledge society. However, this success still faces many challenges amidst future aspirations for smart learning and the reduction of job opportunities (Al-Sayed and Al-Sheikh, 2018).

In the researcher's opinion, the efficiency of human capital is one of the most important pillars for maintaining any successful and continuous organization. Artificial intelligence, its multiple technologies, and anticipating its future are originally based on the existence of human capital with efficiency, skill, experience, and implicit knowledge.

2.2.7. Human Capital Theory (Schultz, 1960).

Schultz based his human capital theory (1960) on three main assumptions when developing the concept of human capital, for which he was awarded the Nobel Prize in 1979. His work focused on the development of human capital, and these assumptions are as follows:
- The assumption that economic growth cannot be explained by an increase in material inputs due to the accumulation of a quantitative stock of human capital.
- Understanding the differences in the amount of human capital invested in individuals allows us to explain the extent of income disparities.
- The higher the ratio of human capital to traditional capital, the greater the potential for income equity if this increase continues (Dahan, 2010).

2.2.8. Human Capital Efficiency

Human capital efficiency is one of the most important strategic factors that determine an institution's success and sustainability in the modern business environment. It represents the actual ability of employees to effectively utilize their knowledge, skills, and experience to achieve organizational goals and enhance productivity. This includes technical, cognitive, and behavioral capabilities, as well as analytical skills, problem-solving, and timely decision-making. Efficiency is also linked to the quality of individual and team performance and the employees' ability to adapt to continuous changes in the work environment, making human capital one of the critical assets on which institutions rely to achieve competitive advantage (Deng & Tan, 2025).

In the contemporary context, human capital efficiency is closely associated with the ability to manage digital transformation and modern technologies. Employees with advanced digital skills can use digital systems and intelligent applications to improve operational processes, reduce errors, and accelerate decision-making, thereby enhancing the quality of services and products. Moreover, continuous training and development programs play a pivotal role in strengthening this efficiency by refining specialized skills, building new capabilities, and updating knowledge in line with rapidly evolving technologies (Elghozail & El Idrissi, 2023).

Human capital efficiency also encompasses the ability to innovate, engage in continuous learning, and uphold organizational values and strategic objectives, all of which contribute to overall organizational performance. By investing in human capital development, institutions can enhance flexibility, increase adaptability to market changes, and achieve higher levels of productivity and quality. Ultimately, human capital efficiency serves as a key indicator of an institution's maturity and its ability to build a sustainable work environment, enabling it to compete effectively and achieve sustainable growth in a rapidly changing world (Mengistae, 2006).

2.2.9. Prior studies

The study by Abdul Aziz and Abdul Razzaq (2025) revealed the role of the digital economy in enhancing the efficiency of human resource development. The digital economy constitutes a fundamental pillar in this regard, as the use of digital technologies provides opportunities to improve skills, increase productivity, and achieve sustainable development.

The research focused on examining the relationship between the digital economy and human resource development, addressing diverse benefits such as reducing unnecessary costs, improving competencies, and promoting continuous learning

through e-learning platforms and digital recruitment. It also highlighted the improvement in employee performance to align with the demands of the digital age.

The study also discussed the challenges facing the implementation of the digital economy, such as the need for appropriate legislation to keep pace with rapid developments, the challenges associated with cybersecurity, the anticipated increase in unemployment resulting from digital transformation, and the widening of the digital divide between societies and developing countries.

The applied study demonstrated the importance of adopting comprehensive digital strategies, such as providing advanced technological infrastructure, allocating sufficient budgets for training, and supporting innovation to improve organizational performance. The study recommended promoting digital transformation as an effective means of improving and increasing the efficiency of human resource management, with a focus on developing legislation, ensuring information security, and developing human capital to achieve a sustainable competitive advantage that meets future needs.

Al-Kurdi (2023) conducted a study to identify the relationship between digital technology and the productive efficiency of human capital. Digital technology has become a key and constant component of daily life in all societies. As a result, the world is witnessing continuous scientific and technological changes, leading to fundamental transformations in human capital, which consists of new economic and productive competencies in its knowledge and skills components.

These new transformations have contributed to the emergence of a highly competitive global economy based on innovation, technology, talent, speed, and productive efficiency. Therefore, organizations are intensively searching for individuals with skills, experience, and talent to ensure they have competitive products and services that distinguish them in the market. In this context, the researcher attempts to study digital technology as a determinant in raising the productivity of human capital among individuals.

To achieve this objective, the researcher used an inductive approach to review studies that addressed the variables of the current study, and a deductive approach to formulate the results.

The study concluded that there is a direct correlation between the productive capacity of human capital and its reliance on digital technology. The importance of the current study lies in the fact that it provided a detailed and in-depth picture of the importance of the role that human capital plays in economic growth, in digital transformation, and in

achieving the well-being of individuals.

Mansour's study (2021) came to identify digital transformation as a mechanism for developing human capital in higher education institutions, The study aimed at determining the level of digital transformation and the level of human capital in university education institutions, identifying the dimensions of the digital transformation most related to the development of human capital in university education institutions from the point of view of the faculty members, and identifying the difficulties facing the digital transformation of human capital development in university education institutions. To a set of proposed mechanisms to support the digital transformation of human capital development in university education institutions, and this study is one of descriptive studies, and the study was based on the scientific method using the comprehensive social survey method for the faculty members of the Faculty of Social Work, Helwan University, who are (114)single, and the study tool was In an electronic questionnaire, and the results of the study concluded that the level of digital transformation in university education institutions is medium, and the level of human capital in university education institutions is medium, and the existence of a statistically significant positive relationship between digital transformation and human capital development in university education institutions.

Al-Hajri's study (2025) analyzed the investment in artificial intelligence in promoting innovation and developing human capital in the State of Qatar. It highlights the available possibilities for employing artificial intelligence technologies in supporting digital transformation, stimulating the environment of creativity, and raising the efficiency of Qatari human resources. The study also reviews relevant national policies and strategies such as the Qatar National Vision 2030, explaining how artificial intelligence can contribute to developing the education system, improving training outcomes, and enhancing the future skills required in the labor market. The study concludes that smart and organized investment in artificial intelligence represents an effective tool to drive sustainable development and build a knowledge-based economy in the State of Qatar.

The study by Al-Yahmedi and Amzat (2022) aimed to identify the impact of artificial intelligence (AI) applications on the development of human capital among administrative leaders in the Ministry of Education in the Sultanate of Oman, from their perspective.

The researchers employed a descriptive-predictive approach, developing a questionnaire to assess the impact of AI applications on human capital development from the leaders' own perspective. The final instrument consisted of 29 items, distributed across two scales: an AI applications scale (13 items) and a human capital development scale (16 items).

The study sample was selected using stratified random sampling. It comprised 290 administrative leaders, representing department directors, their assistants, and administrative and technical supervisors from the Ministry and all educational directorates in the Sultanate of Oman.

The study results showed that the degree of AI application by administrative leaders was moderate in the areas of user behavior and expert availability, and high in the areas of Nidam capability and training and development. The degree of human capital development practiced by administrative leaders was also moderate across all its dimensions.

Furthermore, the results indicated a weak, direct positive impact of AI applications on human capital development among administrative leaders at the Ministry of Education in the Sultanate of Oman.

The study by Ajasam and Nazim (2019) examined the impact of artificial intelligence (AI) on human capital management in Malaysia and its potential effect on enhancing competitive advantage. The study sample consisted of human resource managers and direct hiring managers in Malaysia, with a total of 260 participants. The research employed a descriptive-analytical methodology and revealed that AI is still in its early stages. The findings indicated that the implementation of AI can increase the productive efficiency of human capital within the framework of knowledge management. Moreover, learning through AI positively influences human capital management. Human capital skills and cognitive abilities were identified as strong enabling factors supporting the transition toward progress. Conversely, neglecting these factors could pose a threat to job security. While the prediction of AI's impact on reducing employment opportunities remains unclear and difficult to anticipate, AI-supported deep learning through efficient and enhanced human resource processes has a direct effect on the quality of human capital recruitment.

In contrast, the study by Jatooba, Santosa, and Gutierrez (2019) explored the development of AI research in human resources. The study adopted a quantitative descriptive-analytical approach and examined 32 journal articles published in the knowledge database between 2000 and 2018, which addressed AI applications and their impact on human resources. The study revealed a scarcity of research on AI in the field of human resources and human capital and highlighted the need for future studies on the impact of AI on human resource development. The authors recommended intensifying research

efforts in this area to better understand the role of AI in shaping human capital.

The study by Yawlkar (2019) investigated the impact of artificial intelligence (AI) on human resource management (HRM) and aimed to understand the challenges faced by HR leaders. The research employed a descriptive methodology, suitable for the study's objectives, and used a questionnaire as a data collection tool, drawing information from research papers, websites, and blogs. The results indicated that AI plays a significant role in various HR functions. AI systems can handle tasks such as recruiting, analyzing, and collecting data, thereby reducing the workload in the workplace. The study recommended creating a framework for using AI tools and digital technologies in HR practices. It concluded that AI plays a fundamental role in recruitment, selection, performance analysis, and the collection of employee-related data.

3. STUDY METHODOLOGY:

The study was based on the use of the descriptive correlational approach, as it is suitable for the study's purposes, which measure digital transformation and artificial intelligence and their impact on the efficiency of human capital in institutions and companies registered with the Jordanian Ministry of Industry and Trade.

3.1. Participants:

The study population consisted of individuals working in institutions and companies registered with the Ministry of Industry and Trade. The study population is considered very large due to the open number of individuals in the study population. As for the participants, they were selected by simple random method from the study population, which amounted to (384) participants, according to the sampling table. After distributing the questionnaires to the participants, (370) questionnaires were obtained, after (14) questionnaires were excluded as they were not suitable for the purposes of statistical analysis. Thus, the percentage of the study sample members was (96.4%) of the main sample. The following is an explanation of the study sample members according to demographic characteristics.

Table 1: Distribution of the study sample according to demographic characteristics

Variable	Frequency	Percentage (%)
Gender		
Male	315	85.1
Female	55	14.9
Total	370	100.0
Age		
18-30 years	75	20.3
31-40 years	220	59.5
41 years & above	75	20.3
Total	370	100.0
Work Experience		
Less than 5 years	50	13.5
5-Less than 10 years	180	48.7
10-Less than 15 years	90	24.3
15 years and above	50	13.5
Total	370	100.0

3.2. Study Instrument:

The researcher developed the study instrument by reviewing several previous studies and the instruments used therein. The instrument consisted of four parts:
- **Part One:** Demographic data, including gender, age, and experience.
- **Part Two:** Digital transformation, comprising the following sub-dimensions:
  - Digital technologies used, measured by (5) items.
  - Integration of digital systems, measured by (5) items.
  - Digital efficiency, measured by (5) items.

- **Part Three:** Artificial intelligence, comprising the following sub-dimensions:
  - User behavior, measured by (5) items.
  - Training and development, measured by (5) items.
  - Availability of experts, measured by (5) items.
- **Part Four:** Human capital efficiency, measured by (5) items.

3.3. Validity of the study instrument:

The validity of the study instrument was verified in two ways:

3.3.1. Content Validity:

The scale, after the initial version was prepared, was presented to (5) expert judges in the field of economics at Jordanian universities, in order to give their opinions on the content validity, the belonging of the statements to the scale, their suitability for measuring what they were intended to measure, and their degree of clarity. Appropriate modifications were then suggested, and the (80%) standard was adopted to indicate the validity of the item. Based on the judges' opinions, some items were modified in terms of wording to increase their clarity, and other items were deleted because of their similarity and closeness in meaning to other items, and items were deleted because they were not suitable for the purposes of the study and some of them were not suitable for the dimension to which they belonged. As a result, the scale became composed of (35) items distributed over three variables: digital transformation (15) items, artificial intelligence (15) items, and human capital efficiency (5) items, which indicates the face validity of the instrument.

3.3.2. Construct validity:

The construct validity indicators of the scale were calculated by calculating the correlation of the item score with the dimension to which it belongs, with a pilot sample from outside the current study sample, consisting of (30) employees working in institutions and companies registered with the Jordanian Ministry of Industry and Trade. Table (2) shows those results:

Table 2: Correlation coefficients of the item with the total score of the dimension to which it belongs, using the Pearson Correlation test to determine the construct validity of the study scale.

Digital transformation					
Digital technologies used		Integration of digital systems		Digital proficiency	
Paragraph No.	Correlation coefficient with total score	Paragraph No.	Correlation coefficient with total score	Paragraph No.	Correlation coefficient with total score
1	.521**	1	.414**	1	.544**
2	.472**	2	.419**	2	.639**
3	.515**	3	.695**	3	.668**
4	.467**	4	.590**	4	.725**
5	.624**	5	.630**	5	.643**
Artificial intelligence					
User behavior		Training & development		Expert Availability	
1	.674**	1	.713**	1	.590**
2	.455**	2	.666**	2	.503**
3	.612**	3	.670**	3	.686**
4	.617**	4	.646**	4	.720**
5	.658**	5	.575**	5	.406**
Human capital efficiency					
1	.563**				
2	.421**				
3	.562**				
4	.668**				
5	.533**				

Table (2) shows that the values of the correlation coefficients between the items of the scale and the total score of the dimension to which they belong were higher than (0.30), which is the minimum acceptable level for distinguishing items. This indicates that all items contribute effectively to the total score of the scale, and that all items of the scale measure the same characteristic, which confirms the validity of the scale's construction. Thus, the scale in its final form consists of (35) items.

3.4. Reliability of the Study Instrument:

To calculate the reliability of the study instrument, the researcher used the test-retest method. The instrument was administered to (30) employees working in institutions and companies registered with the Ministry of Industry and Trade, outside the study sample, with a time difference of (14) days between the two administrations. The researcher used Pearson's correlation coefficient to calculate reliability. The reliability coefficient values for the main and sub-indicators and the total score are shown in Table (3).

Table 3: Reliability coefficients for the main dimensions using the test-retest method

Study Variables	Paragraphs	Test -retest
Digital Technologies Used	5	0.84
Digital Systems Integration	5	0.81
Digital efficiency	5	0.82
Digital Transformation	**15**	**0.90**
User Behavior	5	0.88
Training and Development	5	0.81
Expert Availability	5	0.86
Artificial Intelligence	**15**	**0.92**
Human Capital Efficiency	**5**	**0.77**

The reliability coefficient for the digital transformation items was 0.90, for the artificial intelligence items it was 0.92, and for the human capital efficiency items it was 0.77. These reliability coefficient values are considered acceptable for the purposes of this study.

To determine the consistency of each item on the scale with its corresponding dimension for the study sample (n = 370), correlation coefficients were calculated for each item using Cronbach's alpha. Table 4 shows the test results.

Table 4: Reliability coefficients for the items of the study instrument using Cronbach's alpha test

Study variables	Paragraphs	Cronbach's alpha coefficient
Digital Technologies Used	5	0.86
Digital Systems Integration	5	0.84
Digital efficiency	5	0.80
Digital Transformation	**15**	**0.88**
User Behavior	5	0.74
Training and Development	5	0.78
Expert Availability	5	0.81
Artificial Intelligence	**15**	**0.91**
Human Capital Efficiency	**5**	**0.80**

Table (4) shows that the values of Cronbach's alpha coefficient for the sub-dimensions of the scale ranged between (0.74 – 0.91), which are acceptable values for the purposes of the current study.

Scoring:

The five-point Likert scale used in the study was designed to adhere to the rules and characteristics of scales as follows:

Table:

Answer options				
Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
5	4	3	2	1

Based on the above, the means obtained in the study were calculated using the following equation:

Highest value – Lowest value of the answer choices divided by the number of levels, i.e.:

(5-1)/3 = 4/3 = 1.33. This value equals the class width.

Thus, the low level is from 1.00 to 2.33, the medium level is from 2.34 to 3.67, and the high level is from 3.68 to 5.00.

3.5. Study Procedures:

The process of developing the study instrument involved the following steps:

1. Reviewing previous studies related to the study topic, specifically those concerning digital transformation and artificial intelligence and their impact on human capital efficiency. The researcher benefited from some of these previous studies and from measurement tools used in them.
2. Developing the scale's axes and items to align with the study's questions.
3. Reviewing the scale by a group of expert reviewers and incorporating their feedback to implement suggested modifications.
4. Assessing the instrument's reliability through a test-retest method. This involved administering the scale twice to a sample of (30) employees from institutions and companies registered with the Jordanian Ministry of Industry and Trade,

outside the main study sample, with a (14) day interval between the two administrations.

5. The study instrument was distributed to the study sample (employees working in institutions and companies). The researcher explained aspects of the study, its objectives and importance, and emphasized the confidentiality of the information and its use solely for scientific research purposes. The researcher also stressed the importance of handling the measurement tools with care and accuracy. Immediately after distribution, the study instrument was collected, sorted, and any data deemed unsuitable for statistical analysis was discarded.

6. After converting the responses to raw scores, the data was entered into a computer and statistically processed using the Statistical Package for the Social Sciences (SPSS). Appropriate statistical analyses were performed to answer the research questions, and the results were extracted and discussed.

7. The study period lasted 30 days.

3.6. Study Variables:

The study included several variables:

- **The first independent variable**: Digital transformation, which includes the sub-independent variables (digital technologies used, digital systems integration, Digital efficiency).

- **The second independent variable:** Artificial intelligence, which includes the sub-independent variables (user behavior, training and development, availability of experts).

- **Dependent variable:** Human capital efficiency.

3.7. Statistical Analysis:

The study was based on the use of SPSS statistical analysis software version 27, to suit the data for this type of program, and the following statistical methods were used. Descriptive statistics were used to answer the research questions, as follows:

- Frequencies and percentages were calculated to describe the study sample.
- Pearson's correlation test and Cronbach's alpha were used to ensure the reliability of the instrument.
- Means and standard deviations were calculated.
- Multiple regression was used.

4. STUDY RESULTS

First Question: To what extent are digital transformation and artificial intelligence implemented in Jordanian organizations?

To answer this question, means and standard deviations were calculated to determine the responses of the study sample regarding the extent of digital transformation and artificial intelligence implementation in Jordanian organizations. The results are as follows:

First: The extent of digital transformation implementation in Jordanian organizations.

Means and standard deviations were calculated to determine the extent of digital transformation implementation in Jordanian organizations. Table (5) illustrates this.

Table 5: The means of the responses of the study sample regarding "the application of the dimensions of digital transformation" in institutions operating in Jordan, arranged in descending order.

No.	Digital transformation dimension	Mean	Rank	level
2	Digital systems integration	3.49	1	Mid.
3	Digital efficiency	3.48	2	Mid.
1	Digital technologies used	3.46	3	Mid.
	Total	3.47		Mid.

Table (5) shows that the means for (Applying the Dimensions of Digital Transformation in Organizations Operating in Jordan) ranged between (3.49 and 3.46). Digital transformation as a whole achieved an overall mean of (3.47), which is of medium level. Digital systems integration ranked first, with mean of (3.49) with of medium level. Digital efficiency came in second, with mean of (3.48) with of a medium level. Digital technologies used ranked third, with mean of (3.46) with of medium level.

The following is the level of the sub-items for each dimension of digital transformation:

4.1. Digital technologies used

The means and standard deviations were extracted for the responses of the study sample regarding the items of digital technologies used in institutions operating in Jordan.

Table 6: Means and Standard Deviations for the level of "Digital Technologies Used" are listed in descending order.

No.	Paragraph	Mean	SD	Rank	Level
5	The organization utilizes blockchain technology for secure and transparent data storage and transmission during operations.	3.55	0.84	1	Mid
4	The organization employs Virtual Reality (VR) systems to address challenges as they arise.	3.51	0.90	2	Mid
2	It uses software to identify potential work scenarios and gather information.	3.50	0.87	3	Mid
3	The organization leverages big data analytics tools to understand performance and enhance its e-services.	3.42	0.87	4	Mid
1	It utilizes cloud computing for data management and e-services.	3.33	0.82	5	Mid
	Total	**3.46**			**Mid**

Table (6) shows that the means for (digital technologies used) ranged between (3.55 and 3.33), where the dimension obtained a total mean of (3.46), which is at the medium level. Item No. (5) obtained the highest mean of (3.55), with a standard deviation of (0.84), and at a medium level. It stated that (The organization utilizes blockchain technology for secure and transparent data storage and transmission during operations).

In last place came paragraph number (1) with mean of (3.33) and a standard deviation of (0.82), and at a medium level, as the paragraph stated that (It utilizes cloud computing for data management and e-services).

4.2. Digital Systems Integration

The means and standard deviations were extracted for the responses of the study sample regarding the items of digital systems integration in institutions operating in Jordan.

Table 7: Means and Standard Deviations for the "Digital Systems Integration" level, ranked in descending order

No.	Paragraph	Mean	SD	Rank	Level
2	The organization strives to provide integrated digital systems (internet, dedicated communication applications, electronic payment services, emergency services, etc.) to save time and effort when serving customers.	3.66	0.76	1	Mid
4	These digital systems monitor and analyze real-time conditions during operations.	3.52	0.80	2	Mid
5	The integrated digital systems provide all information and services in languages accessible to all customers.	3.51	0.77	3	Mid
1	The organization ensures rapid response between systems in the event of an emergency or site overload.	3.44	0.78	4	Mid
3	The organization works to unify and instantly update data across all systems involved in customer service.	3.33	0.83	5	Mid
	Total	**3.49**			**Mid**

Table (7) shows that the means for (Digital Systems Integration) ranged between (3.66 and 3.33), with the overall mean of (3.49), which is of medium level. Item (2) had the highest mean (3.66), with a standard deviation of (0.76), also it is of medium level. It stated: (The organization strives to provide integrated digital systems (internet, dedicated communication applications, electronic payment services, emergency services, etc.) to save time and effort when serving customers).

Item (3) came in last place with a mean of (3.33), a standard deviation of (0.83), and it is of a medium level. It stated: (The organization works to unify and instantly update data across all systems involved in customer service).

4.3. Digital efficiency

The means and standard deviations were extracted for the responses of the study sample regarding the Digital efficiency items in institutions operating in Jordan.

Table 8: Means and Standard Deviations (SD) for the "Digital efficiency " level, ranked in descending order.

No.	Paragraph	Mean	SD	Rank	Level
3	Digital applications with minimal errors are available for use within the organization.	3.52	0.80	1	Mid
5	The organization ensures the comprehensiveness of the information and data provided to customers through digital applications.	3.50	0.74	2	Mid
1	The digital applications are user-friendly.	3.49	0.76	3	Mid
2	Information received through websites and applications is from a reliable source.	3.47	0.66	4	Mid
4	The digital infrastructure for the applications is well-equipped to ensure high-quality service.	3.44	0.70	5	Mid
	Total	**3.48**			**Mid**

Table (8) shows that the means for (**Digital Systems Integration**) ranged between (3.52 and 3.44), with the dimension achieving an overall mean of (3.48), which is at the medium level. Item (3) had the highest mean (3.52), with a standard deviation of (0.80), indicating a medium level. This item stated: (Digital applications with minimal errors are available for use within the organization).

Item (4) came in last place with mean of (3.44), a standard deviation of (0.70), and also at a medium

level. This item stated: (The digital infrastructure for the applications is well-equipped to ensure high-quality service).

Second: The extent of artificial intelligence implementation in Jordanian organizations.

Means and Standard Deviations (SD) were calculated to determine the extent of artificial intelligence implementation in Jordanian organizations, as shown in Table (9):

Table 9: The Means of the responses of the study sample regarding "the implementation of artificial intelligence dimensions" in institutions operating in Jordan, arranged in descending order.

No.	Dimensions of artificial intelligence	Mean	Rank	level
1	User behavior	3.48	1	Mid.
3	Expert availability	3.02	2	Mid.
2	Training and development	3.01	3	Mid.
	Total	3.17		Mid.

Table (9) shows that the means for the dimensions of artificial intelligence ranged between 3.48 and 3.01. Artificial intelligence as a whole achieved an overall mean of 3.17, which is considered medium. User behavior ranked first with mean of 3.48, with of medium level. Expert availability came in second with mean of 3.02, with of medium level. Training and development ranked third with mean of 3.01, also it's of a medium level.

The following is the level of the sub-items for each dimension of artificial intelligence:

1- User Behavior

The means and standard deviations of the responses of the study sample regarding the items of user behavior in institutions operating in Jordan were extracted.

Table 10: Means and Standard Deviations of the "user behavior" level, sorted in descending order

No.	Paragraph	Mean	SD	Rank	Level
1	AI-powered applications are regularly used in the workplace.	3.65	0.67	1	Mid
3	AI applications provide convenience when completing tasks.	3.54	0.74	2	Mid
4	AI saves time and effort at work.	3.44	0.84	3	Mid
5	AI provides recommendations that aid in work-related decision-making.	3.40	0.800	4	Mid
2	AI systems reduce errors in the workplace.	3.37	0.91	5	Mid
	Total	3.48			Mid

Table (10) shows that the means for (user behavior) ranged between (3.65 and 3.37), where the dimension obtained a total mean of (3.48), which is at the medium level. Item No. (1) obtained the highest mean of (3.65), with a standard deviation of (0.67), and it is of a medium level. It stated that (AI-powered applications are regularly used in the workplace).

In last place came paragraph number (2) with mean of (3.37) and a standard deviation of (0.91), with of

medium level, as the paragraph stated that (AI systems reduce errors in the workplace).

2- Training and Development

The means and standard deviations were extracted for the responses of the study sample regarding the training and development items in institutions operating in Jordan.

Table 11: Means and standard deviations for the "Training and Development" level, sorted in descending order

No.	Paragraph	Mean	SD	Order	level
2	The organization offers specialized training programs in artificial intelligence.	3.45	1.02	1	Mid.
4	The training programs are tailored to the actual work needs of employees.	3.34	1.05	2	Mid.
5	The training programs are continuously updated to keep pace with developments in artificial intelligence.	2.98	1.10	3	Mid.
1	The training programs help me better understand artificial intelligence applications.	2.84	1.15	4	Mid.
3	Training in the use of artificial intelligence helps in solving workplace problems.	2.44	0.97	5	Mid.
	Total	3.01			Mid.

Table (11) shows that means for (training and development) ranged between (3.45 and 2.44), where the dimension obtained a total mean of (3.01), which is at the medium level, and item No. (2) obtained the highest mean of (3.45), with a standard deviation of (1.02), and at a medium level, and it stated that (The organization offers specialized training programs in artificial intelligence).

In last place came paragraph number (3) with mean of (2.44) and a standard deviation of (0.97), with of

medium level, as the paragraph stated that (Training in the use of artificial intelligence helps in solving workplace problems).

3. Expert Availability

The means and standard deviations of the responses of the study sample regarding the Expert Availability in institutions operating in Jordan were extracted.

Table 12: Means and standard deviations of the "Expert Availability" level, sorted in descending order

No.	Paragraph	Mean	SD	Order	level
4	Having AI experts helps reduce errors in operations.	3.58	1.12	1	mid
3	Clear guidance is provided on the optimal use of AI technologies.	3.45	0.99	2	mid
5	The organization is committed to attracting AI specialists.	3.05	0.88	3	mid
1	The organization has AI experts on staff.	2.55	1.04	4	mid
2	The organization has in-house AI project management capabilities.	2.48	1.14	5	mid
	Total	3.02			mid

Table (12) shows that the means for (Expert Availability) ranged between (3.58 and 2.48), where the dimension obtained a total mean of (3.02), which is at the medium level. Item No. (4) obtained the highest mean of (3.58), with a standard deviation of (1.12), and at a medium level. It stated that (Having AI experts helps reduce errors in operations).

In last place came paragraph number (2) with mean of (2.48) and a standard deviation of (1.14), with of medium level, as the paragraph stated that (The

organization has in-house AI project management capabilities).

Results of the second question: What is the level of human capital efficiency indicators in institutions operating in Jordan?

The means and standard deviations of the responses of the study sample regarding the human capital efficiency indicators items in institutions operating in Jordan were extracted, and Table (13) illustrates this.

Table 13: Means and standard deviations of the level of "Human Capital Efficiency Indicators" in institutions operating in Jordan, ranked in descending order

No.	Paragraph	Mean	SD	Order	Level
2	The organization's employees possess the necessary knowledge to perform their tasks efficiently.	3.65	0.77	1	Level
1	Employees have specialized skills that match the requirements of their jobs.	3.62	0.64	2	Level
3	Employees achieve high levels of productivity in completing tasks.	3.60	0.78	3	Level
4	Work is completed accurately and to a high standard.	3.57	0.64	4	Level
5	Employees are adaptable to changes in the work environment.	3.50	0.63	5	Level
	Total	3.59			level

Table (13) shows that the means for (**Human Capital Efficiency Indicators**) ranged between (3.65 and 3.50), where the Human Capital Efficiency Indicators in the operating institutions obtained a total mean of (3.59), which is at the medium level, and item No. (2) obtained the highest mean of (3.65), with a standard deviation of (0.77), and at a medium level, and it stated that (The organization's employees possess the necessary knowledge to perform their tasks efficiently).

In last place came paragraph number (5) with mean of (3.50) and a standard deviation of (0.63), and at a medium level, as the paragraph stated that

(Employees are adaptable to changes in the work environment).

Results of Question 3: Does digital transformation have an impact on human capital efficiency in organizations operating in Jordan?

To answer the third research question, multiple regression analysis was used to identify the impact of digital transformation, with its dimensions (digital technologies used, integration of digital systems, and digital efficiency), on human capital efficiency in organizations operating in Jordan. Table (14) illustrates the results.

Table 14: Multiple regression analysis to identify the impact of digital transformation in its dimensions (digital technologies used, digital systems integration, digital efficiency) on the efficiency of human capital in institutions operating in Jordan

Dimensions	B	standard error	Beta	Calculated T value	T significance level
Digital technologies used	.057	.024	.076	2.386	0.02*
Digital systems integration	1.470	.104	1.673	14.181	0.00*
Digital efficiency	1.200	.141	1.387	8.513	0.00*

Statistically significant at the ($\alpha \leq 0.05$) level. Tabular value (t) = (±1.96)

Table (14), and the results of the t-test, show that the subvariants related to digital transformation (digital technologies used, integration of digital systems, and digital efficiency) have an impact on the efficiency of human capital in Jordanian organizations. The calculated t-values were (2.386, 14.181, and 8.513), respectively, which are significant at a significance level of ($\alpha \leq 0.05$). This indicates a statistically significant impact of digital transformation and its dimensions on the efficiency of human capital in Jordanian organizations.

Results of Question 4: Does artificial intelligence have an impact on the efficiency of human capital in organizations operating in Jordan?

To answer the fourth research question, multiple regression analysis was used to identify the impact of artificial intelligence, with its dimensions (user behavior, availability of experts, training and development), on the efficiency of human capital in organizations operating in Jordan. Table (15) illustrates the results.

Table 15: Multiple regression analysis to identify the impact of artificial intelligence in its dimensions (user behavior, expert availability, training and development) on the human capital efficiency in institutions operating in Jordan

Dimensions	B	standard error	Beta	Calculated T value	T significance level
User behavior	.233	.024	.305	9.724	0.00*
Expert availability	.167	.025	.225	6.593	0.00*
Training and development	.189	.031	.207	6.046	0.00*

Statistically significant at the ($\alpha \leq 0.05$) level. Tabular value (t) = (±1.96)

Table (15) and the t-test results show that the AI-related sub-variates (user behavior, expert availability, and training and development) have an impact on the efficiency of human capital in Jordanian organizations. The calculated t-values were 7.724, 6.593, and 6.046, respectively, which are significant at a significance level of $\alpha \leq 0.05$. This indicates a statistically significant impact of AI, in its various dimensions, on the efficiency of human capital in Jordanian organizations.

5. DISCUSSION OF RESULTS

The findings indicate that the level of digital transformation implementation in institutions operating in Jordan falls within the moderate range across all examined dimensions. This reflects a clear orientation toward adopting digital technologies; however, the level of adoption has not yet reached full digital maturity and still requires further development and enhancement.

Regarding the dimension of digital technologies used, the results suggest that institutions have begun employing modern technologies to enhance data security and operational transparency, including the adoption of advanced technologies for secure data

storage and transfer. This demonstrates a growing awareness of the importance of transitioning to a secure digital environment that supports operational efficiency. On the other hand, the use of cloud computing in data management did not reach a high level, which may indicate organizational or technical challenges, or concerns related to data security and privacy.

As for the dimension of digital systems integration, the findings reveal that institutions are striving to provide interconnected digital systems that facilitate procedures and improve the quality of services delivered to customers. This represents a positive indicator of awareness regarding the importance of integration in enhancing customer experience. However, the unification and real-time updating of data across different systems still require further improvement, suggesting a gap in the actual integration between various technological systems.

With respect to digital efficiency, the results reflect an acceptable level of digital readiness within institutions, as digital applications operate with relatively limited errors. Nevertheless, the digital infrastructure still requires strengthening and development to ensure higher service quality and system stability.

Overall, the results demonstrate that Jordanian institutions are making positive progress toward digital transformation. However, achieving higher levels of efficiency requires increased investment in digital infrastructure, improved system integration, and expanded adoption of advanced technologies to enhance institutional performance and strengthen competitiveness in a rapidly changing business environment.

On the other hand, the findings indicate that the level of artificial intelligence (AI) implementation in institutions operating in Jordan falls within the moderate range across all examined dimensions. This suggests a positive orientation toward adopting AI technologies; however, the level of adoption is still in a developmental stage and has not yet reached full integration or institutional empowerment within the work environment.

Regarding the dimension of user behavior, the results reflect that the use of AI-based applications has become part of daily work practices to a moderate extent, indicating employees' acceptance of and willingness to engage with these technologies. However, the relatively lower perception of AI systems' ability to reduce errors suggests the presence of certain reservations or limited practical experience. This may be attributed to the early stages of implementation or to the incomplete utilization of AI capabilities.

As for training and development, the findings show a moderate level that tends toward the lower side compared to other dimensions. This indicates that AI-related training efforts may still be insufficient to fully support effective implementation. Although some specialized training programs are available, the limited perceived impact of training on problem-solving within the workplace highlights a gap between theoretical knowledge and practical application, potentially reducing the overall benefits of AI adoption.

With respect to the availability of experts, the results demonstrate recognition of the importance of specialized expertise in reducing errors and improving performance. Nevertheless, the limited internal capacity to manage AI projects suggests a shortage of in-house expertise or reliance on external support, which may affect the long-term sustainability and development of AI initiatives.

Concerning the indicators of human capital efficiency, the results also fall within the moderate range, reflecting a solid base of knowledge and skills among employees, particularly in possessing the necessary knowledge to perform tasks efficiently. However, the ability to adapt to changes in the work environment, although acceptable, requires continuous strengthening in light of rapid digital transformations.

Overall, the findings reveal an integrative relationship between AI implementation and human capital efficiency. Achieving higher performance levels requires greater investment in specialized training, strengthening internal expertise, and fostering an organizational culture that supports innovation and continuous learning. Such efforts would contribute to enhancing digital maturity and improving the competitive position of institutions in a rapidly evolving environment.

The results indicate a statistically significant effect of digital transformation, across its various dimensions, on the efficiency of human capital in institutions operating in Jordan. This confirms that adopting digital technologies, ensuring system integration, and enhancing digital efficiency directly contribute to improving employees' performance and strengthening their productive and cognitive capabilities.

This effect can be explained by the fact that the digital technologies used enable employees to access information quickly, facilitate task completion, and reduce the time and effort spent on traditional processes. This, in turn, positively reflects on the quality of performance and the speed of decision-making. The availability of modern digital tools enhances employees' ability to work efficiently and effectively, particularly in data-driven environments that require continuous analysis.

As for digital systems integration, it appears to be one of the most influential factors, as integrating systems helps unify data, reduce duplication, and improve the flow of information across departments. Such integration strengthens institutional collaboration and minimizes errors resulting from fragmented information, thereby enhancing collective performance and enabling better utilization of human capital skills.

Regarding digital efficiency, the readiness of digital infrastructure and the effectiveness of applications contribute to creating a work environment that supports creativity and innovation. Employees are thus able to focus on more strategic tasks rather than routine procedures. A stable digital environment also increases trust in technological systems and encourages their optimal use.

Accordingly, digital transformation should not be viewed merely as a technological upgrade, but rather as a fundamental driver for developing human capital capabilities. The higher the level of digital transformation maturity within an institution, the more positively it is reflected in employees' efficiency through improved productivity, enhanced

continuous learning, and greater adaptability to rapid changes in the business environment.

The results indicate a statistically significant effect of artificial intelligence (AI), across its various dimensions, on the efficiency of human capital in institutions operating in Jordan. This confirms that the adoption of AI applications not only enhances technical processes but also contributes to improving employees' performance and strengthening their cognitive and professional capabilities.

The effect of user behavior can be explained by the fact that employees' acceptance of and actual engagement with intelligent applications improve work quality and reduce the time required to complete tasks. The more interactive and confident users are in AI systems, the greater their ability to benefit from analytical and predictive outputs, which enhances accuracy and supports data-driven decision-making. Therefore, positive user behavior toward AI represents a critical factor in transforming technology into real added value for human capital.

As for the availability of experts, it is considered a fundamental factor in maximizing the impact of AI. The presence of specialized professionals capable of designing, managing, and optimizing intelligent systems ensures the effective utilization of these technologies. Experts also play a key role in transferring knowledge to other employees, building sustainable internal capabilities, and reducing operational errors, which collectively enhance overall organizational performance and human capital efficiency.

Regarding training and development, providing specialized training programs enables employees to acquire the necessary skills to effectively use AI tools. Continuous training helps bridge digital skills gaps, strengthens problem-solving abilities, fosters innovation, and supports adaptation to rapid technological changes. The higher the level of qualification and development, the greater the institution's ability to achieve a stronger return on its AI investments.

Accordingly, artificial intelligence can be considered a strategic lever for enhancing human capital efficiency, provided it is accompanied by user acceptance, the availability of specialized expertise, and continuous investment in training and development. The integration of these dimensions creates an intelligent work environment that supports productivity, fosters innovation, and strengthens institutional competitiveness in a rapidly evolving business landscape.

6. RECOMMENDATIONS:

In the light of the results regarding the impact of digital transformation and artificial intelligence on the efficiency of human capital, the following research recommendations can be formulated:

- Continued implementation of digital transformation and artificial intelligence in Jordanian institutions.
- Enhance specialized training programs in digital transformation and artificial intelligence.
- Attract and develop in-house experts in artificial intelligence.
- Integrate digital systems to improve data flow and support decision-making.
- Foster an organizational culture that encourages innovation and adoption of modern technologies.
- Conduct future studies to assess the long-term impact on human capital.
- Establish clear policies and governance to ensure the safe and effective use of digital technologies.

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