

The Impact of Digital Transformation on Research Effectiveness at PNU's Research Center

أثر التحول الرقمي على فعالية البحث في مركز أبحاث جامعة الأميرة نورة

By

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ABSTRACT

This study aims to explore the impact of digital transformation on research effectiveness at the Research Center at Princess Nourah University (PNU). A descriptive quantitative approach was used, with a focus on digital data collection and statistical analysis to examine relationships and validate hypotheses, and a questionnaire was used as a means of data collection. The sample consisted of 250 participants, who were beneficiaries of the Scientific Research Center at Princess Noura University, including faculty members and graduate students. The study showed that the impact of digital transformation on the research processes at PNU's research center was generally high. Among the dimensions studied, the impact of structural and organizational digital transformation on research quality came first, indicating a very significant impact in this area. This was followed by the impact of digital transformation on search barriers, which also showed a very high impact. Finally, the impact of digital transformation on the development of scientific research tools came last, and although its impact was noticeable, it was less compared to the other dimensions. These results emphasize the importance of digital transformation in improving research quality and addressing challenges, with room for improving the use of research tools. The results showed no statistically significant differences at the 0.05 level, indicating that job title does not significantly affect these dimensions. Based on the findings, it is recommended to enhance the use of digital platforms by providing training and resources to researchers to facilitate remote interaction. In addition, infrastructure optimization is essential to enhance research efficiency and foster a more effective research environment

Chapter One

1.1 Introduction:

The current era has witnessed numerous challenges and rapid technological advancements in the fields of education and learning technologies. These changes have placed various pressures on educational institutions, prompting them to adapt in order to keep up with these developments. Since education is a vital element in the advancement of society, it is essential to update educational systems to confront these ongoing challenges, thus enhancing digital literacy among students in today's world.

Due to shifts in educational technology, it has become necessary to overcome the obstacles that traditional education faces, such as those that hinder the effective achievement of educational goals. As a result, integrating technology and educational techniques into all educational activities and courses has become crucial. This integration contributes to the enhancement of digital literacy through the digital transformation of education.

Digital transformation in education has become a fundamental requirement for the development of education in many countries, including Saudi Arabia, which is working to develop its educational systems by adopting modern technologies. However, this transformation faces several challenges, including the rapid spread of information, communication technologies, and scientific discoveries, as well as the increasing pressure on educational institutions to keep up with these advancements.

The digital technological revolution has brought about profound changes in various social, cultural, and political fields, reshaping how information is accessed. With the emergence of technologies such as artificial intelligence, students now have the ability to access knowledge without restrictions, further promoting the digital transformation in education and facilitating the better use of educational resources

Digital transformation in education has become a fundamental requirement for developing educational systems in many countries, including Saudi Arabia. Education is considered a crucial tool for community development and progress. However, with the challenges of the digital age, including the explosion of knowledge and rapid scientific and technological advancements, it has become difficult to keep pace with these transformations. Technological progress and new challenges in the education sector require continuous improvements to align with the rapid developments.

The characteristics of the digital age have a clear impact on various social, cultural, and political aspects, including educational systems. The digital revolution has brought about

changes in communication systems and learning methods, enabling new ways to access information faster and more efficiently, without restrictions. This digital shift in education is a vital step towards improving the quality of education and expanding access to knowledge.

Universities play a crucial role in this transformation, contributing to community development through education and scientific research while continuing to innovate in response to scientific and technological developments. Universities are not just places of learning but also centers for cultural enrichment and community development, aligning with the goals of digital transformation that aim to facilitate access to knowledge and learning.

The value of any country and its contemporary relevance in the modern world is not solely determined by its global ranking but also by its investment in research and development. Developed nations tend to allocate substantial budgets for scientific research, recognizing it as a key driver of economic development. The level of scientific progress in a country is measured by various indicators, such as the number of annual scientific publications, patents per capita, and the volume of scholarly journals produced. In addition, the funding for books and scientific journals, as well as the availability of technological support systems, play a crucial role in enhancing research output. These factors collectively reflect technological advancement and intellectual growth within a society. "Therefore, this study came to understand the impact of digital transformation on research effectiveness at PNU's Research Center."

1.2 Problem of the study:

Previous studies indicate that public strategies that address digitization in teaching and learning still lack many requirements and face many issues, most notably outdated planning and traditional leadership, which have affected the quality of scientific research centers (Bates, 2015; Selwyn, 2016). One example relates to the adoption of digitization in higher education institutions. The results indicate that although most HEIs have a digital transformation, they are still not achieving the desired goals of this transformation, citing difficulties related to readiness and lack of support for this transformation (Simmons et al., 2015).

Although digital transformation in higher education is an emerging area of research, the exact scope and meaning of digital transformation in higher education institutions is still insufficiently defined. "Digital transformation" in universities has become the subject of

much hype and excitement, and the term is often overused and misused (Gkrimpizi, Magnisalis, 2024).

Research centers are considered one of the facilities that need digital transformation because digital transformation will reflect the importance of raising the level of quality, improving the level of access to knowledge, and benefiting students and researchers from scientific research centers. (Khalil , 2016) that the centers face many obstacles that affect the desired change processes, including the weak scientific research budgets allocated. Lack of availability of electronic devices and rooms necessary to support the transformation necessary to carry out research, Difficult administrative procedures., Insufficient numbers of researchers, Low scientific level of newly graduated researchers. And Lack of auxiliary

Although the existence of research centers in universities is important, it is necessary to have research centers in universities that aim to improve the outputs that universities aim to achieve. These research centers should have great capacities to improve the development and promotion of research and make it more useful for academic and graduate research, collaboration, and capacity building among staff. The roles of research centers need significant support to make their role more positive (Jo-Celene , Simone ,& , José ,2023).

Sadek .H, Abdelhak D, Samar S,(2021) points out that scientific research centers in the Middle East in general need proper planning and leadership with clear leadership that works to make the digital transformation successful and benefit from it, as well as need to address the issues facing funding for this digital transformation, and the digital infrastructure is very important and needs great efforts so as not to weaken the readiness for the digital technological transformation has affected the level of research publication globally and the lack of technological support has weakened the focus of these centers on writing and publishing scientific, medical and engineering research.

Compared to Arab countries in general and Saudi Arabia in particular, it is still at the beginning of its path towards developing the aspect of scientific research by relying on digital transformation plans. Saudi universities still need to ensure and maintain the high quality of their outputs to remain competitive and progress in the long run, by adopting digital transformation strategies and improving the overall quality of learning. Finally, through the process of digital transformation, digital transformation management provides an effective outlet for Saudi organizations to build long-term competitive advantages and foster differentiated development. Therefore, it is necessary to identify the issues that prevent the

realization of the significant role of digital transformation in universities (Al-Otaibi, & Al-Baroudi, 2024).

Princess Noora University faces many obstacles and challenges imposed on it by the new system, which confirms its need to rely on strategic studies to overcome planning obstacles to advance the development centers and make them more related to the needs of society and contribute to solving its issues by scientific methods and raising the level of local and global leadership and investing knowledge in theoretical and applied research fields, which requires consideration of the management of these centers and how to develop them for greater benefit, as research centers need an administrative unit specialized in knowledge development and digital transformation in knowledge management, as well as there are (Al-Namla ,2022).

Within the framework of the university's endeavor to achieve Kingdom's Vision 2030, there remains a need to review its strategic objectives to suit this new stage and introduce Vision 2030 within its mission, vision, performance measurement indicators, outputs and returns through overlapping processes adopted by leaders when setting goals, programs and projects that link their tasks, educational structures, digital transformation and systems in order to serve the achievement of Vision 2030 .

1.3 Importance of Study:

1.3.1Scientific importance:

- 1.3.1.1 This study will help identify the importance of digital transformation for higher education institutions in Saudi Arabia, especially at PNU.
- 1.3.1.2 It will also contribute to identifying the issues that hinder this digital transformation, providing a scientific framework for understanding the challenges facing higher education institutions.
- 1.3.1.3 Researchers and those interested in the topic of digital transformation and its impact on the quality of scientific research can benefit from the results of this study to understand the status of higher education institutions compared to other sectors in implementing digital transformation initiatives.

1.3.2 Practical Importance:

- 1.3.2.1 Raising awareness among university leaders about the importance of digital transformation and encouraging greater digital maturity.

1.3.2.2 Highlighting challenges to help leaders take effective actions to improve the quality of education and research.

1.4 Objectives of the Study

1.4.1 Main Objective:

- 1.4.1.1 To examine the impact of digital transformation on research effectiveness at the PNU Research Center.

1.4.2 Sub-Objectives:

- 1.4.2.1 To analyze the impact of digital transformation on research effectiveness at PNU's research center.
- 1.4.2.2 To identify the challenges facing digital transformation and their impact on research effectiveness at PNU's research center.

1.5 Research Questions

1.5.1 Main Research Question:

- 1.5.1.1 What is the impact of digital transformation on research effectiveness at the PNU Research Center?

1.5.2 Sub-Questions:

- 1.5.2.1 What is the impact of digital transformation on research effectiveness at PNU's research center?
- 1.5.2.2 What are the challenges facing digital transformation and their impact on research effectiveness?

1.6 Research Hypotheses

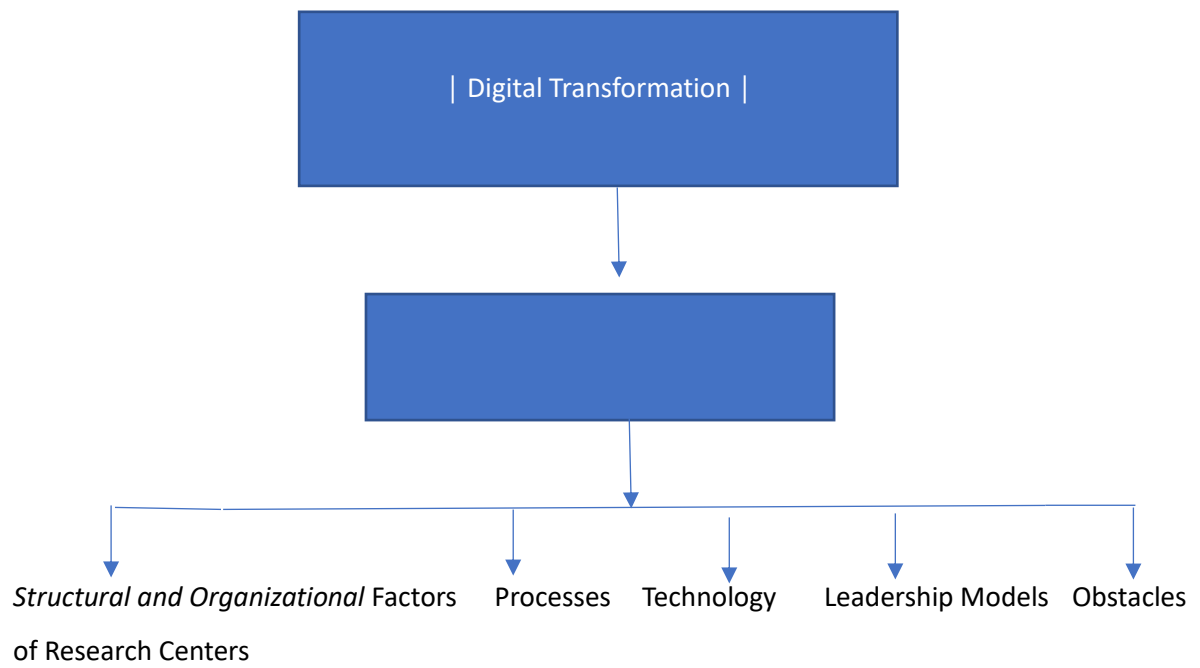
1.6.1 Main Hypothesis:

- 1.6.1.1 There is an impact of digital transformation on research effectiveness at the PNU Research Center.

1.6.2 Sub-Hypotheses:

- 1.6.2.1 There is a statistically significant impact of structural and organizational factors on research effectiveness.
- 1.6.2.2 There is a statistically significant impact of processes on research effectiveness.
- 1.6.2.3 There is a statistically significant impact of technology on research effectiveness.
- 1.6.2.4 There is a statistically significant impact of leadership models on research effectiveness.

1.7 Study Model:



Chapter two

Literature Review

Literature review:

This research includes a review of the theoretical framework that highlights the key concepts related to digital transformation in educational institutions, with a focus on its role in the research center at Princess Nora University. It also reviews previous studies that dealt with the impact of digital transformation on the quality of scientific research tools and the level of obstacles facing scientific research considering digital transformation.

2.1 Scientific Research Centers

Scientific research centers are vital elements that contribute to enhancing the role of universities and developing their academic and innovative performance. In the context of Saudi Arabia's Vision 2030, the Kingdom seeks to strengthen these centers by implementing digital transformation and integrating modern technologies in the field of research and education. Scientific research centers in Saudi universities, such as Princess Nourah bint Abdulrahman University, play a fundamental role in achieving the goals of Vision 2030, which focuses on enhancing higher education and developing scientific research and innovation. These centers are pivotal points for generating knowledge and exchanging ideas among researchers, which contributes to providing practical solutions to economic and social challenges and providing students and researchers with modern technology tools in their academic fields. According to Zahran's study (2023), the Kingdom is witnessing a remarkable expansion in the establishment of specialized research centers that use digital transformation to enhance cooperation between universities and research institutions, which contributes to driving innovation and economic growth.

Digital transformation in research centers is a pivotal factor that contributes to improving access to scientific data and providing an advanced educational environment, as Al-Harthi's study (2021) explains. By adopting modern technologies such as artificial intelligence, big data, and the Internet of Things, researchers can carry out their research with greater efficiency and exchange knowledge more quickly, which enhances their ability to innovate. The benefits of this transformation go beyond being a research tool only; it directly contributes to improving the competitiveness of academic institutions and enhancing their ability to deal with contemporary challenges. University Research Centers (URCs), which began in the United States and are expanding globally, also play a fundamental role in enhancing cooperation between universities and various industries, which enhances

technology transfer and contributes to promoting economic development through successful partnerships between academia and industry. This interaction enables expanding the horizons of entrepreneurial projects and drives the innovation of practical solutions to economic and social challenges, and directly contributes to developing human resources and enhancing their technical capabilities (Torres, 2019).

2.2 Concept of Scientific Research Centers

Collaborative Research Centers (CRCs) are multidisciplinary research facilities located at universities and doctoral-awarding academic institutions. CRCs promote collaboration across scientific disciplines through cross-disciplinary research programs. CRCs provide scientists and researchers with the opportunity to undertake ambitious, long-term projects using university resources and organization. Proposals submitted to CRCs must meet high scientific standards.

According to Bozeman and Boardman (2003), multidisciplinary university research centers are defined as research institutions that aim to stimulate institutional innovation within academia. These centers are considered an essential component of the transformation process within universities, as they seek to expand the scope of their goals by integrating diverse and multiple disciplines, which enhances their ability to interact with different fields of knowledge and contribute to the development of innovative solutions.

National Centre for Scientific Research (2023) defined the Scientific Research Center as an organization that is specialized in coordinating and directing research activities across diverse fields of natural and social sciences, with a focus on promoting scientific innovation and expanding the horizons of knowledge. The center also seeks to evaluate and analyze the practical applications of this knowledge in societal contexts, thus enhancing its effective impact on developing society.

According to UNESCO (2022), scientific research centers are the cornerstone of advancing science and technology in society. They play a pivotal role in developing basic and applied research, and work to qualify scientists and researchers to expand the horizons of knowledge and promote innovation.

Further, The Scientific Research Center is a leading academic institution that conducts in-depth scientific research using multiple methodologies, with the aim of discovering innovative solutions to complex scientific challenges or providing additions of high scientific value in specific fields of knowledge (Oxford Encyclopedia of Science, 2021).

2.3 Importance of Scientific Research Centers

The research center seeks to enhance communication and collaboration between professors, faculty members, scientists, students and industry, with the aim of opening new horizons for academic research and innovation. The center focuses on addressing real-world issues by developing practical solutions, while contributing to making a tangible impact through the production and transfer of advanced knowledge that contributes to the advancement of society (Kumar, 2017).

Alshayea, (٢٠١٣) stressed that scientific research is one of the main pillars of development and progress in societies, as it contributes to modernizing systems and solving contemporary issues through the generation of theoretical and applied knowledge. This process is of great importance in both developed and developing countries. In this context, the Kingdom of Saudi Arabia has paid great attention to scientific research centers within the framework of development plans, with a focus on promoting scientific innovation and developing research and development institutions. From this side, the Kingdom seeks to stimulate research activities in the private sector, enhance cooperation between academic institutions, and accelerate access to advanced technology. It also supports the establishment of innovative environments such as science parks and business incubators that contribute to promoting creativity and technological development.

Yaqout (2007) also explained that scientific research is one of the basic pillars on which the development of the human mind depends, and that the renaissance and prosperity of nations is closely linked to the degree of their interest in scientific research and its applications. Hence, the great importance of scientific research lies in strengthening the institutions concerned with it and its basic tools, such as universities and specialized research centers, whether governmental or private. These institutions are the main engine for generating knowledge and innovating solutions that contribute to the progress of society.

Bin Tareef (2009) pointed out that universities and research centers are a major platform for developing and supporting scientific research, as this plays an important role in achieving the highest level of economic growth at the state level. From this standpoint, many countries have allocated huge budgets and materials that contribute to supporting academic research and scientific projects, believing in the importance of these initiatives in improving efficiency and activating performance in various fields. Moreover, scientific research contributes significantly to driving productivity and improving the quality of products and allows the introduction of new technologies and methods that contribute to the development

of all economic, commercial and social activities. From here, it becomes clear that scientific research plays an important role in achieving comprehensive development for society, whether from an economic, social or political perspective.

Believing in the importance of that, this study aimed to identify how public universities in northern Jordan benefit from the results of scientific research to serve local community institutions and enhance its development in various fields.

2.4 Challenges Facing Scientific Research Centers

The major challenges faced by faculty members in universities to support and encourage research activities include difficulty in securing funding, as they find it increasingly difficult to access traditional funding sources such as R15 and R16 programs. This is compounded by limited institutional financial support. There is also a lack of institutional support in terms of submitting research proposals and managing grants, which burdens them due to the absence of support tools such as templates and budget guidelines, in addition to carrying multiple roles in addition to teaching loads. Furthermore, the cost of research equipment and its maintenance is a major challenge despite the existence of some support programs. Finally, collaboration with other research institutions is an opportunity to enhance research through access to advanced equipment and strengthening research partnerships (Torrente, Dilek, & Segarra, 2023)

Moreover, Pérez-Hernández et al. (2021) and Biranvand and Seif (2020) also summarized the challenges facing research centers that are distributed across several axes as follows:

1. **Legal obstacles:** including weak legislative protection for inventors, ineffective marketing systems, ambiguity of property rights in joint research, and the absence of procedures that enhance the quality of research.
2. **Human obstacles:** including weak commitment to promoting research, lack of qualified personnel to manage knowledge transfer, and lack of incentive for researchers to participate in marketing.
3. **Economic obstacles:** including lack of revenue allocation to researchers, ineffective funding management, and lack of infrastructure needed to market research outputs.

4. **Organizational and political obstacles:** including lack of a clear regulatory framework for marketing research, obstructive bureaucracy, and lack of mechanisms to improve the quality of research.
5. **Communication and information obstacles:** including poor access to data sources and idea bases, and lack of cooperation between universities and industry sectors.

study by Glied et al. (2007), three major issues facing interdisciplinary research centers in academia are highlighted:

6. **Financial sustainability:** Research centers face challenges in securing ongoing funding, which affects their ability to sustain and grow. Financial challenges may come from reliance on federal funding or grants that may be unstable or insufficient to meet ongoing research needs.
7. **Faculty recruitment and retention:** Interdisciplinary research centers often find it difficult to attract and retain outstanding professors in multiple fields. Researchers in these centers may also be stressed by the demands of interdisciplinary work, which can lead to difficulty in maintaining sustainable staffing.
8. **Sustainability of leadership:** Effective and sustainable leadership is a major challenge in these centers. It requires leaders who are able to coordinate between different disciplines and manage human and material resources efficiently. Leadership sustainability requires continuity of vision and strategic direction.

2.5 Requirements for Successful Research Centers

Research centers in universities are considered one of the main pillars that drive scientific and technological progress. For these centers to succeed, a set of basic factors must be available, including advanced infrastructure such as specialized laboratories and modern research facilities, in addition to sustainable funding from various sources such as governments and private institutions, which ensures the continuity and expansion of scientific research ((balyer, A., & Özvural, 2021)

On the other hand, qualified human resources of professors, researchers and graduate students are crucial factors, as academic experiences and continuous training contribute to the development of researchers and enable them to achieve research goals at the highest level. It also requires academic and administrative independence that allows centers to define research areas flexibly and without restrictions, with the ability to manage and fund research

projects with complete freedom. In this context, effective leadership with a clear vision and the ability to direct the team towards achieving research achievements are among the most prominent requirements. Finally, research centers must be pivotal in building strategic partnerships with the public and private sectors, which contributes to transforming research results into applied solutions that meet the needs of society and industry and contribute to driving economic development (Schoen, Laredo, Bellon & Sanchez, 2007).

According to the University of Sheffield, Distinguished research centers require a set of basic conditions to ensure their success and continuity.

-First, they must provide clear added value, i.e. they must be able to accomplish tasks that are difficult to achieve by independent research teams. This includes fostering collaboration between diverse disciplines, establishing new partnerships, and achieving research results that contribute to a greater positive impact on society than individual researchers.

-Second, there must be enough experienced scientists who contribute to achieving the center's goals, along with a clear plan to ensure the center's financial and intellectual sustainability in the long term.

-Third, effective leadership requires the ability to direct research and formulate a future vision, while paying attention to the distribution of responsibilities to avoid dependence on a single person.

-Finally, research centers need to receive external recognition based on outstanding scientific achievements and intellectual progress.

All in all, research centers must have a favorable environment that includes wise leadership, qualified human resources, academic and financial independence, and sustainable sources of funding to ensure long-term scientific and social impact.

2.6 Digital transformation

Process automation has been introduced since the early 1990s. Nearly thirty years later, new technologies such as cloud computing, the Internet of Things (IoT), augmented reality, social media, and decentralized public records of transactions such as blockchain are pushing companies into new digital interactions with customers and supported IT operations. From the mid-2000s to today, smart devices and social platforms have significantly impacted business-to-customer (B2C) communication, opening up new channels of communication with customers. Digital communication has raised expectations for availability across multiple channels and changed the customer service experience with a “customer at the center” approach and real-time communication. With the emergence of new technologies, all industries are undertaking various initiatives to discover and exploit the benefits of technology. This includes shifts in business operating models, and also affects the product portfolio. Processes and organizational structures must also be re-engineered in a way that manages these complex developments. Implementing a new digital business model requires the development of a wide range of capabilities, from influencing the mindset of people and organizational culture to the ability to change. (Zinder, Yunatova 2016). And Digital transformation is the process an organization applies to integrate digital technology into all areas of the business. This process fundamentally changes the way universities deliver value to customers. Organizations are adopting innovative digital technologies to make cultural and operational transformations that had better align with changing customer demands, and there are many definitions of the concept of "digital transformation", depending on how it is currently used in today's world. According to Maltaverne (2017), it refers to "transforming from traditional to delivering new value to customers" Previous studies indicate that public strategies that address digitization in teaching and learning still lack many requirements and face many issues, most notably outdated planning and traditional leadership, which has affected the quality of scientific research centers (Bates, 2015; Selwyn, 2016). One example relates to the adoption of digitization in higher education institutions. The results indicate that although most HEIs have a digital transformation, they are still not achieving the desired goals of this transformation, citing difficulties related to readiness and lack of support for this transformation (Simmons et al., 2015).

Although digital transformation in higher education is an emerging area of research, the exact scope and meaning of digital transformation in higher education institutions is still

insufficiently defined. "Digital transformation" in universities has become the subject of much hype and excitement, and the term is often overused and misused (Gkrimpizi, Magnisalis, 2024).

Research centers are considered one of the facilities that need digital transformation because digital transformation will reflect the importance of raising the level of quality, improving the level of access to knowledge, and benefiting students and researchers from scientific research centers. (Khalil , 2016) that the centers face many obstacles that affect the desired change processes, including the weak scientific research budgets allocated. Lack of availability of electronic devices and rooms necessary to support the transformation necessary to carry out research, difficult administrative procedures. Insufficient numbers of researchers, Low scientific level of newly graduated researchers. In addition, Lack of auxiliary

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Compared to Arab countries in general and Saudi Arabia in particular, it is still at the beginning of its path towards developing the aspect of scientific research by relying on digital transformation plans. Saudi universities still need to ensure and maintain the high quality of their outputs to remain competitive and progress in the end, by adopting digital transformation strategies and improving the overall quality of learning. Finally, through the process of digital transformation, digital transformation management provides an effective

outlet for Saudi organizations to build long-term competitive advantages and foster differentiated development. Therefore, it is necessary to identify the issues that prevent the realization of the significant role of digital transformation in universities (Al-Otaibi, & Al-Baroudi, 2024).

Princess Nourah University faces many obstacles and challenges imposed on it by the new system, which confirms its need to rely on strategic studies to overcome planning obstacles to advance the development centers and make them more related to the needs of society and contribute to solving its issues by scientific methods and raising the level of local and global leadership and investing knowledge in theoretical and applied research fields, which requires consideration of the management of these centers and how to develop them for greater benefit, as research centers need an administrative unit specialized in knowledge development and digital transformation in knowledge management, as well as there are (Al-Namla, 2022).

Within the framework of the university's endeavor to achieve Kingdom's Vision 2030, there remains a need to review its strategic objectives to suit this new stage and introduce Vision 2030 within its mission, vision, performance measurement indicators, outputs and returns through overlapping processes adopted by leaders when setting goals, programs and projects that link their tasks, educational structures, digital transformation and systems in order to serve the achievement of Vision 2030.

2.7 Concept of Digital Transformation:

According to Schallmo, A., & Daniel, R. (2018), digital transformation is defined as digitally enabling the accomplishment of business tasks and creating new value for stakeholders. **Chaurasiya (2023)** emphasized, "Digital transformation is not just a transformation based on digital tools and digital processes. "Digital transformation is not just a transformation based on digital tools and digital processes, but also a transformation that encompasses all business models in a radical way. It has a major impact on the way work is done and is a change in mindset that is evolving faster than we are adapting to it.

Marks, A., & Al-Ali, M. (2020). Argue that Digitization is a tool for promoting change, not an end in and of itself. We can only fully appreciate the power of digital technologies to support the members of an organization when we view the digitization process as a means of transforming it for the better. Transformation through digitization of an organization entails

a shift in culture and mindset, the de-bureaucratization of activities, and placing the user at the center of the systems while optimizing the use of information.

Westerman et al. (2014) defined digital transformation as the use of digital technology to radically improve the performance of organisations, by increasing innovation, improving process efficiency and exploring new business models.

Vial (2019) sees digital transformation as a process by which organizations use digital technology to change their business models and create new value. He emphasizes that digital transformation can lead to fundamental changes in infrastructure, data management and information analysis within organizations.

Schallmo and Williams (2018) define digital transformation as the process of introducing digital technologies into the operational processes and infrastructure of organizations, leading to improved performance and increased agility.

Henriette et al. (2015) defined digital transformation as the process of transforming the traditional business model using digital technologies, with the aim of achieving operational efficiency and improved customer experience.

It is clear from the previous definitions that they cover various aspects of digital transformation, from internal processes to organizational strategies and the importance of this transformation in achieving a high level of accuracy in achievement and efficiency effectiveness.

2.8 Importance of Digital Transformation in Higher Education:

Higher education institutions have made digital transformation a top priority because universities play a critical role in the development and empowerment of societies. Digital transformation is a rapidly expanding trend that has caught the attention of institutions and stakeholders worldwide (Alenezi, & Akour, 2023) Higher education institutions need additional changes, from technical issues to certification issues to support the growing needs of digital learning (Burik & Kim, 2020).

Digital transformation in universities means enabling technology in all the work of the university system, whether it is in the field of education, teaching, scientific research and administrative tasks. The importance of digital transformation in universities comes to improving research and educational output, improving access to more education, and supporting the quality of academic research achievement of all kinds to serve society.

Examples of technological and digital transformation in universities are learning platforms such as Blackboard, Canvas and Moodle, and these platforms have become important and necessary in the learning process and academic achievement, as they have a great role in facilitating students' access to electronic courses. In addition, the completion of duties, participation in the completion of academic research and access to websites that contribute to the collection of information and benefit from it in obtaining knowledge (Alenezi, & Akour, 2023).

Several studies have also asserted that digital transformation is not just about integrating technology into business processes. Digital transformation is a process of creating new methods and practices that are evolutionary and effective in pursuing the mission of higher education. Therefore, Universities have been quick to enable digital transformation in their practices, business models, and operations (Alenezi, 2021).

A study (Ebert Duarte, 2018) and (Spear, 2020) examined the goals of digital transformation on the social and economic levels as follows: At the institutional and community level. Cooperation Promoting the development of more innovative technological systems and financial culture Change the education system to provide new skills and future guidance for people to achieve excellence in digital work., Establishing and maintaining digital communications infrastructure, ensuring its management and accessibility, and striking a balance between service quality and delivery costs., Enhancing digital data protection, transparency, ensuring independence requirements, and enhancing trust, Calculate the accessibility of services, and establish controls, mechanisms and quality of digital services provided to the community Apply new and innovative business models and improve the regulatory framework and technical standards. Achieving the principle of integrity and transparency because of the establishment of roles and responsibilities without relying on the traditional hierarchy, which is characterized by routine and bureaucracy.

In addition, digitization in the higher education sector is increasingly contributing to the achievement of the following main objectives: developing the learning environment for students, increasing the efficiency of operational processes, enhancing computing capabilities to support advanced research, encouraging innovation in teaching methods, thus becoming one of the goals of educational institutions focusing on adopting the concept of digital transformation (DX) to achieve these aspirations on the ground. This section illustrates these objectives as follows (Zitter, ٢٠٢٤) :

- **Developing the learning environment for students:** students' learning experience can be enhanced and they can access content in a more dynamic and easy way by implementing interactive and tailored digital learning tools.
- **Increasing the efficiency of operational processes:** by automating processes and reducing paper-based systems, the efficiency of administrative and organizational performance in educational institutions can be improved.
- **Enhancing computing capabilities to support advanced research:** advanced scientific research and big data analysis can be facilitated in more accurate and effective ways through the more innovative computing resources provided by digital transformation
- **Encouraging innovation in teaching methods:** improving teaching methods and developing educational content by adopting innovative technologies such as artificial intelligence and machine learning
- **Minimize expenses:** educational institutions can reduce expenses associated with traditional infrastructure such as facilities and maintenance by adopting digital solutions and options.

Moreover, digital transformation plays a pivotal role in improving the horizon of collaboration and interaction between students and faculty members in higher education institutions (Abdulrahim, 2020). It has become possible to implement group projects and assignments effectively remotely, providing new opportunities for interaction between instructors and students through advanced electronic platforms. These platforms not only facilitate the exchange of educational materials and assignments, but also enhance access to academic content in a more flexible and effective way. They also contribute to reducing the need for traditional classroom infrastructure, which reduces reliance on physical resources and increases the operational efficiency of educational institutions (Akour and Alenezi, 2022).

2.9 Challenges Facing Scientific Research in the Context of Digital Transformation in Higher Education

Studies conducted by Gkrimpizi, Peristeras, & Magnisalis (2023); Nikša (2021) and Qarzi, meqnaqy, & al-Nadawi, (2022). Indicate that there are a number of Challenges to digital transformation in higher education institutions:

- **Environmental barriers:** These include the lack of a suitable environment for digital transformation, such as the lack of technological infrastructure
- **Strategic barriers:** the lack of clear and effective strategies to implement digital transformation in educational institutions.
- **Organizational barriers:** It is related to the lack of integration of systems and procedures within the organization, which hinders the digital transformation process.
- **Technological barriers:** These include challenges related to the technology used, such as incompatibility between systems.
- **People-related barriers:** Lack of digital skills and technical knowledge among faculty and students.
- **Cultural barriers:** These include resistance to change and lack of a digital culture in the academic community.
- **Lack of awareness of research tools:** Studies have shown that students tend to use general rather than specialized research tools, due to a lack of awareness of them.
- **Lack of control over research methods:** Lack of control over research methods is another reason that hinders the effective use of research tools.

Al-Qumbari and Al-Adel (2023) indicate that there are challenges facing the implementation of digital transformation in universities, including

1. **Lack of Understanding:** Many institutions and stakeholders still do not fully understand the true concept of digital transformation, necessitating a clearer definition of its actual meaning.
2. **Resistance to Change:** Implementing digital transformation projects involves numerous changes, whether at the administrative level, department level, or among the workforce. This requires redistributing tasks and authorities, leading to shifts in administrative leadership and job roles, which often results in resistance to change.

3. **Financial Constraints:** Providing the necessary financial resources is a challenge, as digital technology is constantly and rapidly evolving, necessitating continuous investment to keep up.
4. **Security Challenges:** The information revolution has led to new forms of threats and cybercrimes, such as hacking, which pose risks to information security.

Lupton (2014) points out that digital transformation poses challenges related to data privacy and security, as it becomes more difficult for researchers and organizations to secure sensitive data with the expansion of big data and digital tools.

Baskerville et al. (2020) emphasize that one of the main challenges of digital transformation in scientific research is adapting to new technologies, as this requires the development of new research and technological skills to enable researchers to use digital analysis tools effectively.

Veletsianos and Kimmons in his study (2012) explained that the lack of training on digital tools is another challenge, as not all universities provide sufficient training for researchers on digital analytical tools and big data, which hinders maximising the benefits of digital transformation.

Aithal & Aithal (2016) showed that there are challenges related to digital infrastructure in academic institutions, as universities need significant investments in infrastructure to provide the technologies and resources needed to support digital research, which constitutes a financial burden on them.

Both Kopp and Vickery (2021) point to the technical and organizational obstacles that universities face when trying to integrate digital technologies into education and scientific research. One of these is the lack of adequate infrastructure, weak technical skills of faculty members, and the lack of a clear leadership vision for effective digital transformation in research activities. In this context, the study Dahlström and de Boer (2020) addressed the challenges that universities face in adapting to modern digital technologies and their impact on academic research. Researchers noted the need to adapt new strategies to meet the needs of education and scientific research, requiring modernization of working methods and digital interaction in higher education institutions. On the other hand, the study Pawlowski and Stoeckigt (2020) focused on identifying difficulties in implementing digital transformation strategies in universities, especially in the field of scientific research. The

study highlighted the importance of strategic planning and how these strategies can be successfully implemented to maximize the use of digital technologies within academic institutions.

In the Shah and Rehman study (2021), researchers addressed the organizational challenges of adopting digital technologies in universities, highlighting the importance of supporting academic staff and providing appropriate training for the effective use of digital tools. They also stressed the need for institutional support and strategic planning to ensure the success of the educational institutions' digital transformation process. Accordingly, it is clear that digital transformation in higher education faces significant challenges, including lack of infrastructure, poor technical skills, and lack of strategic planning, critical factors that must be addressed to ensure a successful digital transformation in scientific research.

2. 10 Digital Transformation in Saudi Universities and Vision 2030

Digital transformation in Saudi universities is central matter to the Kingdom's Vision 2030, which seeks to modernize the educational system and enhance the effectiveness of scientific research by integrating advanced technology. This transformation is of strategic importance in higher education institutions such as Princess Noura bint Abdulrahman University, where digital tools are used to enhance learning environments, streamline administrative processes, and improve the educational experience comprehensively. Many studies and reports have addressed this impact. For example, Shuweibi (2023) illustrates the Saudi Government's efforts in building a robust digital education infrastructure, with a focus on integrating ICT into higher education. This is part of Vision 2030's broader goals, which prioritize technological progress to support economic growth and improve the quality of public services.

In 2020, Mabrouk and Abdulrahim addressed the role of the Fourth Industrial Revolution (4IR) in achieving the goals of Vision 2030, highlighting its importance in the development of education and scientific research. They explained that digital tools such as smart devices, artificial intelligence, and blockchain technology are essential elements for enhancing education and research capabilities.

On the other hand, Zahran Study (2023) agrees with this trend, noting that Saudi universities, including Princess Noura bint Abdulrahman University, are establishing advanced research centers in various fields. These centers rely on digital resources to

promote scientific cooperation and encourage innovation, supporting the Kingdom's economic and social objectives within the framework of Vision 2030.

Other studies, such as AL-jabaleen, Sawi and Haif study (2023), indicate the critical importance of digital transformation in promoting faculty satisfaction and improving the quality of scientific research at Saudi universities. The study also examined the role of the Saudi Digital Library in supporting both education and scientific research, facilitating access to academic resources and contributing to increasing scientific production and significantly improving academic performance.

These studies emphasize the central role of digital transformation in promoting higher education and scientific research in Saudi Arabia, in line with the Kingdom's ambitious vision for growth and innovation. This transformation enhances the efficiency of the educational process and drives scientific research, contributing to the achievement of Vision 2030's strategic objectives.

2.11 Digital Transformation and Its Impact on Education and Scientific Research at Princess Noura bint Abdurrahman University"

Interest in information and communication technologies (ICT) has increased around the world, such as distance learning, continuous learning, smart cities, and e-governments to improve the quality of economic growth and digital transformation, which prompted developed countries to develop information infrastructure and digital transformation (Martyakova, Gorchakova, 2019). As digital technology becomes increasingly integrated with the real economy, the digital economy is emerging as a predominant new force driving global economic development, gradually supplanting the traditional economy (Zhao, et al. 2024.p1).

Mechanical headways like savvy gadgets, the Web of Things (IoT), man-made brainpower (simulated intelligence), increased reality (AR) and computer-generated reality (VR), block chain innovation, and different programming applications have made new roads for further developing instructing and learning. These developments have fundamentally upgraded instructive (Gaol & Prasolova-Førland, 2021; OECD, 2021).

Subsequently, as of late, schooling systems overall have expanded their interest in the coordination of data and correspondence innovation (ICT) (Fernández-Gutiérrez et al., 2020; Lawrence & Tar, 2018). Also, focused on their instructive plans to adjust methodologies or strategies around ICT coordination (European Commission, 2019).

The latter brought about issues regarding the quality of teaching and learning with ICTs (Bates, 2015).

Saudi Arabia has experienced several changes because of digital transformation, which prompted the creation of the National Committee for Digital Transformation in Kingdom to advance changes in the public and private sectors in line with Saudi Arabia's Vision 2030 (Alshuaibi, 2023).

The Ministry of Communications and Information Technology has noted that 4IR will be essential in achieving Vision 2030 objectives, given Kingdom is undergoing a process of comprehensive change and reform at all levels. Vision 2030 is considered one of the most significant engine drivers unlocking major economic purpose and enabling the diversification, that Saudi economy requires going forward. (Mabrouk, & Abdulrahim, 2020). The Kingdom has actively prioritized research, development, and innovation (RDI) within Vision 2030, realizing the critical role that RDI plays as a catalyst for economic growth in leading nations (Research, Development and Innovation Authority, 2023).

Scientific research is one of the most prominent elements of Vision 2030, and this comes through the efforts made by Saudi universities in improving the quality of scientific research and by seeking to publish the results of much research in local and international publishing journals and cooperating with research bodies inside and outside Kingdom by exchanging knowledge and expertise and providing modern means of communication and scientific publications. Kingdom has more than 88 diverse research centers that include complex engineering systems, space and aviation, bio-nanotechnology, advanced materials and manufacturing, green nanotechnology, petrochemicals, telecommunications applications, nanomaterials for clean energy applications, common genetics, Nano medicine, water and energy research, building and construction technology, and physics. building and construction technology, applied physics, communications technology and information security, electronics and photonics, biology and environmental research, agricultural and pharmaceutical technology, the Space Research Institute, the Nuclear Science Research Institute, and the Atomic Energy Research Institute, which aims to harness and develop nuclear technology to serve development in all its fields (Zahran,2023).

Princess Nourahhh bint Abdulrahman University sensed the need to achieve leadership in information and communication technology services and the transformation into e-government transactions. It also recognized the significant role that ICT plays and the challenges that it must overcome to stay ahead of the curve and become a smart scientific campus. It also understood how important it was to work on utilizing contemporary ICTs to support the needs of education. As a result, they become conduits for communication between the university community and its goals related to academics, research, creative industries, and administration. As a result, it changes from a conventional learning environment to a cutting-edge learning environment, setting an example of success that should be emulated (Princess Nourahhh bint Abdurrahman University, 2024)

Digital transformation at Princess Noura bint Abdul Rahman University (PNU) is a key focus aimed at promoting integrated education and scientific research. Researchers, such as Almahmadi (2023), have reviewed the University's remarkable progress in developing its digital infrastructure, in line with global trends to improve access to and quality of research. This shift is also an essential part of strengthening cooperation and partnerships that meet domestic and international research needs.

In addition, studies such as those conducted by Alharthi (2022) highlight the transition from traditional to digital education, citing significant benefits such as enhanced flexibility and reduced costs. However, this shift is not without significant challenges, especially in courses that require practical training, as digital transformation has not yet been fully achieved in these areas.

Algoblan, Sawy, Y & Alhaif, (2023) Emphasizes Princess Nourahh bint Abdulrahman University recognizes the importance of digital transformation in the academic sector, as digital resources play an effective role in enhancing scientific life, especially in improving the quality of research and information circulation, and it also achieves a great deal in achieving job satisfaction for faculty members at Princess Nourahh bint Abdulrahman University. The Saudi Digital Library has a great impact on the advancement of teaching and scientific research processes due to the interest of the university administration in this regard. Elements of excellence of digital resources lead to enhancing the quality of scientific life such as Ease of research and freshness of information, and that faculty members rely mainly on publishing in international

publishing observatories such as WOS, SCOPUS, EBSCO, with Recording researchers' master data in data monitoring observatories. On publishing in international publishing observatories such as WOS, SCOPUS, EBSCO, with Recording researchers' master data in data monitoring observatories.

Digital resources facilitate the users to access resources electronically through the internet; the research community is the largest user of digital resources. Along with usage research from the IT field, we are also contributing to it. The purpose of contribution is to improve the speed and easy to access from different locations such as work or home (Khan, Kumari, & Firdaus, 2015). According to some scholars, digital resources has only one that is online which only make difference as compare to traditional or manual resources . Online or digital resources are the combination of other digital resources, which are connect through network and have digital form of data i.e. articles and e-books, which facilitate users to access digital, form of data from different (Abbas A, & Faiz, 2013).

In addition, the higher education sector has always been the backbone of overall society development. While it helps reshaping the community of youth Researchers into full functioning members of society, it is also a fertile ground for creativity, innovation and scientific research. Enhancing an educational system necessitates a comprehensive assessment of its operational dynamics encompassing organizational structure, functional processes, instructional methodologies, and educational curricula, inclusive of the integration of cutting-edge technological pedagogical tools aligned with contemporary and refined content, thereby establishing a discernible standard of educational excellence. A multitude of both highly developed and burgeoning nations have embarked upon a concerted endeavor to integrate increasingly sophisticated technological and digital pedagogical modalities within their educational frameworks accordingly, this research was conducted to identify The Impact of Digital Transformation on Research Effectiveness at PNU's Research Center.

2.12 Theories of Digital Transformation

The studies and research that are integrated in the changes resulting from digital transformation strategies varies considerably, with similar terms such as e-government, digital government, and transformative government being used, sometimes leading to confusion between the concepts associated with them. However, these concepts share a common core, which is the study of how the public sector uses ICT to improve the

quality of services, change organizational processes, and enhance institutional culture. These studies also include the impact of digital transformation on creating added value. Among the most important theoretical works that form the basis of research in this area are Fontaine's "Technology Legislation Framework" and Dunleavy et al.'s "Digital Governance Approach."

In short, Fountain's (2004) approach views the impact of technology on organizations from an institutional perspective, distinguishing between objective technology, such as the Internet, and implemented technology, which relates to the use and design of those technologies by individuals within the organization. He suggests that the perception and use of technology depends on the organizational structure, while implemented technology influences the structure of the organization. On the other hand, Dunleavy and colleagues' (2006) "Governance of the Digital Age" approach provides a view of organizational change induced by technology, suggesting that it is not the technology itself that brings about change, but rather the way organizations use technology that changes work practices. This approach also considers the broader impacts of technology on organizational change and organizational culture, as well as new ways of dealing with information and government services. From these two frameworks, the basic elements of digital transformation can be deduced.

Many theories and research that explain digital transformation and its importance have spread, the most prominent of which is the path theory, which focuses on the impact of historical events on the current operations of organizations. This theory is based on three basic characteristics: first, it is a causal process influenced by early events; second, the first event is emergent and context-dependent; and finally, the causal pattern takes two forms: a self-reinforcing mechanism or an interactive sequence where each event affects subsequent events. Despite its use in information systems research, the path theory explained the inertia of legacy systems and digital innovations, not digital transformations. As for digital transformations, they involve interconnected digital technologies and organizational practices, and for this reason, the assemblage theory (AT) was applied to understand the interaction between social and technical entities. These interactive processes are subject to processes of stability and instability over time, where stability is what gives shape and identity to the assemblage through processes such as territoriality, symbolization, and interlocking (Rolland, K.-H., & Hanseth, 2019).

Open innovation theory is based on the idea that innovation should not be limited to an organization's internal boundaries but can be achieved through collaboration with third parties such as universities, customers, or even other companies. As part of digital transformation, organizations can apply this theory by sharing digital knowledge with third parties, increasing their ability to innovate quickly and adapt to changes in the market (Chesbrough, 2003).

Moreover, the theory of adoption and proliferation (Diffusion of Innovations) theory that was presented by Everett Rogers is one of the most prominent theories explaining how modern technologies are embraced and spread within institutions. According to this theory, innovations go through multiple stages, starting with the adoption of the innovative category and then moving to the wider groups in society. In the context of digital transformation, this theory can be used to understand how employees respond and adopt new techniques in the working environment (Rogers, 2003).

These diverse theories about digital transformation are essential means of understanding how modern technology is absorbed and applied in enterprises. By leveraging these theoretical frameworks, organizations can improve digital transformation strategies and reach desired results thus, practical applied studies have shown that digital transformation is not merely a reliance on new technologies, but a comprehensive process involving the modification of institutional culture, continuous innovation, and effective interaction with social media.

2.12 Previous studies

Khalifa (2024) examined the impact of AI on academic writing and research, through a systematic review of 24 studies published since 2019. The review identified six key areas in which AI contributes: facilitating idea generation and research design, improving content and structure, supporting literature reviews, enhancing data management, assisting with editing and publishing, and ensuring ethical compliance. The results showed that tools like ChatGPT contribute significantly to improving academic efficiency, but they also addressed challenges related to academic integrity and the use of AI in tandem with human input. The study recommended integrating these tools into research workflows with an emphasis on ethical use and appropriate training.

Brunetti, et al. (2022) explores the impact of digital transformation on academic research publishing, focusing on the perspective of management scholars. Using a

qualitative approach that included direct observations and semi-structured interviews with Italian and international researchers, the study sought to understand the role of digital professional services and software in improving the process of publishing academic papers, both individually and collaboratively. The observations aimed to provide a comprehensive picture of digital services aimed at supporting academic research, while the interviews aimed to measure academics' awareness of these digital tools and their impact on the quality of publication, in addition to understanding their expectations regarding the role of these tools in the future. The results showed that researchers' awareness of these tools remains limited due to the multiplicity of available tools and their frequent use, which leads to distraction and ineffective interaction with their full potential. Although digital tools have helped improve research productivity and quality, academics expressed concerns about some of their associated limitations, such as the difficulty of adapting to many tools and the lack of effective support for their integration. In this context, the researchers presented proposals to improve these tools to enhance academics' ability to benefit from them more effectively to support the scientific publishing process.

Gkrimpizi, T., Peristeras, V., & Magnisalis (2023) illustrated the issue of digital transformation in higher education institutions by identifying and classifying barriers to the effective implementation of digital transformation initiatives. The researchers relied on a systematic literature review (SLR) to analyze previous studies, which led to the identification of twenty major barriers that were classified into six main categories: environmental, strategic, organizational, technological, people-related, and cultural. The study contributes to providing an in-depth understanding of these barriers, which enhances the ability of higher education institutions to formulate sustainable and effective strategies and interventions. In addition, the study provides vital insights for stakeholders and decision-makers to support digital transformation initiatives and enhance their ability to achieve the desired goals.

Khawaji (2023) aimed to explore the requirements of digital transformation in Saudi universities from the perspective of faculty members, including administrative, technological, and human requirements. The researcher used a quantitative descriptive approach based on a questionnaire to collect data, which was sent electronically to faculty members. The results showed that human requirements were the most important with an average of 2.25, followed by administrative requirements with an average of

1.95, then technological requirements with an average of 1.64. Participants also provided suggestions for improving the mechanism for implementing digital transformation, and finally the researcher provided recommendations to enhance the implementation of digital transformation in universities.

The study by Al-Otaibi and Albaroudi (2023) aimed to explore the role of digital quality management in enhancing the development of Saudi institutions through digital transformation. The study included a review of 36 research papers classified into three categories: education and learning, digital transformation, and quality management. The results showed weaknesses in digital quality management systems in educational institutions, with the research relying on traditional methodologies such as Lean Six Sigma and total quality management. The study emphasized the importance of continuous quality review to ensure success and progress, noting that digital quality management contributes to building competitive advantages and supporting the sustainable development of Saudi institutions.

The study of Abbas A, & Faiz A (2013) aimed to evaluate the usefulness of digital and traditional libraries in higher education. The study involved semi-structured interviews with 12 students from three faculties of Foundation University, Islamabad. The results showed that digital libraries provide quick access and ease of research, while traditional libraries require physical attendance. However, students indicated that the intellectual environment and the feeling of holding books in traditional libraries cannot be replaced by digital libraries.

When comparing the current study on “The Impact of Digital Transformation on Research Effectiveness at the Research Center at Princess Nourah University” with the other studies I mentioned, several similarities and differences can be observed, especially regarding the use of tools and the descriptive approach.

2.13 Comparing the Current Study with Previous Studies

When comparing the current study on “The Impact of Digital Transformation on Research Effectiveness in the Research Center at Princess Nourah University” with the other studies I mentioned, many similarities and differences can be observed, especially with regard to the use of tools and the descriptive approach.

Similarities:

1. **Focus on digital transformation:** All previous studies address the topic of digital transformation, whether in improving the academic publishing process (Brunetti et al., 2022), in supporting academic writing (Khalifa, 2024), or in addressing barriers to digital transformation in higher education (Jakrumbazi et al., 2023). In your study, you focus on the impact of digitization on research effectiveness, an idea that is consistent with these studies that highlight the effects of digitization on academic performance and productivity.
2. **Using a questionnaire as a data collection tool:** The current study relies on the questionnaire as a tool to collect information from the participants, which is a common method in many of the mentioned studies such as Khawaji (2023) who used the questionnaire to collect the opinions of faculty members about the requirements of digital transformation in Saudi universities. The questionnaire provides a systematic way to analyze participants' opinions and collect quantitative data that supports the findings.
3. **Descriptive method:** The current study uses the descriptive approach that aims to understand and analyze the current reality of digital transformation practices in the research center. This is in line with many other studies such as Khalifa's (2024) study which used a systematic literature review to describe and analyze how AI is supported in academic writing.

Differences:

1. **Focus on the academic sector vs. University:** In the current study, your focus is on an academic research center within PNU, while other studies on digital transformation, such as Jakrumbazi et al. (2023) and Khawaji (2023), focus on universities and educational institutions in general, which broadens the scope of the application being studied. Your study is narrower in scope but focuses on the depth of digital transformation within a specific academic research center.
2. **Challenges and opportunities:** In studies such as Brunetti et al. (2022) and Khawaji (2023), the challenges of digital transformation are addressed in broader contexts such as publication quality and the challenges facing academic institutions in terms of human and technological resources. Whereas the current study may be

more specialized in the positive impacts of digital transformation on academic research and its tools.

Chapter three

Research Methodology

3.0 Research Methodology

This chapter indicates the methodology used in the study, study population, study sample, study instrument with its consistency and reliability, variables of the study, and ethical considerations. In addition, statistical analysis procedure.

3.1 Research Design

The study will utilize the quantitative approach in order to gather numeric data that concerned with frequencies of the elements and interpret this data numerically.

Quantitative research techniques were utilized to examine occurrences affecting the study's sample population. Different numerical data is gathered using various techniques in this form of investigation, with statistical analysis used to combine, compare, or illustrate relationships between the data. Quantitative research methods involve surveys, controlled observations, and experiments. It is the collection and analysis of numerical data to explain, predict, or manage variables. This form of research is useful for examining causal connections between variables, forecasting outcomes, and applying findings to larger groups of people. Quantitative research aims to evaluate a pre-established theory or hypothesis and determine its validity through the findings. Researchers use quantitative data analysis to identify patterns in data sets over time (Sreekumar, 2023).

Apuke (2017) mentioned that a quantitative research approach involves measuring and examining variables to produce outcomes. It includes using statistical methods to examine numerical data and provide answers to questions regarding who, how much, what, where, when, how many, and how.

Additionally, quantitative research involves collecting, analyzing, interpreting, and reporting the findings of a study. The methodology of data analysis employed by the researcher involves the use of mathematical models. Three significant changes in quantitative research are related to how research is planned, how tests and measurements are conducted, and how data is analyzed statistically. Quantitative research entails gathering numerical data and analyzing it using mathematical models as the primary method of data analysis. Furthermore, the researcher utilizes inquiry methods to guarantee consistency with the methodology for collecting statistical data (Williams, 2007). This approach is suitable for recognizing The Impact of Digital Transformation on Research Effectiveness at PNU's Research Center.

3.2 Research Population

This study will involve 1,000 researchers and beneficiaries of scientific research services at Princess Noura University Research Center, including students, faculty members and health care researchers.

3.3 Sample and Its Characteristics

In this study, a random sample of faculty members, postgraduate students, and researchers who have benefited from scientific research services will be selected at Princess Noura University Research Center, numbering 250 beneficiaries. This sample represents a wide variety of target groups, allowing accurate and comprehensive representation of all aspects of research. The random selection process will be conducted to ensure a balanced and equitable representation of each category, thereby enhancing the credibility and quality of the results. The following table shows the characteristics of the study sample:

Table (1): frequency and percentage of the demographic data of impact of digital transformation on the effectiveness of research center

Variables	category	Frequency	percentage
Gender	male	106	42.4%
	female	144	57.6%
Jop title	Faculty member	104	41.6%
	Another employee	99	39.6%
	Postgraduate studies	47	18.8%
Technical experiences	Yes	167	66.8%
	No	83	33.2%

"It is evident from the table that the percentage of females (57.6%) surpasses that of males (42.4%) in the studied sample. Additionally, the majority of participants work as faculty members (41.6%), followed by other employees (39.6%), with the fewest being in postgraduate studies (18.8%). Regarding technical experiences, the majority of individuals possess technical experience (66.8%) compared to those who do not have technical experience (33.2%)."

3.4 Sample Size Determination

To accurately calculate sample size, a special formula can be used based on several factors, such as degree of confidence, error margin, and size of the target community. The basic formula for sample size calculation is as follows:

$$n = \frac{N \times p(1-p)}{\left[\left[N - 1 \times \left(d^2 \div z^2 \right) \right] + p(1-p) \right]}$$

Where:

- **N:** Size of the population
- **Z:** The standard score corresponding to the confidence level (0.95), which is equal to 1.96
- **Q:** Error margin, equal to 0.05
- **P:** Proportion estimate, assumed to be 0.50 when unknown

3.5 Data Collection

3.5.1 Data Collection tools

The study will employ an electronic questionnaire to gather data. With careful design, questionnaires can produce high quality, useable data, achieve good response rates³, and offer anonymity, which encourages more candid and open responses than, say, interviews. All of these factors can help to reduce bias (Marshall, 2005).

According to Sreejesh (2014), a questionnaire is essentially a prearranged list of questions that are given to interviewees along with explicit instructions outlining the order and selection criteria. This type of tool is highly adaptable and can be used in a variety of research fields, including experimental design and survey research. It gives researchers a methodical framework for gathering information for data collection and analysis.

With benefits like affordability, accessibility, and the ability to reach a wide range of demographics, questionnaires provide researchers with a powerful and adaptable tool for data collection across a variety of research domains. However, because of its

structured format, which facilitates standardized data collection, organization, and analysis, they are especially useful for quantitative research projects (Dalitso, 2024) Because of this importance of the questionnaire; the research will adopt the questionnaire to answer the study questions.

The questionnaire used in this study consists of two main parts. The first part focuses on the collection of data on participants' demographic characteristics. The second part focuses on studying the impact of structural and organizational digital transformation at Princess Noura University's Research Centre, which includes three main dimensions:

- **The impact of structural and organizational digital transformation on the development of scientific research tools**, and this dimension includes 10 phrases.
- **The impact of structural and organizational digital transformation on research constraints**, this dimension also includes 10 phrases
- **The impact of structural and organizational digital transformation on research quality**, this dimension consists of 10 phrases

The study used a self-questionnaire using Google Forms. Different strategies were used to reach the study sample. These strategies ranged from direct communication to electronic communication through social media platforms and applications. Hospital directors at Mukal Abdullah bin Abdulaziz Hospital were contacted by phone to familiarize them with the content and objectives of the research and were asked to encourage their staff to voluntarily participate in the survey. The questionnaire was also sent to faculty members and graduate students, and WhatsApp groups were used to disseminate the survey link as widely as possible. , which helped cover a wide range of potential participants. The survey link was shared with official and professional WhatsApp groups related to the study sample, which helped reach many participants in a short period. The beginning of the questionnaire contained informed consent that included a brief description of the study, its objectives, and contact information for the researcher if participants wanted to communicate with the researcher for any reason related to the research. Participants were informed that their participation was entirely voluntary and that they could withdraw at any time. To maintain the confidentiality of the participants' data, all participants were anonymous, therefore, there would be no indication of the identity of the participant.

3.5.2 Validity tool:

The researcher conducted a test of validity for the questionnaire using two types of validity: Face validity and Internal consistency validity. Alpha Cronbach's was also used to calculate the constant factor. These procedures are described in detail below:

- **Face Validity:** The authenticity of the content was verified by presenting the questionnaire to 12 faculty arbitrators and experts in digital technology, where they provided their observations on the relevance of the items to measure the targeted dimensions, in addition to assessing their formulation and suitability for the local context. Items that received unanimity from 80% or more of the arbitrators on their validity were accepted for inclusion in the scale, and their observations were considered for the implementation of the necessary amendments, whether by deletion or modification in accordance with their observations.
- **Internal Consistency Validity:**

The validity of the questionnaire was verified by applying it to 30 respondents of the study sample. The following table illustrates the values of the coefficient correlation between each item of the questionnaire and its dimensions, as well as with the overall degree of the instrument.

Table (2) Correlation Analysis between Items and the Three Dimensions Used in the Study

Dimension 1		Dimension 2		Dimension 3	
Item	Correlation	Item	Correlation	Item	Correlation
١	0.825**	١١	0.845**	٢١	٠,٨٢٥ **
٢	0.812**	١٢	٠.835**	٢٢	0.845**
٣	0.848**	١٣	0.820**	٢٣	0.835**
٤	0.845**	١٤	0.838**	٢٤	0.820**
٥	0.835**	١٥	0.935**	٢٥	0.845**
٦	0.820**	١٦	0.822**	٢٦	0.835**
٧	0.848**	١٧	0.848**	٢٧	0.820**
٨	0.825**	١٨	0.844**	٢٨	0.848**
٩	0.844**	١٩	0.825**	٢٩	0.845**
١٠	0.825**	٢٠	0.830**	٣٠	0.835**

** Acceptable correlation coefficient at the at the significance level $\alpha = 0.05$.

Table (2) shows the Correlation coefficient between item and dimensions, with most correlation values ranging from 0.820 to 0.848, indicating a strong and marked correlation between item and dimensions, reflecting the good coherence of the questionnaire.

3.5.۳ Reliability of the study

Stabilization indicators were calculated using the retest method, where the questionnaire was applied to a sample of 30 individuals from outside the study sample, at an interval of two weeks. Alpha Cronbach's has also been calculated for the questionnaire, and the following table shows how the alpha Cronbach's coefficient is calculated.

Table (3) Reliability of the study

Dimension	Number of Item	Cronbach Alpha
Developing Scientific Research Tools	۱۰	۰,۸۵۹
Research Constraints	۱۰	۰,۸۸۷
Research Quality	۱۰	۰,۹۰۳
Total	۳۰	۰,۹۳۱

The results of table (3) show that Cronbach's total coefficient value was 0.931, reflecting a high degree of stability. For sub-dimensions, Cronbach's coefficient value ranged from 0.805 to 0.903, which is high and considered suitable for research purposes.

3.5.۴ Tool correction method:

Table (4)The levels were classified according to the scale

Arithmetic Mean	Level
From 1 to 1.80	Very low
From 1.81 to 2.60	Low
From 2.61 to 3.40	Medium
From 3.41 to 4.20	High
From 4.21 to 5	Very high

3. 5.5 Statistical Methods

To achieve the study objectives, several appropriate statistical methods were employed using the Statistical Package for the Social Sciences (SPSSversion 25) program, which is abbreviated as (SPSS). The following statistical measures were computed: frequencies and percentages were calculated to identify the functional characteristics of the study participants

and determine the responses of the study sample to the study instrument's axes. Also, the Pearson correlation coefficient was used to calculate the internal consistency reliability of the study instrument. Cronbach's Alpha coefficient and half method were employed to calculate the reliability coefficient of the various dimensions of the study instrument. Descriptive analysis was used for the representation of the sample characteristics. Mean was calculated to determine the extent of increase or decrease in the study sample's responses to the main axes (item means) and to rank the axes according to the highest mean. Standard Deviation was utilized to ascertain the deviation of the study community's responses for each item of the study axes and each main axis from its arithmetic mean. The standard deviation illustrates the dispersion in the study participants' responses for each item of the study axes, in addition to the main axes. As its value approaches zero, responses are concentrated, and their dispersion decreases across the scale. A t-test was used to measure the demographic variables, and an (ANOVA) was used to determine the effect of the demographic variables.

Chapter four Results

4. Preface

This chapter presents the results derived from the data analysis conducted in this study.

This chapter aims to provide insights into the findings obtained from the research, shedding light on their significance and implications within the context of the study objectives.

4.1 Q1: There is an impact of digital transformation on the effectiveness of research center?

The means and standard deviations there is an impact of digital transformation on the effectiveness of research center

Table (٩): The means and standard deviations of the there is an impact of digital transformation on the effectiveness of research center

N.	Dimension	Mean	Standard dev.	rank	Degree
3	The impact of structural and organizational digital transformation on the quality of research at Princess Nourah University Research Center.	4.26	0.71	1	Very high
2	The impact of structural and organizational digital transformation on research obstacles at Princess Nourah University Research Center.	4.21	0.74	2	Very high
1	The impact of the structural and organizational digital transformation on the development of scientific research tools at Princess Nourah University Research Center.	4.10	0.66	3	High
	total	4.19	0.64		

Table (٩) The arithmetic averages of the dimension of the impact of digital transformation on research operations in the center were very high and high, as the total arithmetic mean (4.19) came with a high degree and a standard deviation (0.64). As for the dimensions of the study, dimension (3) (The impact of structural and organizational digital transformation on the quality of research at Princess Nourah University Research Center.) came in first place with an arithmetic mean (4.26) with a very high degree and a standard deviation (0.71), and dimension (2) (The impact of structural and organizational digital transformation on research obstacles at Princess Nourah University Research Center.) came in second place with an arithmetic mean (4.21) with a very high degree and a standard deviation (0.74), and dimension (1) (The impact of the structural and organizational digital transformation on the development of scientific research tools at Princess Nourah University

Research Center.) came in last place with an arithmetic mean (4.10) with a moderate degree and a standard deviation (0.64) The results showed that “the impact of the structural and organizational digital transformation on research quality ranked first in the arithmetic averages, and this indicates that the organizational and structural digital transformations have contributed very effectively to raising the level of research quality in the center.” The impact of the structural and organizational digital transformation on research barriers ranked second, and this reflects that the digital transformation contributed to reducing or overcoming some research barriers, and this may be through simplifying procedures or improving the efficiency of research management, which reduced the barriers that were facing researchers. Finally, the impact of structural and organizational digital transformation on the development of scientific research tools ranked last in the ranking of averages, which may indicate that the impact of digital transformation on the development of scientific research tools was limited or less important to the participants

4.2 H1: There is a statistically significant to the structural and organizational effectiveness of research (scientific research tool, obstacles of research centers, quality of research centers) at the PNU research centers

The means and standard deviations of the sub-dimension were also extracted as follows:

Firstly: scientific research tool dimension

Table (٦): The means and standard deviations of the scientific research tool dimension

Parag. N.	Parag.	mean	Standard dev.	Rank	Degree
9	Digital transformation helps reduce the time and effort spent on routine research operations by automating tasks related to research tools	4.43	0.65	1	Very high
2	The organizational structure in the research center contributes to providing the necessary research tools	4.31	0.65	2	Very high
8	The use of modern technologies contributes to analyzing big data, which raises the quality and accuracy of research tools	4.30	0.73	3	Very high
10	It contributes to facilitating access to global digital information sources, which enhances researchers' awareness of the latest scientific developments	4.30	0.82	4	Very high

4	The organizational structure provides digital communication channels between researchers to use research tools optimally	4.22	0.98	5	Very high
7	The digital transformation in the center contributes to enhancing cooperation between researchers through the available digital platforms regarding research tools	4.20	0.88	6	High
6	The organizational structure contributes to stimulating innovation in the use of digital tools to achieve advanced research results	4.15	0.86	7	High
3	The organizational structure provides sufficient support for the use of advanced scientific research tools	4.14	0.93	8	High
5	The presence of a flexible organizational structure contributes to a rapid response to researchers' needs regarding research tools	4.12	0.94	9	High
1	The distribution of tasks in the center contributes to facilitating the effective use of digital scientific research tools	2.80	1.05	10	Moderate
Total		4.10	0.66		High

Table (°) shows that the scientific research tool dimension as a whole came in at a high degree with an arithmetic mean of (4.10) and a standard deviation of (0.66), the arithmetic means of the paragraphs ranged between (2.80 - 4.43). As for the study paragraphs, paragraph (9) (Digital transformation helps reduce the time and effort spent on routine research operations by automating tasks related to research tools) came in first place with an arithmetic mean (4.43) with a very high degree and a standard deviation (0.65), while paragraph (2) (The organizational structure in the research center contributes to providing the necessary research tools) came in second place with an arithmetic mean (4.31) with a very high degree and a standard deviation (0.65), while paragraph (5) (The presence of a flexible organizational structure contributes to a rapid response to researchers' needs regarding research tools.) came in the penultimate place with an arithmetic mean (4.12) with a high degree and a standard deviation (0.94), while paragraph (1) (The distribution of tasks in the center contributes to facilitating the effective use of digital scientific research tools) came in last place with an arithmetic mean (2.80) with a moderate degree and a standard deviation (1.05). Paragraph 9, “Digitalization reduces the time and effort spent on routine research processes by automating tasks associated with research tools,” received the highest score, indicating that respondents highly value the role of digitalization in streamlining routine processes and accelerating the completion of tasks through automation. This high rating reflects the importance of digitalization in improving operational efficiency and saving time

and effort, allowing researchers to focus on the most important aspects of their research instead of being preoccupied with administrative tasks. The researcher also explains that paragraph 1, which states “The distribution of tasks in the center facilitates the effective use of digital research tools received the lowest score, indicating a wide variation in the opinions of the participants about the effectiveness of the distribution of tasks in the center to facilitate the use of digital tools. This assessment suggests that task allocation may not be optimally managed or that participants may not see a clear impact on the use of digital tools, suggesting that there may be a gap in administrative organization in this context

Secondly: obstacles of research centers dimension

Table (٦): The means and standard deviations of the obstacles of research centers dimension

Parag. N.	Parag.	mean	Standard dev.	rank	degree
9	Digital transformation provides opportunities for virtual collaboration between researchers through effective digital platforms	4.52	0.69	1	very high
8	Digital transformation improved security technologies, which increased researchers' confidence in using digital tools.	4.43	0.72	2	very high
7	Digital transformation provides quick and easy access to digital sources and global scientific journals	4.42	0.84	3	very high
10	Digital transformation has contributed to increasing awareness of the importance of modern technologies in enhancing the quality of scientific research	4.40	0.75	4	very high
6	Automating routine research processes thanks to digital transformation saved researchers time and effort	4.32	0.80	5	very high
5	Digital transformation helped increase funding allocated to developing research technologies and tools.	4.24	0.89	6	High
3	Digital transformation helped provide ongoing training programs to develop researchers' technical skills.	4.17	0.93	7	High
4	Digital transformation contributed to improving the integration between the various digital systems at the research center	4.11	0.94	8	High
2	Digital transformation led to the provision of modern and effective software tools that support scientific research	3.98	0.94	9	High
1	Digital transformation contributed to improving the technical infrastructure and facilitating research.	3.54	1.26	10	moderate
Total		4.21	0.74		High

Table (٦) shows that the obstacles of research centers dimension as a whole came in at a high degree with an arithmetic mean of (4.21) and a standard deviation of (0.74), the arithmetic means of the paragraphs ranged between (3.54 - 4.52). As for the study paragraphs, paragraph (9) (Digital transformation provides opportunities for virtual collaboration between researchers through effective digital platforms.) came in first place with an arithmetic mean (4.52) with a very high degree and a standard deviation (0.69), while paragraph (8) (Digital transformation improved security technologies, which increased researchers' confidence in using digital tools.) came in second place with an arithmetic mean (4.43) with a very high degree and a standard deviation (0.72), while paragraph (2) (Digital transformation led to the provision of modern and effective software tools that support scientific research) came in the penultimate place with an arithmetic mean (3.98) with a high degree and a standard deviation (0.94), while paragraph (1) (Digital transformation contributed to improving the technical infrastructure and facilitating research.) came in last place with an arithmetic mean (3.54) with a moderate degree and a standard deviation (1.26). The researcher attributes the occurrence of paragraph (9): “Digitalization provides opportunities for virtual collaboration among researchers through effective digital platforms.” This reflects that respondents see digital transformation as a great opportunity to enhance virtual collaboration among researchers, by providing digital platforms that facilitate scientific collaboration and knowledge exchange remotely. This high rating indicates the importance of digital collaboration platforms in improving the work of research centers and transcending spatial boundaries. The researcher also explained that paragraph (1): “Digital transformation contributes to improving the technical infrastructure and facilitating research.” This reflects a divergence in participants' views on the effectiveness of digital transformation in improving technical infrastructure. This assessment may indicate that there are challenges or deficiencies in the technical infrastructure, or that current improvements do not fully meet the requirements of researchers, limiting the full benefit of digital transformation.

Thirdly: quality of research centers dimension

Table (7): The means and standard deviations of the quality of research centers dimension

Parag. N.	Parag.	mean	Standard dev.	rank	Degree
2	Digital transformation contributes to achieving a high level of quality of scientific research at the center	4.46	0.73	1	very High
3	Digital transformation helps improve the quality of research produced at the center	4.44	0.71	2	very High
10	The use of modern digital tools at the center contributes to improving the accuracy of research processes.	4.40	0.75	3	very High
4	Digital transformation supports the enhancement of standards that ensure the quality of research	4.36	0.83	4	very High
6	Digital transformation encourages the training and development of researchers, which is positively reflected in the quality of research produced.	4.34	0.75	5	very High
5	Digital transformation contributes to the effective allocation of necessary research resources	4.34	0.90	6	very High
7	Digital transformation helps support data accuracy and ensure the quality of research results	4.30	0.78	7	very High
1	On the variable of quality of research centers in light of digital transformation	4.17	1.05	8	moderate
9	Digital transformation provides additional resources that raise the level of quality of research and experiments	4.14	1.05	9	moderate
11	The digital transformation at the center supports the ability to monitor the quality of research and develop it continuously	4.11	0.85	10	moderate
8	Digital transformation enhances the center's ability to implement comprehensive quality reviews of research produced	3.86	1.20	11	moderate
Total		4.26	0.71		High

Table (7) shows that the quality of research centers dimension as a whole came in at a high degree with an arithmetic mean of (4.26) and a standard deviation of (0.71), The arithmetic means of the paragraphs ranged between (3.86 - 4.46). As for the study paragraphs, paragraph (2) (Digital transformation contributes to achieving a high level of quality of scientific research at the center) came in first place with an arithmetic mean (4.46) with a very high degree and a standard deviation (0.73), while paragraph (3) (Digital transformation helps improve the quality of research produced at the center) came in second place with an arithmetic mean (4.44) with a very high degree and a

standard deviation (0.71), while paragraph (11) (The digital transformation at the center supports the ability to monitor the quality of research and develop it continuously.) came in the penultimate place with an arithmetic mean (4.11) with a high degree and a standard deviation (0.85), while paragraph (8) (Digital transformation enhances the center's ability to implement comprehensive quality reviews of research produced.) came in last place with an arithmetic mean (3.86) with a high degree and a standard deviation (1.20). The researcher interprets paragraph (2): "Digital transformation contributes to achieving a high level of scientific research quality in the center. The highest arithmetic mean (indicating that the participants believe that digital transformation has a significant role in improving the quality of scientific research in the center. This high rating reflects the extent to which participants are convinced of the importance of digital transformation in enhancing research quality and supporting the production of high-quality scientific research. As the researcher interprets paragraph (8): "The digital transformation enhances the center's ability to carry out comprehensive quality reviews on the research produced." The lowest arithmetic mean indicates a divergence in participants' opinions about the extent to which digital transformation contributes to enhancing comprehensive quality reviews. This assessment may reflect the existence of challenges or insufficient infrastructure to support quality reviews comprehensively and effectively.

4.3 Q2 : Are there statistically significant differences between the average responses of the study sample members regarding structural and organizational effectiveness of research (scientific research tool, obstacles of research centers, quality of research centers) at the PNU research centers according to the variables of gender, job title and technical experiences?

A one-way analysis of variance test was conducted for the variable of job title and a t-test for independent samples for gender and technical experiences

Firstly: gender variable

Table (8): An independent sample t test was conducted for the gender variable.

Dimension	Group	Number	Mean	Stand. Dev.	Calculated t	Sig
scientific research tool	Male	106	3.95	0.76	3.063	0.002*
	Female	144	4.20	0.55		
obstacles of research centers	Male	106	3.99	0.80	4.480	0.000*
	Female	144	4.37	0.54		
quality of research centers	Male	106	4.04	0.81	4.481	0.000*
	Female	144	4.43	0.57		
Total	Male	106	3.99	0.75	4.313	0.000*
	Female	144	4.34	0.50		

the table (8) show that there are statistically significant differences at the significance level (0.05) between the (male) and the (female) categories. We find that the statistically significant differences in all dimensions of the study (scientific research tool) (obstacles of research centers) (quality of research centers) (overall performance) were in favor of the female category, which

obtained arithmetic mean (4.20) (4.37) (4.43) (4.34) respectively, which are higher than the arithmetic averages for the (male) category, which reached (3.95) (3.99) (4.04) (3.99) respectively, which reject the hypothesis that there is an effect of the independent variable (job title) on the dependent variable (scientific research tool) (obstacles of research centers) (quality of research centers) (overall performance), which we accept the hypothesis that there is an effect of the independent variable (gender) on the dependent variable (scientific research tool) (obstacles of research centers) (quality of research centers) (overall performance). The researcher attributes the differences in favor of the female group. This suggests that females may have more positive perceptions or experiences in these areas than males, reflecting a greater interaction or stronger impact of digital transformation and technological innovations in the research work environment. These differences may be due to greater institutional support or training opportunities for females, or perhaps different gender priorities or interests in dealing with digital tools or improving the quality of performance in research centers.

Secondly: job title variable

Table (9): A one-way analysis of variance test was conducted for the job title variable

Dimension	Source of variation	Sum of square	Df	Mean square	F value	Sig
scientific research tool	Between group	1.666	2	0.833	1.932	0.147
	Within group	106.474	247	0.431		
	Total	108.140	249			
obstacles of research centers	Between group	0.646	2	0.323	0.670	0.513
	Within group	119.090	247	0.482		
	Total	119.736	249			
quality of research centers	Between group	0.035	2	0.018	0.035	0.966
	Within group	126.819	247	0.513		
	total	97.656	249			
Total	Between group	0.553	2	0.276	0.663	0.516
	Within group	102.924	247	0.417		
	total	83.656	249			

Table (9) show that there are no statistically significant differences at the significance level (0.05) between the independent variable (job title) and the dependent variables (scientific research tool) (obstacles of research centers) (quality of research centers) (overall performance), as all statistical significance values were higher than 0.05, which we reject the hypothesis that there is an effect of the independent variable (job title) on the dependent variable (scientific research tool) (obstacles of research centers) (quality of research centers) (overall performance). The results suggest that job title does not have a noticeable or significant impact on research operations or research center performance. Thus, other factors, such as experience, training, or institutional support, could be more influential in shaping these variables, not just job title.

Thirdly: technical experiences variable

Table (١٠): An independent sample t test was conducted for the technical experience's variable

Dimension	Group	number	Mean	Stand. Dev.	Calculated t	Sig
scientific research tool	yes	167	3.93	0.68	6.125	0.000*
	no	83	4.43	0.43		
obstacles of research centers	yes	167	4.13	0.74	2.640	0.009*
	no	83	4.37	0.54		
quality of research centers	yes	167	4.18	0.78	2.809	0.005*
	no	83	4.44	0.50		
Total	yes	167	4.08	0.69	4.025	0.000*
	no	83	4.42	0.46		

The table (١٠) show that there are statistically significant differences at the significance level (0.05) between the (yes) and the (no) categories. We find that the statistically significant differences in all dimensions of the study (scientific research tool) (obstacles of research centers) (quality of research centers) (overall performance) were in favor of the "no" category, which obtained arithmetic mean (4.43) (4.37) (4.44) (4.42) respectively, which are higher than the arithmetic averages for the (male) category, which reached (3.93) (4.13) (4.18) (4.08) respectively, which we accept the hypothesis that there is an effect of the independent variable (technical experiences) on the dependent variable (scientific research tool) (obstacles of research centers) (quality of research centers) (overall performance). The researcher repeats the finding that those who answered “no” to the question related to technical experiences had more positive perceptions or evaluations regarding all dimensions of the study, which may reflect greater influence or a higher ability to deal with digital tools and challenges in research centers. This could indicate that people who do not face challenges in using technologies or who have advanced technical experiences are more appreciative of digital transformation in research centers.

Chapter Five Summary of results

5.1 Preface

This chapter includes the essence of the research findings through a comprehensive examination of the results; it seeks to offer a deeper understanding of the research questions, it is structured to offer a systematic presentation of the results, followed by an in-depth analysis and discussion to contextualize the findings within the existing literature and theoretical frameworks. Furthermore, through comprehensive analysis and interpretation of the data, the study has shed light on key insights and implications relevant to the topic under investigation. Based on these findings, several recommendations and suggestions have been formulated to guide future research endeavors and practical interventions in the field.

5.2 Summary of results

The results showed the following

- The first dimension: “The impact of structural and organizational digital transformation on the development of scientific research tools at the PNU Research Center” received a mean of 4.10, with a standard deviation of 0.66, and came in third place with a high score.
- The second dimension: “The impact of structural and organizational digital transformation on the barriers to research at PNU Research Center” obtained a mean of (4.21), with a standard deviation of (0.74), and ranked second with a very high score.
- The third dimension: “The impact of structural and organizational digital transformation on the quality of research at PNU Research Center” obtained a mean of (4.26), with a standard deviation of (0.71), and came in first place with a very high score.
- The results showed that there were statistically significant differences at the 0.05 level between male and female groups in all dimensions of the study (scientific research tools, obstacles of research centers, quality of research centers, and overall performance). The arithmetic averages were in favor of the female category in all dimensions, which indicates the influence of gender on these variables

- The results indicated that there were statistically significant differences at the 0.05 level between the yes and no categories in all dimensions of the study (scientific research tools, research center obstacles, research center quality, and overall performance). The arithmetic means were in favor of the No category in all dimensions, indicating the impact of technical experiences on these variables.
- The results also showed that there are statistically significant differences at the 0.05 level between males and females in all dimensions of the study (scientific research tools, research center obstacles, research center quality, and overall performance). The arithmetic means were in favor of females in all dimensions, indicating the influence of gender on these variables.

5.3 Recommendations:

1. Enhance the use of these platforms by providing training and resources to researchers to facilitate remote interaction.
2. Improving infrastructure as a basic step to enhance research efficiency.
3. Work on providing advanced digital research tools that contribute to accelerating research processes and improving their accuracy.
4. Enhancing investments in quality through technology.
5. The need for continuous training programs on the use of digital tools and improving technical skills, especially for new researchers or those who face challenges in using modern technologies.
6. The need to identify the challenges faced by researchers in research centers related to technological tools and ensure the continuity of technical support.

5.4 Study suggestions:

1. The need to develop research platforms and environments that include smart digital tools that contribute to facilitating data collection and analysis, taking into account the need to improve the user interface to be more interactive.
2. Conduct periodic assessments of the quality of research using digital tools to ensure continuous improvement in research output. Researchers can also be encouraged to use techniques such as artificial intelligence to improve the accuracy of results.
3. Develop comprehensive training programs for the center on the use of modern digital tools, with a focus on developing the technical skills needed to support digital transformation in scientific research.

4. Conduct regular surveys to identify technological barriers that researchers may face and work on improving these aspects to provide a more supportive research environment.
5. Implementing strong security measures such as encryption and data protection, and organizing training courses for researchers on digital security best practices.
6. Conducting future studies that address solutions on how to activate the role of digital transformation in scientific research centers

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List of Appendices

Appendix A: Copy of the questionnaire used in the study.

I am a Master's candidate (Management) at the University of MidOcean University, College of Management ...Currently, I to examine the this study aims am conducting a study titled “The Impact of Digital Transformation on Research Effectiveness at PNU's Research Center

I would like to request your cooperation to answer this questionnaire. Any information obtained will be kept confidential and only used for academic purposes. Your cooperation is highly appreciated. Thank you in advance for agreeing to participate in this study. If you have any questions, please do not hesitate to contact my honorable supervisor or myself.

Supervisor Associate Professor Faculty of

..... @gmail.com Phone:

Master Candidate Faculty of University Name

..... @gmail.com Phone :

Section A: A: Demographic Characteristics

Please tick (✓) the appropriate choice:

1- Gender:

☐ Male

☐ Female

2- JOp title:

☐ Faculty member

☐ Another employee

☐ Postgraduate studies

3- Technical experiences

☐ NO

☐ YES

Section B: Please indicate your degree of agreement or disagreement with the following statements, so please sign (✓) for the choice that reflects your opinion by choosing one of the five alternatives.

The following set of statements measures 'The Impact of Digital Transformation on Research Effectiveness at PNU's Research Center.' Please mark according to your level of agreement."						
Section A :The impact of the structural and organizational digital transformation on the development of scientific research tools at Princess Nourah University Research Center.						
Item No	Items	١	٢	٣	٤	٥
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	The distribution of tasks in the center contributes to facilitating					

	the effective use of digital scientific research tools					
2	The organizational structure in the research center contributes to providing the necessary research tools					
3	The organizational structure provides sufficient support for the use of advanced scientific research tools					
4	The organizational structure provides digital communication channels between researchers to use research tools optimally					
5	The presence of a flexible organizational structure contributes to a rapid response to researchers' needs regarding research tools					
6	The organizational structure contributes to stimulating innovation in the use of digital tools to achieve advanced research results					
7	The digital transformation in the center contributes to enhancing cooperation between researchers through the available digital platforms regarding research tools					
8	The use of modern technologies contributes to analyzing big data, which raises the quality and accuracy of research tools					
9	Digital transformation helps reduce the time and effort spent on routine research operations by automating tasks related to research tools					
10	It contributes to facilitating access to global digital information sources, which enhances researchers' awareness of the latest scientific developments					
Section B: The impact of structural and organizational digital transformation on research obstacles at Princess Nourah University Research Center.						
Item No	Items	1	2	3	4	5

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	Digital transformation contributed to improving the technical infrastructure and facilitating research					
2	Digital transformation led to the provision of modern and effective software tools that support scientific research					
3	Digital transformation helped provide ongoing training programs to develop researchers' technical skills.					
4	Digital transformation contributed to improving the integration between the various digital systems at the research center					
5	Digital transformation helped increase funding allocated to developing research technologies and tools.					
6	Automating routine research processes thanks to digital transformation saved researchers time and effort.					
7	. Digital transformation provides quick and easy access to digital sources and global scientific journals.					
8	Digital transformation improved security technologies, which increased researchers' confidence in using digital tools					
9	Digital transformation provides opportunities for virtual collaboration between researchers through effective digital platforms					
10	Digital transformation has contributed to increasing awareness of the importance of modern technologies in enhancing the quality of scientific research					

Section C: The impact of the structural and organizational digital transformation on the development of scientific research tools at Princess Nourah University Research Center.

1	On the variable of quality of research centers in light of digital transformation.					
2	Digital transformation contributes to achieving a high level of quality of scientific research at the center					
3	Digital transformation helps improve the quality of research produced at the center	.				
4	Digital transformation supports the enhancement of standards that ensure the quality of research					
5	Digital transformation contributes to the effective allocation of necessary research resources	.				
6	Digital transformation encourages the training and development of researchers, which is positively reflected in the quality of research produced					
7	Digital transformation helps support data accuracy and ensure the quality of research results					
8	Digital transformation enhances the center's ability to implement comprehensive quality reviews of research produced					
9	Digital transformation provides additional resources that raise the level of quality of research and experiments					
10	The use of modern digital tools at the center contributes to improving the accuracy of research processes					
11	The digital transformation at the center supports the ability to monitor the quality of research and develop it continuously					



Midocean University

College of Management

Department of Master of Project Management

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Center**

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Year:2024