

## ENABLING DIGITAL TRANSFORMATION AND KNOWLEDGE MIGRATION: THE IMPACT OF NLP, AI, AND ML IN MOBILE APPLICATIONS

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**Purpose:** The study intends to draw attention to the limitations of human complex values, the absence of user-facing connectivity and interoperability among mobile apps, and how these factors have slowed down the pace of digital transformation.

**Design/methodology/approach:** Through Google Play Store download rates, the study tracked consumer interactions with digital transformation through mobile apps. Based on their categories, a total of seventy-eight (78) mobile apps were analyzed, contrasted, and assessed. Each download rate was interpreted as the user's acquisition of the integrated NLP, AI, and ML algorithms in mobile app system settings.

**Findings:** The findings demonstrated low user involvement in NLP, AI, and ML as tools of knowledge migration from mobile applications to digital transformation compared to the global population, and none of the 78 mobile apps have interconnection and interoperability with other apps.

**Research limitations/implications:** The study draw attention to the limitations of human complex values, the absence of (study) user-facing connectivity and interoperability among mobile apps, and how these factors have slowed down the pace of digital transformation. In order to advance the pace of digital transformation, there must be an active presence of non-user-facing connectivity and interoperability issues among mobile apps.

**Practical implications:** A wealth of research has shown that because people are complex, digital transformation has not succeeded and instead relies on human values and interactions. Furthermore, users' access and operational scope are restricted by the absence of connectivity and compatibility among mobile apps, resulting in an excessively dispersed distribution of knowledge and data.

**Social implications:** The ability to continuously drive improvements in the global economy from institutionalization to business and healthcare is made possible by contemporary instruments such as digital transformation and knowledge transfer. Emerging mobile applications that organize events, manage lectures, and transmit knowledge, human thoughts, and sentiments are the result of natural language processing, artificial intelligence, and machine learning. These technologies have revolutionized the traditional documentary into a digitalized system.

**Originality/value.** The study revealed that digital transformation has not achieved the anticipated transformation due to low user engagement and a lack of interconnectivity among mobile apps. As a result, knowledge migration has not been properly disseminated over the world.

**Keywords:** Natural language processing, artificial intelligence, Machine learning, Digital Transformation, Mobile Apps, Knowledge migration.

## 1. Introduction

One of the most technological driving forces behind global development, urbanization, and modern civilization has been the advent of mobile applications. Technology comes with changes to people's living styles which is a challenge to organizations to see into the challenges how they can accompany solution advances (Guarda et al., 2021). Mobile apps have a sophisticated way of collecting personal data, unique details, and in-depth knowledge from users and migrating to digital systems. The forces of demand and supply in mobile apps have an inelastic approach that takes users' data unaware. The algorithm embedded in the mobile app influences users' altitude, aptitude, approach to the environment, engagement with others and things around, and boosts users' confidence. The ability to reshape customer values to transform their operations using digital technologies to achieve a desirable interaction and collaboration using mobile apps can be seen as digital transformation. For instance, Facebook, Instagram, LinkedIn, Twitter, YouTube, WhatsApp, and many other mobile apps have tremendously changed users' attitude, aptitude, and confidence based on the amount of dataset collected from previous users. Institutions, businesses, organizations, and establishments wishing to generate brand customer value propositions to transform their models of operational needs, required new portfolios (Berman, 2012). For the past decades, a lot of transformations have taken place leading the world through a series of transformations known as digital transformation. In the wake of digital transformation, most institutions, businesses, religious establishments, and healthcare centers have launched mobile apps to interact with their users (Ho, Hsu, 2022). Mobile apps have become an important tool that allows business owners, educational providers, healthcare services, and Christians to have an encounter with God. Mobile apps are now a place for customers and retailers to engage in various ways and share data amongst themselves. Most businesses also obtain insight into what people think, believe, and feel about their products and services via mobile apps.

Many sectors that now host web pages today started with mobile apps. Although most institutions don't pay attention to the importance of mobile applications, it has been observed that they carry the details and information to wider areas. Mobile apps enable digital transformation to secure the most convenient multitasking abilities, applications, and system software for its users. The first mobile app used in the hotel was in 2009 (Bilgili, Koc, 2021). This application was known as RapidBook. Digital transformation is already swiping across all sectors like businesses and learning institutions through mobile apps and telemedicine are currently engaging as well (Wu et al., 2022). Since the outbreak of COVID-19, many institutions, businesses, and healthcare have increasingly engaged in mobile apps (Park et al., 2022; Banskota et al., 2020). Many institutions, businesses, religious establishments, and healthcare centers established good relationships with users during the pandemic. This process is still in divided tone as most systems are yet settled on their choice of the most preferred mode of functionality. Some institutions, businesses, and healthcare preferred continuous online via mobile apps while some prefer traditional classroom, shopping, and in-person services.

The study investigates Google Play Store download rates. During the findings, the study tracked consumer interactions with digital transformation through mobile apps, and their categories. A total of seventy-eight (78) mobile apps were analyzed, contrasted, and assessed. Each download rate was interpreted as the user's acquisition of the integrated NLP, AI, and ML algorithms in mobile app system settings.

Although a lot has been achieved with the development of mobile apps that has tremendously transformed many businesses, learning institutions, religious establishments, and healthcare centers, there is yet another big problem that is yet to be sorted out. The number one risk preventing the wider adoption of mobile apps into our day-day activities is the risk and security challenges associated with it. A survey was carried out (Schwertner, 2017), and their findings reveal that limited mobile app engagements in business are due to the risk associated with them. The lack of interoperability of mobile apps with other information communication technologies has limited the level of digital transformation. Until today, most mobile apps still operate independently without a possible system of a similar brand to interact with the same users. The lack of interconnectivity and interoperability amongst mobile apps has an adverse impact on the level of engagement from global use. There exists a limited control mechanism associated with mobile apps. Most owners independently managed these applications without a possible system that set standard regulatory compliance.

## 2. Literature Review

Section is made up of Natural language processing toward Digital Transformation, Artificial Intelligence Towards Digital Transformation, Machine learning Towards Digital Transformation, Digital transformation overview Concept of Digital Transformation According to This Study Way Forward on Digital Transformation, and Way Forward Strategy on Digital Transformation.

### 2.1. Natural language processing toward Digital Transformation

This section examined some literature reviews that highlight the importance of digital communication that is transforming our human communication from text, documentary, and mobile apps to a digital independent system. Amongst the complex and interdisciplinary context, computational tools based on linguistics, computer science, and artificial intelligence that can perform a feasible technique to support data analysis and discussion is no other system than natural language processing (Perazzoli et al., 2022). To (Locatelli et al., 2021) suggested building pairing Information Modeling according to EU aims to digitalize technologies to seize the full potential of the digital transition. The study analyzed 254 bibliographic records from Scopus Database analyzing the structure and dynamics. To (Kalyanathaya et al., 2019) examined the conversation systems with a focus on Language Processing, Machine Translation, and Deep learning. The combination of deep Learning techniques, and natural language processing is attracting a lot of applications in domains like healthcare, finance, manufacturing, education, retail, and customer service. Digital transformation is driven by a flood of software technologies (Ebert, Duarte, 2018). The study went ahead to list the software technologies which are sensor microdevices and actuators embedded with the internet of things, machine learning, artificial intelligence, and facilitating the convergence of IT like natural language processing. Following the precipitated change in the world observed during COVID-19, natural language processing has become an essential and focal point for most businesses. Many businesses driven by the power of artificial intelligence have resulted in the development of mobile apps that require sophisticated great details of customer insight. To (Di Giuda et al., 2020) investigated the state of art of textual translation theories, methods, and tools into formal and numerical requirements to support information modeling in the project management process. They revealed that natural language processing necessitated the application and success of information modeling that supports the management process for project management. To (Kasztelnik, Delanoy, 2020) suggests a novel technique for quantifying text from a questionnaire research instrument using the natural language algorithm for data insight business decisions. Their suggestions revealed that natural language algorithms and human domain knowledge can support a better understanding of essential business decisions. A natural language processing concept was suggested to handle digital shop floor management

in a manner that can further bring a higher value to the shop floor team and decision-makers (Müller et al., 2021). The study examined 2,735 entries for digital tickets for floor shop issues. The suggested technique was accurate, quick, and detailed. There is a rebirth in the field of natural language processing from the manual encoding of linguistic data into an automated corpus-based learning method (Brill, 1995). This transformation can only be observed as part of the digital transformation of computer linguistics challenging the traditional documentary.

## **2.2. Artificial Intelligence Towards Digital Transformation**

This section details techniques that transition our day-to-day activities from traditional documentary, analysis, solution-oriented, automated application and evaluation to a digital system with the help of artificial intelligence.

Artificial intelligence is a Technological advancement that is aimed at restructuring our lives, inspiring change, and ensuring a great future for the world at large (Sairete et al., 2021). Artificial intelligence is expected to grow up to 34% per year by 2030 in the United Arab Emirates. Healthcare, businesses, and retail are expected to greatly benefit from the profound development of artificial intelligence than other sectors of the economy. There is a change in the maritime and shipbuilding industry, and supply chain management due to the move toward digital ecosystems. This change has brought about increased operational complexity and requires a reliable communication and coordination system such as artificial intelligence (Diaz et al., 2023). There is an urgent need for artificial intelligence-based cybersecurity in the supply network that can predict and monitor shipbuilding supply networks and determine ripple effects from disruptions. Intelligent automation uses artificial intelligence to create smart processes that enable thinking systems, self-function, and self-adapt to their understanding to deliver automated services (Christou et al., 2023). This study examined intelligence autonomous systems that will transform into a digital transformation era. Artificial intelligence has been echoing in everyone's lips since the advent of ChatGPT (Holzinger et al., 2023). Open artificial intelligence has broken a record in the much-expected development in the field of artificial intelligence. The advances in artificial intelligence have resulted in a breakthrough in the following areas: Food Security, Health and Well-being, Clean Water, Clean Energy, Responsible Consumption and Production, Climate Action, and Life below Water. Digital transformation is a global transformation system that is capturing attention in every sector and encouraging major investment (Möller, 2023). Artificial intelligence stands as several emerging influencing transformation applications for industrial sectors. Digital transformation has one of the most important impacts on firm internationalization (Feliciano-Cestero et al., 2023). The study examined existing theories related to digital transformation and internationalization and their findings revealed that digital transformation impact firms both at individual, firm, and macro level.

### **2.3. Machine learning Towards Digital Transformation**

This section details techniques that transition our day-to-day activities from traditional documentary, analysis, solution-oriented, automated application and evaluation to a digital system.

A study to examine buyers' attitude on Facebook (Khoa et al., 2022) The study uses supervised learning of machine learning. The results revealed that informativeness, entertainment, interactivity, credibility, and personalization positively affected the buyer's attitude. Artificial intelligence is rebranding the way we live, learn, and work (Sarirete et al., 2021). The combination of the growing ICT-driven ability observed across our socio-economic political and cultural systems along with growing consumer expectations add value to whatever we are doing. The advances in technology, manufacturing, and engineering have made it easy for companies to produce high-quality products (Sahija, 2021). There is a need to establish more efficient processes to help companies grow and remain competitive. The study suggests the use of machine learning and augmented reality in optimizing basic discrete manufacturing processes such as improving plant Floor Operations, facilitating quality management processes, better prediction of failures, and facilitating inventory management. To (Malamousi et al., 2022) examined three objectives in the study. One of the interesting objectives of this study was the assessment of the performance of Machine Learning methods on the key enabling technology for thermal and cold spray. They examined surface engineering and discussed several adoption strategies. Digital transformation in the era of Industry 4.0 is manifesting through information techniques, computerized control, and communication networks (Çınar et al., 2020). The transformation of digital systems in Industry 4.0 can collect massive amounts of operational data and process it into pieces of equipment to harvest data for making automated fault detection and diagnosis. A study by (AIDhaheeri et al., 2022, April) examined digital transformation using machine learning and the Quality of UAE Government Services and requirements. The study concluded that UAE institutions and bodies that seek to develop must invest in the creation of innovative services. The constant demands and increasing market competition are effectively exerting great pressure on the business to maintain its existence (Ramkumar et al., 2022, April). The development of digital technology that mostly depends on the platform uses advanced codes and machine learning algorithms.

### **2.4. Digital transformation overview**

A special issue examined digital transformation with the support of six in-depth contributions (Cho et al., 2021). The first contribution examined the impact of digitalization on profitability, the second contribution examined dissatisfied clients' repurchase behavior in online markets, the third contribution examined online intention to purchase, the fourth contribution examined the impact of customers' intention to continuously engaged online, the fifth contribution examined uncovered marketer-generated content relationship and the

sixth contribution review product evaluation and information perception. These sixth authors let us understand that there are great opportunities, business potential, and available ready users-owner insight when engaged digitally and there exist both human, capital and market development opportunities associated with digital transformation. To (Tabrizi et al., 2019) a survey of directors, CEOs, and senior executives argues that digital transformation is not about technology but about changing mindsets. Their study revealed that digital transformation (DT) risk was the number one concern in 2019. Out of the 70% of all DT engagements of about \$1.3 trillion spent on DT about \$900 billion went to waste. From the findings, only about 400 trillion succeeded. This study survey suggested five lesson steps to assist organizations to walk through digital transformation. A literature review and an online survey were launched to identify the importance of skills for an effective digital transformation (Sousa, Rocha, 2019). The findings revealed that mobile technology is important as more and more users engage in the use. The study suggests that most organizations should rethink their strategy regarding skills development to achieve a desirable result to the challenges of digital transformation. Digital transformation is a new competitive environment that is changing consumers' habits by pushing financial institutions to address their digitalization process as a matter of urgency (Cuesta et al., 2015). The study further explained that organizations required adjustments to secure a place in the digital systems to continue functioning. Enabling digital transformation (Gens, 2013), examined creatively leveraged technologies that transformed the relationship between businesses and customers. The creative leverage technologies are cloud, mobile, social, and Big Data. The study revealed that the changes are already taking place and will accelerate over the coming years. Indian digital transformation of library services was examined (Singh, 2018). Their survey consists of a 24/7-day evaluation. Their findings revealed that almost all academic libraries operate an e-resource. The digital transformation has revolutionized entire industries, but most organizations ignore or misapply the principles, ideas, and methods (Doukidis et al., 2020). A cross-sectional study examined and measured users' experience while using the Tawakkalna (AlGothami, Saeed, S2021). The study received 87 participants and among them, 75 participants had experience with mobile apps. The findings revealed that Tawakkalna is good with a score of  $1.51 > 0.8$ . The study recommended improvement to the app following feedback from the survey feedback. According to (Alekseevna et al., 2017) examine the stages of activity and society's digital transformation using a conceptual description. The study uses examples from media and retail to support their description. A low-code development platform for digital transformation was examined (Phalake, Joshi, 2021). They said new applications are not enough to face the rapid changes in the market but required methods that enable them to build their apps by configuring the functions instead of coding the software from scratch. According to (Schallmo et al., 2018) McKinsey defined digital as the creation of value, optimization of processes, and building foundational capabilities that support business initiatives. To (Nguyen Duc, Chirumamilla, 2019) study security risks associated with technologies from engineering management.



Their findings revealed that software security risks and future research work have implications for both practitioners and managers. A study investigates the transformation of ICT and its significance in business using the Apple pay system (Liébana-Cabanillas et al., 2020). Their study invited 539 users to respond to an online questionnaire, and an analysis of structural equations. Results revealed that imaginary benefit (perceived value) is the driving force (variable) that influences the desired (intention) to use. To (Zaharia, Pietreanu, 2018) outlines airport digitization trends, their structure, management, and means of implementation and identify the changes. The study revealed that Romanian airport challenges include appropriate IT infrastructure for future resource allocation. To (Heilig et al., 2017) studied digital transformation in the logistic system. The study identifies three stages of respective digital transformations using a well-known model from literature.

## **2.5. Digital Transformation concepts**

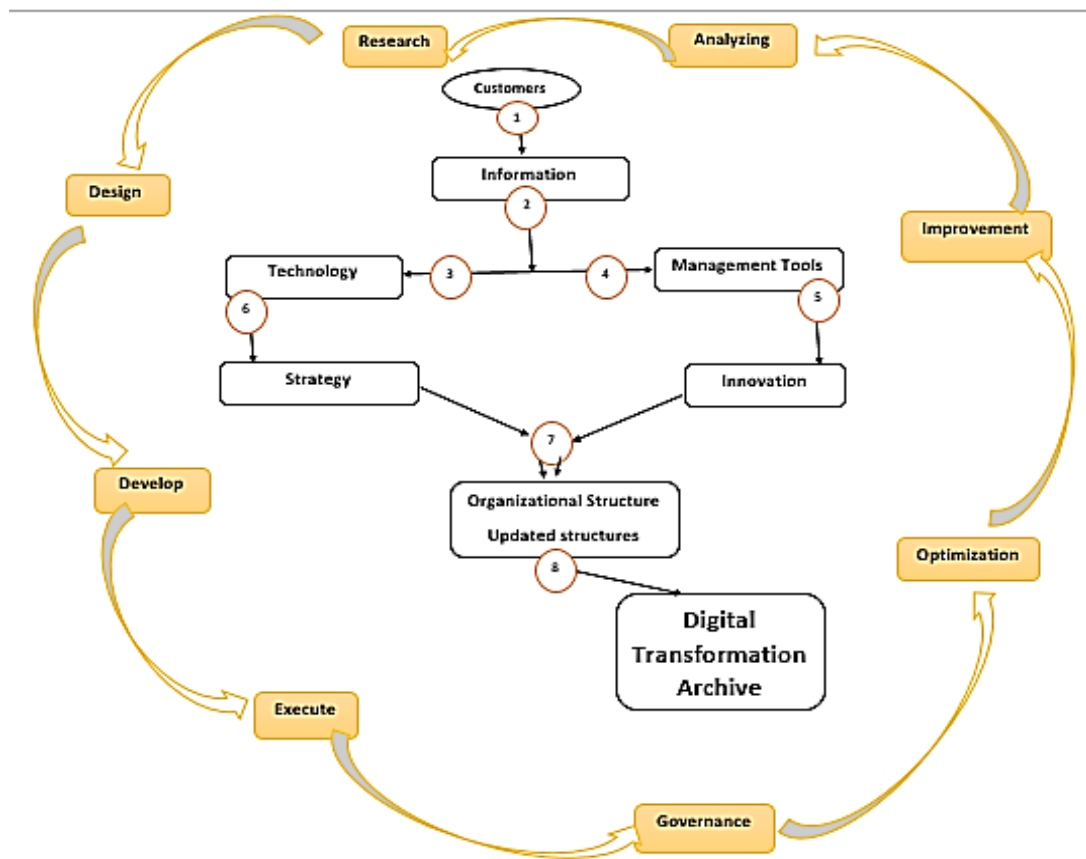
Digital transformation. A concept in business that is specifically focused on the human element, (Verina, Titko, 2019). According to (Morakanyane et al., 2017) said a lot has been said about DT both at the academic level and industrial levels but they still think there is a misunderstanding of the real concept of DT. They further said to fully understand digital transformation, there is a need to understand the concept with specifications based on terms of what it is, the characteristics, drivers, impacts, and transformed areas. To (Pihir et al., 2019) said digital transformation is a strategy focused on oriented and customer-centric changes to achieve and meet up with the innovative and emerging opportunities of information and communication technology.

According to (Gong, Ribiere, 2021) digital transformation is a very important change in technology for most organizations in our world of emergent and continuous changes in societies but the term DT has been so broadly used that it becomes very confusing. Since there is no concise approach to tackling DT, it has been used in many different approaches that are becoming more confusing to many businesses. Even though the changes are very fishable, many businesses still find it difficult to fulfill the requirements needed to run a successful business in tee a of DT.

### *2.5.1. Concept of Digital Transformation According to this Study*

According to von (Rosing, Etzel, 2020), the authors introduce a digital transformation circle that is made up of four stages Understand, Innovate, Transform, and Continuously Improve. This proposed circle is very useful, and this study finds it lacking some elements which would have made it more concise. The following format as per the figure below explains a wider concept that would better enhance digital transformation.





**Figure 1.** Digital transformation integrated circle.

Source: author’s own copy.

Figure 1 above is a systematic integration of the circle of digital transformation according to (Rosing, Etzel, 2020). The finding of this piece of work that the author feels will put a much more concise approach to the concept of digital transformation. Many concepts have been put together by many researchers and industries to help businesses achieve a much better goal in the much-transformed society by technology. Many approaches conflict with others' opinions. This study keenly followed the concept put together by (Rosing, Etzel, 2020) to come up with the figure above. Figure 1 presents the concept of digital transformation in light of knowledge migration with the help of natural language processing, artificial intelligence, and machine learning as tools.

**Research (customers).** There is a need to research who the institution or organization or establishment or organizations focus is on. A thorough search should focus on the people in the market or target location both in the present and future. There should be a deep focus on natural language processing as it helps provide the approach to communicating with the target customers. Also, artificial intelligence should be the next technology to help institutions, businesses, establishments, and organizations predict the customer pattern of needs. Machine learning should be used to train the patterns of communication natural language processing provided for the research team to use and targeted the customers. Also, machine learning should be used to train the obtained data the artificial intelligence predicted about the customers.

**Analysis (information).** Natural language processing should be used to analyze language pattern designs and various languages associated with its target audience. Artificial intelligence should be used to predict design based on information captured by the customers. Machine learning algorithms should train patterns of the design required for technical development.

**Design (technology).** This section should focus on the technology required to fulfill the requirements needed in designing the products or services required based on the information gathered.

**Improvement (management tools).** Based on the prediction from the design section the type of management tools should be able to tell if there is need for a continuous improvement throughout the lifecycle or if used for a particular duration and dumped. With a focus on natural language processing, artificial intelligence, and machine learning, every system requires continuous improvement especially when it comes to human attributes. For instance, the language of a person required continuous improvement throughout the lifecycle and generations. Unlike systems incorporated to understand humans required continuous improvement.

**Optimization (innovation).** When products and services are not human-oriented, it is obvious that the system, application, and software don't require a deep focus on optimization but when they are human-oriented, there is a must to fulfill the need for constant optimization to meet up with human complex nature. The sixth stage (Development) (strategy). When a thin line is drawn between people oriented and non-oriented, a perfect strategy is reached for a better customer focus. Systems that decided to be product-oriented and serviced oriented don't require many optimizations in their development stage or throughout the process and Vis-versa.

**Execution (Organization structure).** When development focuses on people or customers the process is developed with a deal of optimization as a priority. When the execution stage was based on product-oriented and serviced oriented without customer focus, a deal should be reached with optimization as a non-essential requirement.

**Government (digital transformation archived).** It will be very easy to allow a business to continue on the eve of any technological advancement once it's able to fully fulfill the said stages above. Most institutions, business establishments, and organizations fail to achieve a digital transformation because of the choices they made during their development. Once a bad route is taken, it's often very difficult for a company to move forward. When a system doesn't give room for continuous optimization of its tools and employees, it is hard for such a company to succeed in the break of new technology. Once employees are unable to match with continuous optimization, it is very costly for a company to hire new employees to meet up with new technology. Also, when a company doesn't optimize its tools or types of equipment, it's very difficult to acquire new ones once in the break of a new technology. The choices a company made during its development stage have a big rule on its governance in the present and future.

### 2.5.2. *Way Forward on Digital Transformation*

Besides the many challenges associated with digital transformation, there are still ways companies, institutions, and organizations can survive these challenges.

1. There is a need for customer care with in-depth mobile applications.
2. There is a need for information awareness on the level of NLP, AI and ML integration.
3. There is a need for technological know-how-based user engagement with mobile apps.
4. There is a need for management tools for comprehension assessment of mobile technology.
5. There is a need for innovative openness between users and engineers.
6. There is a need for strategic openness at the level of NLP, AI and ML application in mobile apps.
7. There is a need for organizational structure flexibility to adapt to users' needs and wants.
8. There is a need for digital transformation awareness with effective application of mobile technology of NLP, AI and ML.

### 2.5.3. *Way Forward Strategy on Digital Transformation*

The figure represents a suggestion for future strategies for businesses based on different concepts introduced by the school of thought. The level at which technology is advancing is much faster than expected and there is a need for a standard approach to be followed by most businesses.

Digital transformation in the light of natural language processing, artificial intelligence, and machine learning through mobile apps as tools of knowledge migration to digital transformation should consider this approach.

Firstly, every business, institution, establishment, and organization should think about their customers (people, clients, and employees).

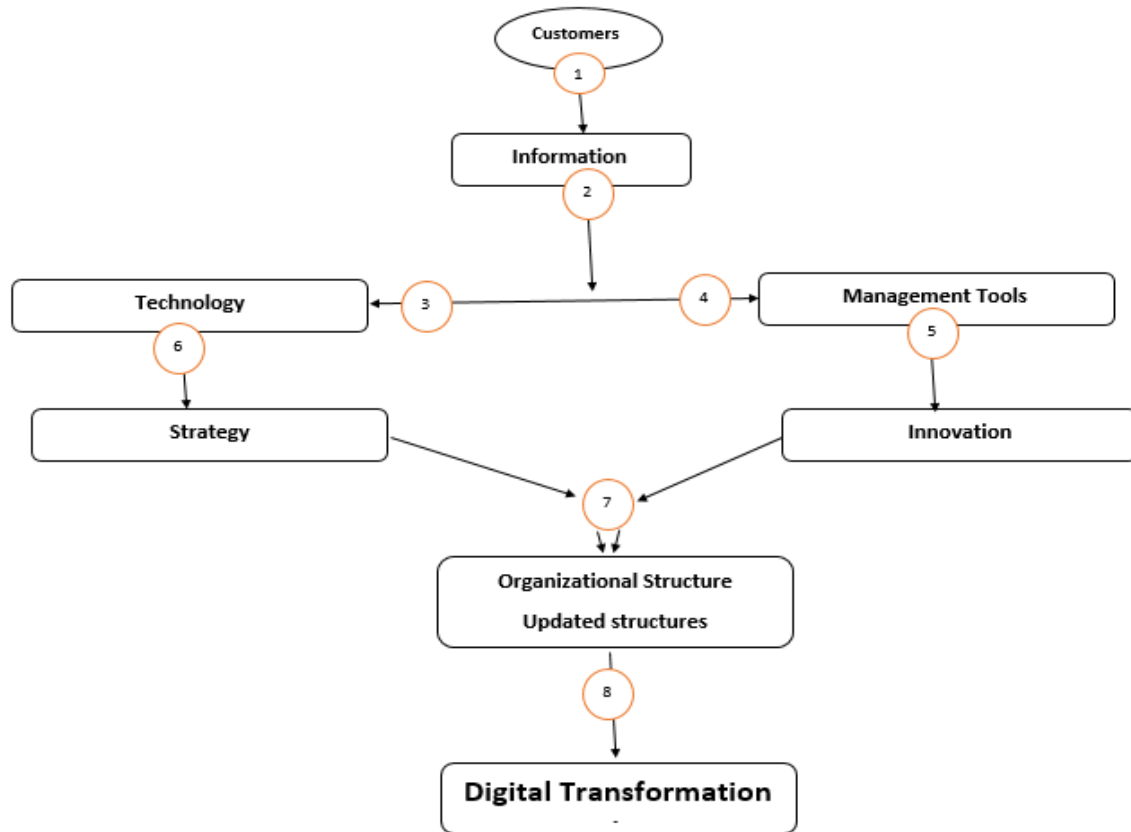
The second stage in the light of natural language processing, artificial intelligence, and machine learning as tools of knowledge migration to digital transformation should focus on information (data, and knowledge).

Thirdly, businesses, institutions, businesses. Establishments and organizations should think about technology (techniques of operations, implementation, and assessment).

Furthermore, the business, institution establishment, and organizations should think about management tools (Human resources, autonomous systems, or robot-assisted personnel)

The fifth level should be focused on innovation (optimization possibilities or rebranding or new developments).

The seventh level should be focused on the strategy (close encoded system or open system). Then the organizational structure (learning institutions, businesses, establishments or organizations).



**Figure 2.** future digital transformation strategy.

Source: author's own copy.

Figure 2 is all about the technological mobile journey to digital transformation. The first stage is customer focus, followed by information, technology, management tools, innovation, strategy, organizational structure, and digital transformation achieve. The reason for this proposed process is that customers are key to businesses' functions. Information nowadays is what makes up the technology that is driving the many changes in our societies. Most technologies are now business oriented, and they take into account management tools. For every business to succeed, it must focus on its innovative strategy. Innovation allows new ways to implement new technology. The strategy is required to meet up with technological advancements. Once a good open mindset is built within every company and its employees about the need for new ways of trying out functions. This is the best approach to maintain a constant strategy for meeting up with technological advancements. New stratifies and innovation allow the organizational structure to change without resistance from employers and stakeholders. Once innovation and strategies allow for change in organizational structures, there are high prospects for meeting digital transformation.

## 2.6. Other requirements for change

- There is a need for onboarding, training, and support for the company's employees.
- There is a need to create change leadership teams There is a need for digital transformation consultants.
- There is a need to align digital transformation with the company's goals and strategies.
- There is a need for the company to be agile and flexible to meet new changes.
- There is a need for the company to strive to be up to date with digital transformation tools.

To summarize, one can say that digital transformation is a modern formal transformation in the 21st century that is aimed at allowing businesses to become more transparent, convenient, more open to the public, and more responsive to the immediate needs and wants of their employers and customers. The digital transformation has come with a set of rules and regulations called algorithms that if a business fails to rule along this transparent paradigm, it finds it very difficult to compete with others and eventually unable to fulfill its mission.

## 3. Applied Method

This section examined some selection of mobile apps that are popularly used in educational institutions, business purposes, healthcare services, religiously oriented, and many others. The various mobile applications are examined as bridges of NLP, AI, and ML for knowledge migration to a digital transformation based on their various engagement. Each mobile app is evaluated in terms of user engagement based on the rate of downloads. Each application is examined in detail with regard to the total number of users in order to understand the level of transformation of natural language processing, artificial intelligence, and machine learning algorithms across the globe.

### 3.1. Mobile apps for educational-oriented services

Students' perception of mobile technology adoption for library service apps was examined (Yip et al., 2021). The study revealed that mobile technologies in Hong Kong and most Asian countries have not been sufficiently studied.

**Table 1.**  
*Education Apps*

Mobile Apps	Web of Science	Mendeley	Wikipedia	Research Gate	Chat GPT	Academia. Edu	Google chrome	Mozilla Firefox	Yahoo	Microsoft office	Duolingo
Level Engage	50K+	50K+	50M+	100K+	5M+	1M+	10B+	100M+	100M+	500M+	100M+

Source: Own copy derived from play store.

### 3.2. Mobile apps for business-oriented services

A study was carried out to demonstrate how individual mobile users facilitate the using of mobile applications and their popularity of the mobile application (Islam et al., 2010).

**Table 2.**  
*Business Apps*

Mobile Apps	YouTube	Microsoft Teams	Zoom meeting	WebEx	Facebook	Twitter	Instagram	Whats-App Business	Grammarly
Level Engage	10B+	100M+	1B+	100M+	5B+	1B+	1B+	500M+	10M+

Source: Own copy derived from play store.

### 3.3. Mobile apps for medical oriented services

A study examined Mobile apps for health-oriented services used in mobile devices by healthcare professionals that have transformed many aspects of clinical practice (Ventola, 2014).

**Table 3.**  
*Medical Apps*

Mobile Apps	MDCalc	MEDLINE	QxMD	Medscape	Micromedex	MediCode	UpToDate
Level Engage	1M+	1K+	100K+	5M+	100K+	500K+	1M+

Source: Own copy derived from play store.

**Table 4.**  
*Games*

Mobile Apps	Subway Surfers	Stumble Guys	Roblox	Candy Crush Saga	Race Master 3D	FIFA Mobile	Merge & Fight	Free Fire MAX	Bridge Race
Level Engage	1B+	100M+	500M+	1B+	100M+	100M+	5M+	100M+	100M+

Source: Own copy derived from play store.

**Table 5.**  
*Social Apps*

Mobile Apps	Instagram	Facebook	WhatsApp	Telegram	Messenger	Twitter	Discord	WeChat	Pinterest
Level Engage	1B+	5B+	5B+	1B+	5B+	1B+	100M+	100M+	500M+

Source: Own copy derived from play store.

**Table 6.**  
*Entertainment Apps*

Mobile Apps	Tik Tok	Netflix	YouTube	Amazon Prime Video	HBO Max	Rakuten TV
Level Engage	1B+	1B+	10B+	500M+	100M+	1M+

Source: Own copy derived from play store.

**Table 7.**  
*Shopping Apps*

Mobile Apps	eBay	Amazon	Walmart	OLX	Alibaba	Tiendamia
Level Engage	100M+	500M+	500M+	10M	100M+	1M+

Source: Own copy derived from play store.

**Table 8.**  
*Food & Drink Apps*

Mobile Apps	McDonalds	Uber Eats	Starbucks	Zomato	Foodpanda	Swiggy
Level Engage	100M+	100M+	100K+	100M+	100M+	100M+

Source: Own copy derived from play store.

**Table 9.**  
*Dating App*

Mobile Apps	Tinder	Bumble	Badoo	Tantan	Grindr	Snapchat	JAUMO
Level Engage	100M+	50M+	100M+	50M+	50M+	1B+	50M+

Source: Own copy derived from play store.

**Table 10.**  
*Money Transfer Apps*

Mobile Apps	PayPal	Google Pay	Cash App	Paytm	Alipay	NuBank
Level Engage	100M+	500M+	5M+	100M+	10M+	100M+

Source: Own copy derived from play store.



**Table 11.**  
*Fitness Apps*

Mobile Apps	Blood Pressure App Pro	Home Workout	Lucky Step	Da Fit	FitCoach	Zepp
Level Engage	10M+	100M+	10M+	10M+	10M+	10M+

Source: Own copy derived from play store.

**Table 12.**  
*Travel Apps*

Mobile Apps	Google Maps	Waze	Bolt	Uber	Booking.com	Flix Bus	Airbnb	FlightRadar24
Level Engage	10B+	100M+	50M+	500M+	500M+	10M+	100M+	50M+

Source: Own copy derived from play store.

**Table 13.**  
*Religious Apps*

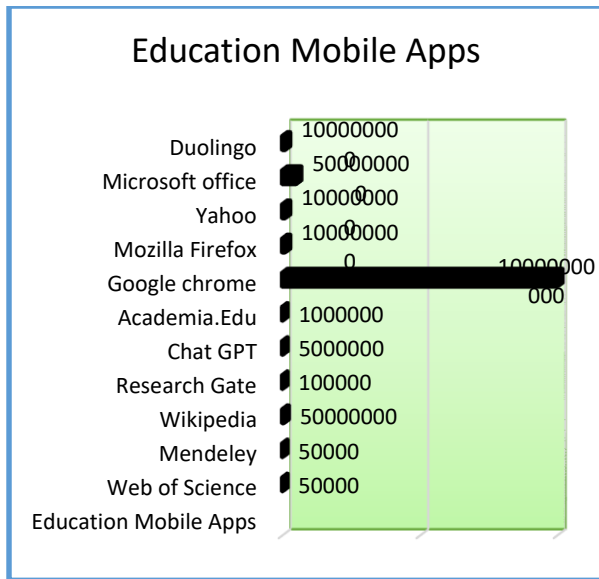
Mobile Apps	King James Bible	Good News Bible	Modern Warship	Watch and Pray	God is Good	Apostle Joshua Selman Sermons	Book of Enoch
Level Engage	5M+	1M+	10M+	100k+	100k+	10K+	100K+

Source: Own copy derived from play store.

Tables 1-12 represents the various selected mobile apps that this study examines in this paper. The methodology separated the mobile application into education, business, health, social, entertainment, social, dating, food & drinks, fitness, travel, religious, and shopping oriented. When the selection was done, the next step was to obtain data on each. The study uses the google play store to verify its mobile app download rate.

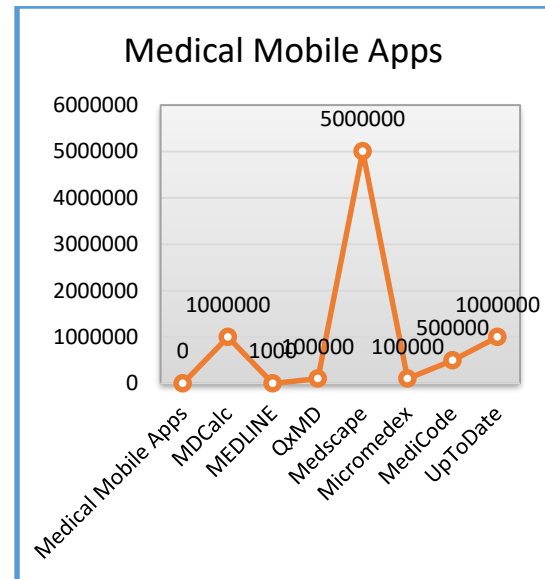
## 4. Results

This section provided an analysis of six mobile apps from Education, business, healthcare, social, entertainment, and religion. The selection is analysis to show the differences that exist and how users engage with mobile apps. The section show clearly which mobile apps are most relevant to the users based on their level of engagement.



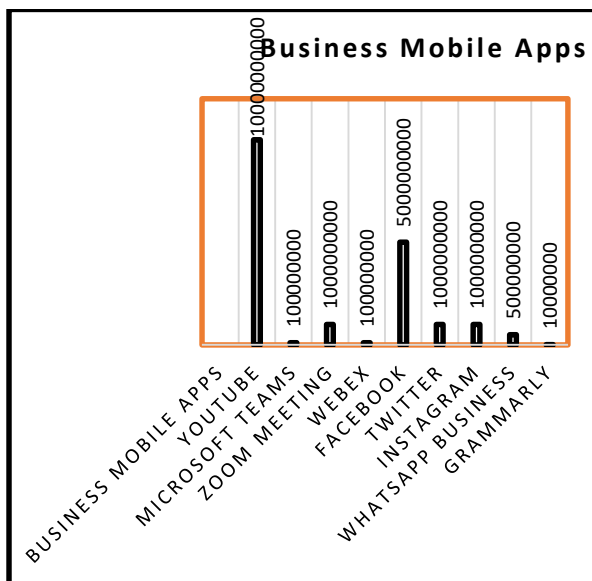
**Figure 3.** Education mobile apps.

Source: Author's own copy.



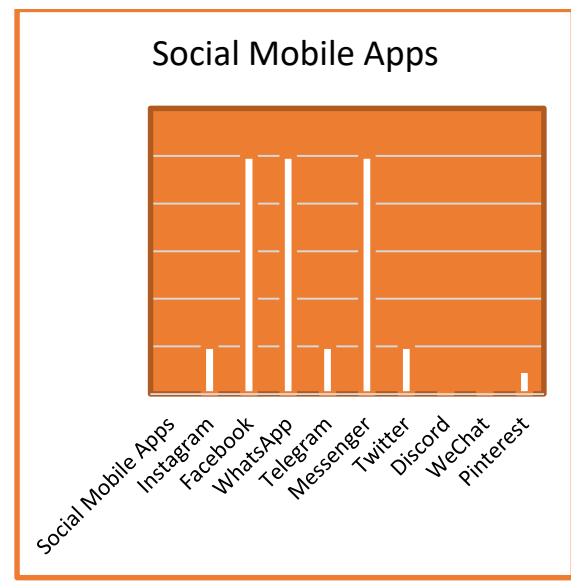
**Figure 5.** Medical mobile apps.

Source: Author's own copy.



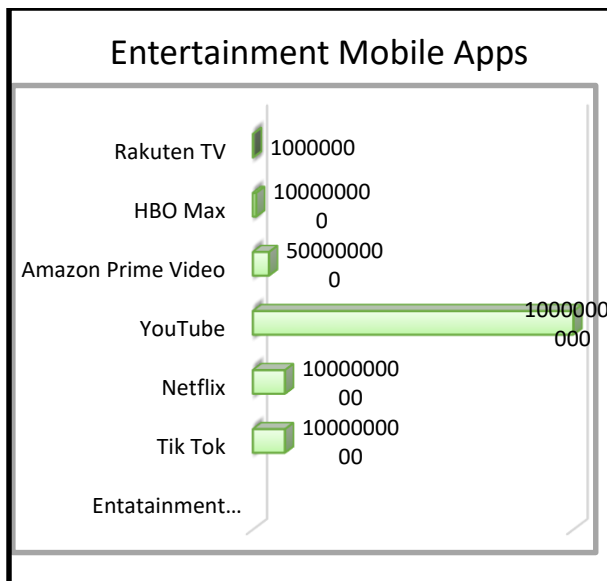
**Figure 4.** Business mobile apps.

Source: Author's own copy.



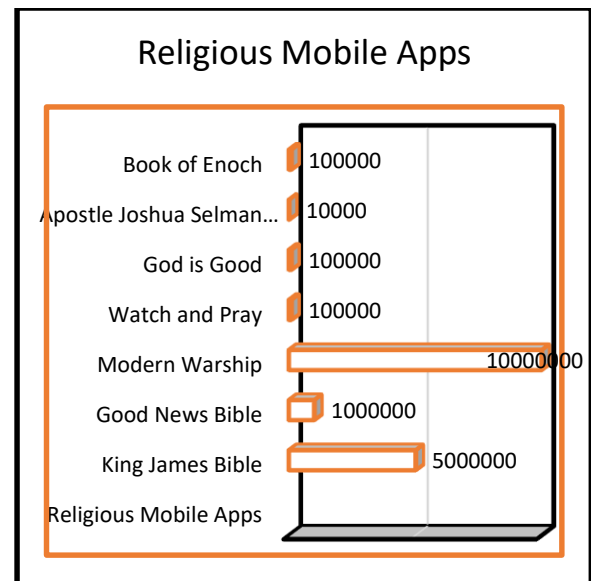
**Figure 6.** Social mobile apps.

Source: Author's own copy.



**Figure 7.** Entertainment mobile apps.

Source: Author's own copy.



**Figure 8.** Religious mobile apps.

Source: Author's own copy

Figures 3-8 represents the selected mobile apps in the following sectors of the economy (education, business, health, social, entertainment, and religious).

From the figures above, we can see that now exceeds a billion. When you compare with the world's population, we are able to independently agree that digital transformation is yet to achieve its desired success rate based on human laxity in engaging and interacting with technological advance applications. The advent of mobile applications has a way and technique of integrating the world into a single central system that closes the gap between industry, education, business, healthcare entertainment, social, religious, and political sectors, policymakers, and practitioners. Figures 3-8 and Table 1-12 show that none of the mobile apps according to the examination have not exceeded 1 billion. The world's population is about 8 billion and if we take off 25% for pupils under 18 years, the world's population will be 6 billion that can effectively engage with mobile apps.

## 5. Challenges/Limitations of Digital Transformation

**Security.** The transformation of organizations, institutions, establishments, and companies from traditional systems of management to the digital space has come with high-level security challenges. Companies battle with a lack of digitally skilled employees and the same time with the search for specialized to manage cyberspace against malicious agents.

**Competencies.** One of the challenging factors in digital transformation is competency. Matching client awareness with employee services, the company's products, and goals is quite challenging based on the level of know-how from the client's side due to the rapid digitalization of the information system.

**Organizational structures.** Coming to light of the advent of digitalization has put industrial performance to the big test. Companies, organizations, institutions, and establishments are now required to restructure and transform to something much more flexible to meet global changes.

**Support.** The new management approach and data available for employees is too huge which is posing a big management warfare for most employers. Companies nowadays pay very little attention to employees' demands due to the vast data available. Employees are now required to develop both technological and analytical skills to meet up with technological pressure, but face set back because of limited support.

**Complex software.** The constant changes in technology are giving companies, organizations, and institutions are very hard time in their day-day business approach. Most organizations are forced to search for new skills, tools, applications, and techniques to meet up with technological upgrades. Every day new technological tools emerge, and companies are required to acquire these tools. The cost of this equipment is sometimes very expensive.

**Cultural mindset.** The world is constantly evolving. As the world shifts from being a local village to a global village, there have been a lot of changes concerning cultural norms. Digital transformation is pushing into the world a similar culture based on technological programs. The way most young people and some elderly is very different from the way they used to in the past. The pressure becomes too advanced which is posing a huge challenge for companies in understanding their customers.

## 6. Conclusion

Natural language processing, artificial intelligence, and machine learning have a great algorithm that runs across borders, triumphs over language barriers, and fulfilled almost all the modern-day needs and wants that are stocked in our modern-day preferential world's advanced opportunities. Digital transformation is globally understood as a complex problem where management, Institutions, organizations, establishments, and businesses need to balance between achieving organizational agility, vision, goals, and objectives. The study concluded that a reshaping of user's value, and influencing their operations and interaction with interoperability and interconnectivity mobile apps would do a much better for digital transformation. There is a need to put users' knowledge into a central location that can be easy to study by most sectors of the world to produce better-tailed products and services. It is very difficult to resist the modern changes put at our disposal by digital transformation. The benefits of students relying on the tools put together thanks to digital transformation are more economically significant to the growth of institutions, businesses, healthcare, and most

importantly a country. Any resistance to adapting to the desires, needs, and wishes of students faces a very adverse impact on the students, institutions, businesses, and healthcare.

## References

1. AlDhaheeri, R.A., Sulaiman, I.F., Matrooshi, H.A.A. (2022, April). *The Relationship Between Digital Transformation and Quality of UAE Government Services Through Machine Learning*. The 8th International Conference on Advanced Machine Learning and Technologies and Applications (AMLTA2022) (pp. 412-421). Cham: Springer International Publishing.
2. Alekseevna, T.E., Yakovlevna, R.E., Vasilievich, R.D. (2017, October). *The concept of digital transformation of the society*. Tenth International Conference Management of Large-Scale System Development (MLSD).
3. AlGothami, S.S., Saeed, S. (2021). *Digital Transformation and Usability: User Acceptance of Tawakkalna Application during COVID-19 in Saudi Arabia*. Pandemic, Lockdown, and Digital Transformation: Challenges and Opportunities for Public Administration, NGOs, and Businesses, 95-109.
4. Banskota, S., Healy, M., Goldberg, E.M. (2020). 15 smartphone apps for older adults to use while in isolation during the COVID-19 pandemic. *Western Journal of Emergency Medicine*, 21(3), 514.
5. Berman, S.J. (2012). Digital transformation: opportunities to create new business models. *Strategy & leadership*, 40(2), 16-24.
6. Bilgili, B., Koc, E. (2021). Digital transformation in tourism. In: *Emerging transformations in tourism and hospitality* (pp. 53-65). Routledge.
7. Brill, E. (1995). Transformation-based error-driven learning and natural language processing: A case study in part-of-speech tagging. *Computational linguistics*, 21(4), 543-565.
8. Cho, W., Fan, M., Yoo, B., Zhang, H. (2021). Special issue on digital transformation: challenges and opportunities. *Information Systems and e-Business Management*, 19(2), 387-388.
9. Christou, P., Hadjielias, E., Simillidou, A., Kvasova, O. (2023). The use of intelligent automation as a form of digital transformation in tourism: Towards a hybrid experiential offering. *Journal of Business Research*, 155, 113415.
10. Çınar, Z.M., Abdussalam Nuhu, A., Zeeshan, Q., Korhan, O., Asmael, M., Safaei, B. (2020). Machine learning in predictive maintenance towards sustainable smart manufacturing in industry 4.0. *Sustainability*, 12(19), 8211.

11. Cuesta, C., Ruesta, M., Tuesta, D., Urbiola, P. (2015). The digital transformation of the banking industry. *BBVA Research*, 1, 1-10.
12. Di Giuda, G.M., Locatelli, M., Schievano, M., Pellegrini, L., Pattini, G., Giana, P.E., Seghezzi, E. (2020). *Natural language processing for information and project management. Digital transformation of the design, construction and management processes of the built environment*, 95-102.
13. Diaz, R., Smith, K., Bertagna, S., Bucci, V. (2023). Digital Transformation, Applications, and Vulnerabilities in Maritime and Shipbuilding Ecosystems. *Procedia Computer Science*, 217, 1396-1405.
14. Doukidis, G., Spinellis, D., Ebert, C. (2020). Digital transformation-a primer for practitioners. *IEEE Software*, 37(5), 13-21.
15. Ebert, C., Duarte, C.H.C. (2018). Digital transformation. *IEEE Softw.*, 35(4), 16-21.
16. Feliciano-Cestero, M.M., Ameen, N., Kotabe, M., Paul, J., Signoret, M. (2023). Is digital transformation threatened? A systematic literature review of the factors influencing firms' digital transformation and internationalization. *Journal of Business Research*, 157, 113546.
17. Gens, F. (2013). *The 3rd platform: Enabling digital transformation*. USA: IDC, 209.
18. Gong, C., Ribiere, V. (2021). Developing a unified definition of digital transformation. *Technovation*, 102, 102217.
19. Guarda, T., Balseca, J., García, K., González, J., Yagual, F., Castillo-Beltran, H. (2021, March). Digital transformation trends and innovation. *IOP Conference Series: Materials Science and Engineering*, Vol. 1099, No. 1. IOP Publishing, p. 012062.
20. Heilig, L., Schwarze, S., Voß, S. (2017). *An analysis of digital transformation in the history and future of modern ports*.
21. Ho, S.C., Hsu, Y.P. (2022). Paving the way for digital transformation: Investigate Customer experiences of using mobile apps. *Pacific Asia Journal of the Association for Information Systems*, 14(1), 3.
22. Holzinger, A., Keiblinger, K., Holub, P., Zatloukal, K., Müller, H. (2023). AI for life: Trends in artificial intelligence for biotechnology. *New Biotechnology*, 74, 16-24.
23. Islam, R., Islam, R., Mazumder, T. (2010). Mobile application and its global impact. *International Journal of Engineering & Technology*, 10(6), 72-78.
24. Kalyanathaya, K.P., Akila, D., Rajesh, P. (2019). Advances in natural language processing—a survey of current research trends, development tools and industry applications. *International Journal of Recent Technology and Engineering*, 7(5C), 199-202.
25. Kasztelnik, K., Delanoy, N. (2020). Data analytics and social media as the innovative business decision model with natural language processing. *Journal of Business and Accounting*, 13(1), 136-153.
26. Khoa, B.T., Anh, H.N., Ly, N.M., Truong, N.X. (2022). A Study on Buying Attitude on Facebook in the Digital Transformation Era: A Machine Learning Application.

- In: *Data Engineering for Smart Systems: Proceedings of SSIC 2021* (pp. 497-510). Singapore: Springer.
27. Liébana-Cabanillas, F., García-Maroto, I., Muñoz-Leiva, F., Ramos-de-Luna, I. (2020). Mobile payment adoption in the age of digital transformation: The case of Apple Pay. *Sustainability*, 12(13), 5443.
  28. Locatelli, M., Seghezzi, E., Pellegrini, L., Tagliabue, L.C., Di Giuda, G.M. (2021). Exploring natural language processing in construction and integration with building information modeling: A scientometric analysis. *Buildings*, 11(12), 583.
  29. Malamousi, K., Delibasis, K., Allcock, B., Kamnis, S. (2022). Digital transformation of thermal and cold spray processes with emphasis on machine learning. *Surface and Coatings Technology*, 433, 128138.
  30. Möller, D.P. (2023). Cybersecurity in digital transformation. In: *Guide to Cybersecurity in Digital Transformation: Trends, Methods, Technologies, Applications and Best Practices* (pp. 1-70). Cham: Springer Nature Switzerland.
  31. Morakanyane, R., Grace, A.A., O'reilly, P. (2017). *Conceptualizing digital transformation in business organizations: A systematic review of literature*.
  32. Müller, M., Alexandi, E., Metternich, J. (2021). Digital shop floor management enhanced by natural language processing. *Procedia CIRP*, 96, 21-26.
  33. Nguyen Duc, A., Chirumamilla, A. (2019). Identifying security risks of digital transformation-an engineering perspective. In: *Digital Transformation for a Sustainable Society in the 21st Century*. 18th IFIP WG 6.11 Conference on e-Business, e-Services, and e-Society, I3E 2019, Trondheim, Norway, September 18-20, 2019, *Proceedings*, 18 (pp. 677-688). Springer International Publishing.
  34. Park, H.S., Jeong, S., Chung, H.Y., Soh, J.Y., Hyun, Y.H., Bang, S.H., Kim, H.S. (2022). Use of video-based telehealth services using a mobile app for workers in underserved areas during the COVID-19 pandemic: A prospective observational study. *International Journal of Medical Informatics*, 166, 104844.
  35. Perazzoli, S., de Santana Neto, J.P., de Menezes, M.J.M.B. (2022). Systematic analysis of constellation-based techniques by using Natural Language Processing. *Technological Forecasting and Social Change*, 179, 121674.
  36. Phalake, V.S., Joshi, S.D. (2021). Low code development platform for digital transformation. In: *Information and Communication Technology for Competitive Strategies (ICTCS 2020) Intelligent Strategies for ICT* (pp. 689-697). Singapore: Springer.
  37. Pihir, I., Tomičić-Pupek, K., Tomičić Furjan, M. (2019). Digital transformation playground-literature review and framework of concepts. *Journal of Information and Organizational Sciences*, 43(1), 33-48.
  38. Ramkumar, G., Othman, B., Malviya, B., Mohamma, A.J., Narayana, M.S., Verma, D. (2022, April). *A Conceptual Analysis on the Impact of Machine Learning Towards on*



- Digital Marketing Transformation*. 2nd International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE). IEEE, pp. 2274-2278.
39. Sahija, D. (2021). *Critical review of machine learning integration with augmented reality for discrete manufacturing*. Independent Researcher and Enterprise Solution Manager in Leading Digital Transformation Agency, Plano, USA.
  40. Sairete, A., Balfagih, Z., Brahim, T., Mousa, M.E.A., Lytras, M., Visvizi, A. (2021). Artificial Intelligence: Towards Digital Transformation of Life, Work, and Education. *Procedia Computer Science*, 194, 1-8.
  41. Sariete, A., Balfagih, Z., Brahim, T., Lytras, M.D., Visvizi, A. (2021). Artificial intelligence and machine learning research: towards digital transformation at a global scale. *Journal of Ambient Intelligence and Humanized Computing*, 1-3.
  42. Schallmo, D.R., Williams, C.A., Schallmo, D.R., Williams, C.A. (2018). *History of digital transformation. Digital Transformation Now! Guiding the Successful Digitalization of Your Business Model*, 3-8.
  43. Schwertner, K. (2017). Digital transformation of business. *Trakia Journal of Sciences*, 15(1), 388-393.
  44. Singh, B.P. (2018, December). Digital Transformation of library services in the Mobile World: The future trends. In: *Publishing Technology and Future of Academia* [referat na konferenciji], pp. 335-49.
  45. Sousa, M.J., Rocha, Á. (2019). Digital learning: Developing skills for digital transformation of organizations. *Future Generation Computer Systems*, 91, 327-334.
  46. Tabrizi, B., Lam, E., Girard, K., Irvin, V. (2019). Digital transformation is not about technology. *Harvard business review*, 13(March), 1-6.
  47. Ventola, C.L. (2014). Mobile devices and apps for health care professionals: uses and benefits. *Pharmacy and Therapeutics*, 39(5), 356.
  48. Verina, N., Titko, J. (2019, May). *Digital transformation: conceptual framework*. Proc. of the Int. Scientific Conference “Contemporary Issues in Business, Management and Economics Engineering”, pp. 9-10.
  49. von Rosing, M., Etzel, G. (2020). Introduction to the digital transformation lifecycle. *CEUR Workshop Proceedings*, Vol. 2574, No. 2018, pp. 92-99.
  50. Wu, T., Simonetto, D.A., Halamka, J.D., Shah, V.H. (2022). The digital transformation of hepatology: The patient is logged in. *Hepatology*, 75(3), 724-739.
  51. Yip, K.H.T., Lo, P., Ho, K.K., Chiu, D.K. (2021). Adoption of mobile library apps as learning tools in higher education: a tale between Hong Kong and Japan. *Online Information Review*, 45(2), 389-405.
  52. Zaharia, S.E., Pietreanu, C.V. (2018). Challenges in airport digital transformation. *Transportation research procedia*, 35, 90-99.