Artificial Intelligence (AI) and Automation on Employee Productivity in Public Hospitals in Rivers State

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Abstract: *This study examined the impact of artificial intelligence and automation on employee productivity in public hospitals in Port Harcourt, Rivers State. Cross sectional research design was adopted in studying two (2) public hospitals in Port Harcourt (i.e University of Port Harcourt Teaching Hospital and Braithwaith Memorial Hospital). From the field survey, we retrieved and analyzed two hundred and fifty-nine (259) sets of questionnaire using regression analytical tool in determining the causal relationships existing among the variables. The findings revealed that the dimensions artificial intelligence namely; chatbot, AI diagnostics and automation exhibited significant effect on employee productivity within the hospitals. We then concluded that the artificial intelligence and automation affected employee productivity within the organization. This led to our recommendation for public health institutions and other institutions on how essential it is for organizational leaders and managers to adequately create enabling working environment for healthier behavior within the organization so as to prevent bad practices that would in turn result in unfavourable outcomes such as employee turnover for the organization.*

Keywords: *Artificial Intelligence (AI), Automation, Employee Productivity, Task Accomplishment, Service Quality*

1.0   Introduction

Improving employee productivity has been one of the most important objectives for several organizations. This is because higher levels of employee productivity provide an organization and its employees with various advantages. For instance, higher productivity leads to favourable economic growth, large profitability and better social progress (Sharma & Sharma, 2014). Additionally, employees who are more productive can obtain better wages/salaries, better working conditions, and favourable employment opportunities. Moreover, higher productivity tends to maximize organizational competitive advantage through cost reductions and improvement in high quality of output (Baily et al., 2005; Hill et al., 2014; Wright, 2004). All of these benefits have made employee productivity worthy of attention. Therefore, looking at its antecedents is very important to ensure organizational survival and long term success.

Globally, the needs-based shortage of healthcare workers was estimated to be about 18 million in 2013 (World Health Organization, 2016). This shortage is being driven by a broad set of factors related to chronic underinvestment in health workforce education, recruitment and labour market constraints (Hernandez-Pena, Poullier, Van Mosseveld, et al., 2013). The shortage and distribution challenges have led to increases in the workload

and stress-related burnout of remaining staff, creating unsatisfactory work environments. This is not only driving up the rates of attrition, but is also causing a growing reluctance among new graduates to pursue a healthcare career. Recent studies (Hassmiller, & Cozine, 2006; Dall, West, Chakrabarti, Reynolds, & Iacobucci, 2018) have shown that the ongoing staffing shortages will not only increase patient waiting times, but also dramatically impact the overall quality of healthcare (Rogers, et al., 2004 cited in Hazarika, 2020).

Health systems have to radically rethink strategies to safe- guard quality and safety, maximize efficiencies and ensure that staff are satisfied and actively supported in their jobs. Rapid, disruptive technological change has the potential to drive health- care reforms to improve efficiency and augment provider satisfaction, thus improving patient experiences and outcomes (Mesko, Hetenyi, & Gyorffy, 2018). This prospect has focused global attention on the integration of technologies such as artificial intelligence (AI) and automation to address current and emerging health system challenges, including the workforce (WHO, 2016; Bloom, Khoury, & Subbaraman, 2018).

Today's Artificial Intelligence (AI) trends are closely related to digital technology and business. AI and automation are used to optimize efficiency and effectiveness in various industries, such as healthcare, manufacturing, transportation and retail (Rai, 2020). AI and automation are also used to improve customer experience and analyze data to make better business decisions. AI trends are predicted to continue to develop and integrate with the Internet of Things (IoT) and 5G technologies (Zhang, Wen, Sun, Guo, Ha, & Lee, 2022). According to Hazarika (2020), AI is being deployed in various applications, including assisting in administrative tasks, mining health records, designing treatment plans and providing consultations. The use of AI can make certain time-consuming repetitive processes faster and more efficient. This allows healthcare providers to spend more time on tasks that focus on the clinical context of their patients and attending to their needs (Hazarika, 2020). So, AI has the potential to improve the employee productivity in the healthcare sector. Although several researches have emphasized about the significance of artificial intelligence and automation in driving performance and positive business outcomes, there are only few empirical evidences to support such claims. It is also noted that artificial intelligent should be considered as a key organizational strategy that involves all the levels of an organization (McKinsey Global Institute, 2017). Davenport and Glover (2019) reported that artificial intelligence has become one of the main challenges/activities that need to be well managed to fulfil organization objectives. They also demonstrated that there is a need to test its effect on performance outcomes.

In fact, the issue of employee productivity has recently emerged in the literature and carries extreme significance. For instance, previous research works surrounding the topic of employee productivity in service contexts have been largely neglected (Brown et al., 2009; Filitrault et al., 1996). As such, the definition of employee productivity has been hard to conceptualize and measure. For instance, the common definition of productivity has mainly emphasized on the ratio between input costs and output value, despite existing associated implications that it could depend on the nature of business. Overall, there appears to be an ambiguity in conceptualizing, measuring, and testing the antecedents of employee productivity. Hence, this study aims to test the effect of artificial intelligence and automation on employee productivity in public hospitals in Port Harcourt

to cover existing gaps in the literature. Understanding and addressing these issues is crucial for AI to be accepted and used effectively in the healthcare industry.

Statement of the Problem

Today's healthcare environment is rapidly evolving. While some of these changes are evolutionary and incremental, others have been revolutionary and transformative. These changes have not only impacted clinical processes and practices of healthcare providers, but have also affected the experiences for patients and their families.

A case in point is the exponential growth in biomedical and clinical evidence. The doubling time of medical knowledge in 1950 was estimated at 50 years, in 1980 it was 7 years and in 2010 it was 3.5 years. In 2020 it is projected to be only 73 days (Densen, 2011). The sheer volume of information, coupled with time constraints and cognitive limitations, has outstripped the capacity of healthcare providers to apply this new knowledge. Studies on the adoption of proven innovations in healthcare confirm that there is unjustifiable slowness and incomplete implementation of evidence- based practices, even in the best academic health centres (Institute of Medicine, 2001).

Clinical encounters are becoming increasingly complex, as patients present with multimorbidity. In the UK, for example, recent estimates suggest that one in six patients have more than one chronic condition, and these patients account for approximately one-third of all general practice consultations (Fortin, Bravo, Hudon, Vanasse, & Laponte, 2005). Although multimorbidity is common and costly, clinical practice guidelines and models of care delivery are still largely built on vertical monomorbid approaches (Fortin, Lapointe, Hudon, & Vanasse, 2005).

The Internet has revolutionized the way information is shared and accessed. Patients and their families now have more knowledge of, competence with and engagement in their health decision-making (Tansaker, Barlett, & Trpkov, 2014). They are also demanding more sophisticated, convenient, transparent, affordable and personalized care.

Against the background of steady advances in clinical knowledge and changing patterns of health needs, the traditional model of decision-making by solo providers relying on their memory and personal experience is inadequate to effectively address twenty-first-century health challenges. In addition, the growth of consumerism and the proliferation of internet-accessible sources of health-related information will continue to modify the provider–patient relationship.

Technological advancements have provided a breakthrough in addressing some of these challenges. From devices to medicines, technological developments have increased diagnosis and treatment options and contributed to improvements in efficiency and quality of healthcare. By transforming healthcare delivery, the use of technology has led to remarkable increases in longevity and quality of life (Balogh, Miller, & Ball, 2015). Until recently, technology has not been routinely used to gather, integrate and interpret data to formulate clinical decisions (Parasuraman, Sheridan, & Wickens, 2000; Jiang, Jiang, Zhi, et al., 2017). Technologies such as AI have the potential to analyse and identify patterns in complex data and support healthcare providers in the delivery of care (Dilsizian, & Siegel, 2014).

Several things could be improved with the level of acceptance of AI and automation by health workers. Several factors influence the acceptance of AI and automation in the health sector. The need to understand technology by health professionals is essential.

Health professionals need to understand how AI technology works and its benefits before using it effectively (Paranjape, Schinkel, Panday, Car, & Nanayakkara, 2019). Only now, there is a dependence on humans in managing health and patient care. Some healthcare professionals still need to be more confident to replace their jobs with technology. They are concerned that AI will not be able to perform tasks that humans do.

Another barrier to using AI today is the significant initial investment (Gupta, Yadav, Kusi-Sarpong, Khan, & Sharma, 2022). Installing an AI system can require a significant initial investment, discouraging some hospitals and healthcare practitioners from investing their money. The amount of this investment is sometimes still controversial, related to the level of privacy and data security concerns. There are concerns about how AI together with automation will manage and protect sensitive patient information. So the cost and benefit ratio calculation needs to be studied more deeply (Flavian, Perez-Rueda, Belanche, & Casalo, 2022).

Aim & Objectives of the Study

The purpose of this study is to investigate the impact of artificial intelligence and automation on employee productivity in public hospitals in Port Harcourt. The following are the study's specific objectives:

i. To examine the effect of Chatbot on employee productivity in public hospitals in Port Harcourt.

ii. To examine the effect of AI Diagnostics on employee productivity in public hospitals in Port Harcourt.

iii. To examine the effect of automation on employee productivity in public hospitals in Port Harcourt.

iv. To examine the overall effect of AI and automation on employee productivity in public hospitals in Port Harcourt.

Research Questions

This study will be primarily steered along the direction of the following research questions:

i. What is the effect of Chatbot on employee productivity in public hospitals in Port Harcourt?

ii. What is the effect of AI Diagnostics on employee productivity in public hospitals in Port Harcourt?

iii. What is the effect of Automation on employee productivity in public hospitals in Port Harcourt?

iv. What is the overall effect of AI and Automation on employee productivity in public hospitals in Port Harcourt?

Research Hypotheses

Ho1: Chatbot has no significant effect on employee productivity in public hospitals in Port Harcourt.

Ho2: AI Diagnostics has no significant effect on employee productivity in public hospitals in Port Harcourt.

Ho3: Automation has no significant effect on employee productivity in public hospitals in Port Harcourt.

Ho4: Overall AI and Automation has no significant effect on employee productivity in public hospitals in Port Harcourt.

Review of Literature
2.1 Artificial Intelligence (AI)

A careful overview of the definitions of AI indicates that AI as a concept has remained a contested terrain since its first use in the mid-1950s. In fact, as John McCarthy, an early pioneer of AI who coined the very term in 1955, once famously stated: 'As soon as it works, no one calls it AI anymore' (Vardi, 2012). According to observers, this uncertainty is underpinned by the difficulties in identifying what intelligence embodies in humans, despite the vast availability of studies in various fields of research on this topic, ranging from psychology to neuroscience (Miailhe and Hode, 2017, AI HLEG, 2019a, Samoili *et al.*, 2020).

An important repercussion of this lack of definition appears to be the emergence of multiple descriptions of AI. For instance, in the European Commission's Joint Research Centre Flagship report on AI, the concept was defined as:

'AI is a generic term that refers to any machine or algorithm that is capable of observing its environment, learning, and based on the knowledge and experience gained, taking intelligent action or proposing decisions' (Craglia et al., 2018: 18).

OECD's AI Experts Group explains an AI system as:

'a machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations or decisions influencing real or virtual environments. It uses machine and/or human-based inputs to perceive real and/or virtual environments; abstract such perceptions into models (in an automated manner e.g. with ML [machine learning] or manually); and use model inference to formulate options for information or action. AI systems are designed to operate with varying levels of autonomy. (OECD, 2019a: 15, brackets added).

IBM, on the other hand, favours the concept of 'augmented intelligence' over that of AI, for according to them AI 'brings to mind to the notion of replacing human intelligence with something synthetic' (Rossi, 2016: 1). According to IBM, AI is defined as:

'the capability of a computer program to perform tasks or reasoning processes that we usually associate to intelligence in a human being. Often it has to do with the ability to make a good decision even when there is uncertainty or vagueness, or too much information to handle' (Rossi, 2016: 1).

According to Suparman, AI is defined as a sub-field of computer knowledge specifically intended to create software and hardware that can fully mimic some of the functions of the human brain (Nahavandi et al., 2022). AI is a step to develop computers, robots, or applications or programs that work intelligently, just like humans (Cioffi et al., 2020). The purpose of creating AI itself is to:

. Creating an expert system, namely a system that can perform intelligent behavior, learn, demonstrate, explain, and advise users.

. To implement human intelligence into machines, create a system that can ⌞SEP⌟understand, think, learn, and behave like humans (Confalonieri et al., 2021).

AI offers the potential for innovative and exciting developments in the workplace through the increasing availability of data and big data and the capacity to process data through algorithms, leading to widespread and profound changes in how work is done (EU-OSHA, 2021). Research on 12 developed economies estimated that AI could increase labour productivity by up to 40% by 2035 compared to expected baseline levels, through intelligent automation, complementing and enhance the skills and ability of existing workforces and driving innovations. Human-AI teams help mitigate error and could expand opportunities for human workers. Human-AI teams have been found to be more productive than either AI or workers alone (Prudy & Daugherty, 2017). Consultancies' and thinktanks' forecasts run alongside a series of governmental, regional and international organizations' high-level reports on the significant impact of AI on economies and societies, including the United States, United Kingdom, ILO, and the European Union, which in most cases predict that AI will improve productivity (Moore, 2019).

AI is expected to improve productivity in two ways. First, some activities previously carried out by people will be automated. Second, through machine autonomy, systems will operate and adapt to circumstances with reduced or no human control. AI is expected to change, and accelerate, the profile of tasks that can be automated – through intelligent automation. New AI-powered applications can increasingly perform relatively complex tasks that involve making predictions, such as transcription, translation, driving vehicles, diagnosing illness and answering customer inquiries (chatbots) (OECD, 2019c). Robots embedding AI are becoming mobile, smart and collaborative. Their use removes workers from hazardous situations and the quality of work is improved by handing repetitive tasks to fast, accurate and tireless machines. Cobots can also facilitate access to work for many people (ageing workers or with disabilities) and collaborate with human workers in a shared workspace (EU-OSHA, 2021).

AI technologies leveraging big data can also help inform governments, employers and workers about local labour market conditions, which can help identify and forecast skills demands, direct training resources and connect individuals with jobs. The organizational level AI-enhanced HR practices have already begun to make job matching and training more efficient. It can help better connect job seekers, including displaced workers, with the workforce development programmes they need to qualify for emerging and expanding occupations. AI may help make works more interesting by automating routine tasks, allowing more flexible work and possibly a better work-life balance (OECD, 2019c). Digitalized management methods/People analytics tools can aid employers to measure, report and understand employee performance, aspects of workforce planning, talent management, distribution of work, and operational management (Collins, Fineman & Tsuchida, 2017; PwC, 2019). Indeed, algorithmic decision making in people analytics could be used to support workforces by aligning employee performance feedback and performance pay - and workforce costs - with business strategy and support for specific workers (Moore, 2019). This also has the potential of facilitating less hierarchical and more participative management practices (Smit et al., 2020).

Chatbot

Hospitals can use chatbots to provide information and efficiently serve patients. Chatbots have many benefits in business development, including saving the customer time, being

available 24/7, improving the quality of the customer experience, saving on service costs, increasing the number of sales, and helping lead generation (Chang, Hwang & Gau, 2022). Chatbots also proactively build conversations with customers and collect essential data such as visitors' email addresses, phone numbers, and product preferences (Cohen, 2018). Chatbots help businesses reduce customer service costs and improve reputations. Research results show that bot services also have the potential to get an investment return higher (Nguyen, Waizenegger & Techatassanasoontorn, 2022). Chatbots can also be utilized in nursing application (Brian, et al., 2020).

The chatbot market is growing rapidly and is projected to reach $314 billion by 2023. The healthcare industry is also adopting this technology, as a recent study in the USA showed that people are willing to use healthcare app solutions for remote consultations. AI is revolutionizing the healthcare industry, with its market expected to exceed $150 billion in 2026 (Arpita, 2020).

Chatbots are AI-powered robotic applications that offer precise communication tools for audio and textual messaging. There are three types of chatbots in healthcare: task-oriented, information-oriented, and open/close domain. AI is being used in many aspects of healthcare, such as illness detection and treatment (Jovanovic, Baez & Casati, 2020). Chatbots are helping patients by providing better healthcare support and diagnosing serious health conditions. They also assist health workers in collecting crucial health data. AI-enabled chatbots are highly responsive and offer professional communication skills, which will improve basic healthcare services in countries with low doctor-patient ratios (Fan, Chao, Zhang, et al., 2021). Chatbots are revolutionizing the healthcare industry by giving a personal touch to the diagnostic and treatment procedure by enabling early detection of illness and improving the treatment process (Xu, Sanders, Li, & Chow, 2021).

AI Diagnostics

AI algorithms can assist in making medical diagnoses based on symptoms and test results (Kumar, Koul, Singla, & Ijaz, 2022). AI is playing a critical role in the medical imaging field. From reducing the computation time needed to produce images from CT scans to performing real-time inferences on endoscope cameras, AI streamlines workflows and improves medical care. Precision medicine is one example of AI applications in healthcare. It leverages genomic analytics and other patient data to provide tailored care for each individual. Predictive analytics is also an essential part of AI applications in healthcare (Adi, Anwar, Baig, & Zeadally, 2020). It helps health systems understand trends and improve public health strategies by monitoring and anticipating care needs.

Digitization of pathology has improved clinical lab workflows, but AI must be considered for full benefits in clinical diagnostic. AI is faster and more accurate in image analysis, increasing productivity and accuracy of pathology labs. AI models trained to detect tumors showed higher accuracy compared to human pathologists and could result in cost savings for hospitals by reducing misdiagnosis. AI also improves staff satisfaction by reducing manual tasks and workload and enabling flexible working. Better diagnostic accuracy and consistency with AI assistance results in improved patient outcomes.

2.2   Automation

Automation (in Greek means self-study), robotization or industrial automation or numerical control is the use of control systems such as computers to control industrial machines and process controls to replace human operators. Industrialization itself is a

stage in the implementation of mechanization, where humans carry out the concept of permanent mechanization of industrial machines as operators by placing machines as assistants following physical work demands, which is a massive decrease in human needs as sensors as well as concerns work mentality (Paśko et al., 2022). Automation is a technology that combines the application of mechanics, electronics and computer-based systems through processes or procedures that are usually arranged according to an instruction program and combined with automatic control (feedback) to ensure whether all instructions have been carried out correctly, thereby increasing productivity, efficiency and flexibility. Fords in Detroit first used the word automation. This term is used to describe mechanical devices and machine tools so that they become a continuous production line (Wang et al., 2022).

Santoso argues that automation is a process to automatically control a tool's operation, which can replace humans' role in observing and making decisions. The existing control system is starting to shift to control system automation, so human intervention in controlling is very small (Santoso et al., 2020). An equipment system that is controlled automatically is very convenient compared to a manual system because it is more efficient, safe and thorough. Then Ghifari argued that automation is a field of science requiring its users to change manual machines to automatic ones so that automation can simplify existing life processes (Mehmood et al., 2020).

By reducing the cost of producing a subset of tasks, automation raises the demand for labor in nonautomated tasks (Autor 2015; Acemoglu and Restrepo 2016). In particular, automation leads to the substitution of capital for labor because at the margin, capital performs certain tasks more cheaply than labor used to. This reduces the prices of the goods and services whose production processes are being automated, making households effectively richer, and increasing the demand for all goods and services. The productivity effect could manifest itself in two complementary ways. First, labor demand might expand in the same sectors that are undergoing automation (Acemoglu and Restrepo, 2017). A telling example of this process comes from the effects of the introduction of automated teller machines (ATMs) on the employment of bank tellers. Bessen (2016) documents that concurrent with the rapid spread of ATMs—a clear example of automating technology that enabled these new machines to perform tasks that were previously performed more expensively by labor—there was an expansion in the employment of bank tellers. Bessen suggests that this is because ATMs reduced the costs of banking and encouraged banks to open more branches, raising the demand for bank tellers who then specialized in tasks that ATMs did not automate.

Another interesting example of this process is provided by the dynamics of labor demand in spinning and weaving during the British Industrial Revolution as recounted by Mantoux (1928). Automation in weaving (most notably, John Kay's fly shuttle) made this task cheaper and increased the price of yarn and the demand for the complementary task of spinning. Later automation in spinning reversed this trend and increased the demand for weavers. In the words of John Wyatt, one of the inventors of the spinning machine, installing spinning machines would cause clothiers to "then want more hands in every other branch of the trade, viz. weavers, shearmen, scourers, combers, etc." (Quoted in Mantoux 1928). This is also probably the reason why the introduction of Eli Whitney's cotton gin in 1793, which automated the labor-intensive process of separating the cotton

lint from the seeds, appears to have led to greater demand for slave labor in southern plantations (Rasmussen 1982).

The productivity effect also leads to higher real incomes and thus to greater demand for all products, including those not experiencing automation. The greater demand for labor from other industries might then counteract the negative displacement effect of automation. The clearest historical example of this comes from the adjustment of the US and many European economies to the mechanization of agriculture. By reducing food prices, mechanization enriched consumers who then demanded more nonagricultural goods (Herrendorf, Rogerson, and Valentinyi 2013), and created employment opportunities for many of the workers dislocated by the mechanization process in the first place (Acemoglu and Restrepo, 2017).

This discussion also implies that, in contrast to the popular emphasis on the negative labor market consequences of "brilliant" and highly productive new technologies set to replace labor (e.g., Brynjolfsson and McAfee 2014; Ford 2016), the real danger for labor may come not from highly productive but from "so-so" automation technologies that are just productive enough to be adopted and cause displacement, but not sufficiently productive to bring about powerful productivity effects.

2.3   Employee Productivity

One of the key issues that most organizations face nowadays is the need to improve employee productivity. Employee productivity is an assessment of the efficiency of a worker or group of workers. In actual terms, productivity is a component that directly affects the company's profits (Gummesson, 1998; Sels, De Winne, Delmotte, et al., 2006). Productivity may be evaluated in terms of the output of an employee in a specific period. Typically, the productivity of a given worker will be assessed relative to an average out for employees doing similar work. It can also be assessed according to the number of units of a product or service that an employee handles in a defined time frame (Piana, 2001). As the success of an organization relies mainly on the productivity of its employees, therefore, employee productivity has become an important objective for businesses (Cato & Gordon, 2009; Gummesson, 1998; Sharma & Sharma, 2014). Many studies have focused on one or two ways to measure productivity and since many different approaches are taken, it can be challenging to compare the results (Nollman, 2013). Overall, there is a lack of an effective and standardized way to assess productivity. According to Sharma and Sharma (2014), employee productivity is based on the amount of time that an employee is physically present at his/ her job, besides the extent to which he/ she is "mentally present" or efficiently working during the presentation at the job. Companies should address such issues to ensure high worker productivity. Ferreira and Du Plessis (2009) indicated that productivity can be evaluated in terms of the time spent by an employee actively executing the job he or she was hired to do, to produce the desired outcomes expected from an employee's job description.

Previous literature has discussed the advantages of employee productivity which would lead to organizational success. According to Sharma and Sharma (2014), higher productivity results in economic growth, higher profitability, and social progress. It is only by increasing productivity, employees can obtain better wages/ salaries, working conditions, and larger employment opportunities. Cato and Gordon (2009) also demonstrated that the alignment of the strategic vision to employee productivity is a key contributor to the success of an organization. This alignment as a result would motivate

and inspire employees to be more creative, and this ultimately can improve their performance effectiveness to accomplish organizational goals and objectives (Morales et al., 2001; Obdulio, 2014). Moreover, higher productivity tends to increase the competitive advantage through a reduction in costs and improvement in the quality of output.

2.4   Theoretical Framework

Technological Determinism Theory

The theoretical framework adopted for this study is the Technological Determinism Theory. This is a theory that is premised on the fact that societies change alongside with technology. The theory believes that social progress follows an unavoidable course that is driven by technological innovation. The theory has two central concepts:

(1) That technological development itself follows a predictable, traceable path that is beyond any cultural or political influence and

(2) That technology in turn organizes society in a way to further develop itself. The communication theorist and media scholar Marshall McLuhan laid out one famous example of technological determinism in his book "Understanding media: The extension of man", wherein he asserted that "the medium is the message". This rejection of "content" in favour of the technological medium as an important consideration in media studies is only one facet of technological determinism but, in many ways, it represents the classic example.

The term "technological determinism" was coined by Thorstein Veblen in 20th century and this revolves around the preposition that technology in any given society defines its nature.

Karl Marx believed that technological progress led to newer ways of production in a society and this ultimately influenced the cultural, political, and economic aspects of a society, thereby inevitably changing society itself.

According to Winner, the theory has two basic assumptions.

i)   That the technology of a given society is a fundamental influence of the various aspects and sectors like, agriculture, health, education and others which a society exist.

ii) Changes in technology are the primary and most important source that leads to change in the society in different ways including health, agriculture, industry etc.

History shows numerous examples which explain why technology is considered to be determining the society that we live in. The inversion of smart phones have changed the way patients in the hospital can reach out to a doctor, drugs prescription online, searching for a good medical expert and the facility and how patients can take care of their own health even without being told by an expert, but through digital media. The discovery of steam power led to the development of the industrial society and the introduction of computers has led to the dawn of the information age. Therefore, it changes the way people think and how they interact with others and can be described as a three-word logical proposition as social progress is driven by technological innovation.

2.5   AI, Automation and Employee Productivity

Zayum, Aule, and Hangeior (2017) examined the effect of Performance Appraisal on Employee Productivity in Plateau State Internal Revenue Service. The study was guided by two objectives and two null hypotheses of no significant relationship. The study adopts a survey research design. The population of the study consists of all 1580 employees of

PSIRS. The sample size of the study was 319; this was determined using the Taro Yamane formula. The sample size was allocated to the population using Burley's Proportional formula. The instrument of data collection was a structured questionnaire. The instrument was subjected to face and content validity. Data collected were analyzed using frequency, percentages, and tables. A logit regression model was used to assess the nature and degree of relationship between a dependent variable and independent variables study revealed that management by objectives and 360-degree feedback appraisal techniques enhanced employee productivity in PSIRS. It was recommended that PSIRS should enforce management by objectives to enable staff to participate in organizational goal setting and understand areas of responsibility to further improve productivity. The 360-degree feedback appraisal techniques should also be encouraged to serve as a pre-requisite for supervisors and employees to discuss organizational weaknesses, productivity standards, and areas of improvement.

Chai and Gooi (2019) conducted a study on intelligent automation uptake and labor productivity in United Kingdom. This study attempts to shed light on how minimum wage have sparked an early adoption of artificial intelligence (AI) automation, bringing about most important societal changes in labor productivity in each industry of UK as well as the job distribution in the landscape of UK industries. The determinants of labor productivity in each sector is examined from year 2008 to year 2015 in order to grasp the relationship between labor productivity and AI automation along with other control variables which consists of non-AI related capital stock, expenditure of research and development, fraction of workforce with tertiary education, average weekly earnings and average actual working hours. The findings of this study aims to provide a clearer picture of the potential of AI automation in improving the current labor productivity shortfall for economists and policy makers with a glimpse of what AI automation can do to improve their daily tasks and the firms to know where to target their investments. However, continued research will be required to accurately capture the effects of AI automation on labor productivity as there are no explicit measurements for AI due to unavailability of standardized methods.

Hazarika (2020) examined artificial intelligence; opportunities and implications for the health workforce. Healthcare involves cyclic data processing to derive meaningful, actionable decisions. Rapid increases in clinical data have added to the occupational stress of healthcare workers, affecting their ability to provide quality and effective services. Health systems have to radically rethink strategies to ensure that staff are satisfied and actively supported in their jobs. Artificial intelligence (AI) has the potential to augment provider performance. This article reviews the available literature to identify AI opportunities that can potentially transform the role of healthcare providers. To leverage AI's full potential, policymakers, industry, healthcare providers and patients have to address a new set of challenges. Optimizing the benefits of AI will require a balanced approach that enhances accountability and transparency while facilitating innovation.

Thillaivasan and Wickramasinghe (2020) conceptualize the impact of AI and automation on leadership, human capital and organizational performance. Humanity is at the brink of the Fourth Industrial Revolution which is poised to change businesses, industries and societies. This paper aims to conceptualize the novel impact of the digital transformation in terms of AI and automation on organizational performance by scrutinizing the impact of AI on two key elements, to transform the leadership and human capital that are used

by all organizations in their performance measurement approaches and models. The investigation was conducted by way of an extensive literature review and found significant implication on factors selected. The investigation also revealed that AI and automation will also have significant implications on the configuration of the future organization. Considering these implications, the study postulate that organizational performance metrics of today need to evolve significantly to measure performance of future organization.

Aravala, Kumar, Devarakonda & Suman (2020) examined the impact of artificial intelligence on productivity of the employees. AI moved beyond the tag of buzzword and penetrated as an essential entity in this competitive arena. In this study the line of focus is towards highlighting the role played by artificial intelligence in various forms to enhance the productivity of the employees. Primary research was carried out to know the role played by AI driving employee motivation to enhance the productivity of the employees. It was done by conducting a survey through online questionnaire. The sample size includes 100 respondents. The methodology of research is purely based on the facts and insights collected through secondary research and the responses received through the questionnaire as part of primary research. According to the inputs from the responses few insights are drawn as part of the study. Majority of the respondents opine AI as a better tool which adds business value and ensures process optimization. In addition to this virtual phone systems and automated employee performance reports are some of the current practices implemented in the organization. In other words, most of the respondent's state that revolution of chatbots, advent of automation and application of analytics are few potential reasons to implement AI at organizations. The study concludes that AI is a boon which creates more and more opportunities to survive and ensure the rise in productivity and accuracy of the employee performance with quick turnaround.

Muhammad, Lawal, Igbinovia, & Adamu (2022) investigate the COVID-19 effect on automation-related jobs, remote work, and labor productivity in Nigeria. The data collected was cumulative monthly data from March 2020 to April 2021 via world health organization website for Nigeria confirmed cases of COVID- 19 while other data are automation related jobs, remote working and labor productivity in Nigeria. This study uses empirical analysis such as the Johansen co-integration test to assess whether the series are co- integrated, implying the usage of a vector error correction model (VECM) and indicating that the variables have a long-term relationship. A causality test was also carried out, which revealed that COVID-19 had a considerable impact on automation, remote work, and labor productivity in Nigeria. In the meantime, COVID-19, automation-related professions, remote working, and labor productivity are all linked in the short and long run, according to the Johansen cointegration, vector auto regression (VAR), and vector error correction models (VECM). Granger causality demonstrates that COVID-19 occurrences in Nigeria have a causal effect on the risk of automation-related professions, distant work, and labor productivity, demonstrating the study's value. Romero, Opoku, Syabbariyah, *et al* (2023) explore the benefits and challenges of artificial intelligence (AI) in nursing. This study discussed the trend of AI (Artificial Intelligence) and its role in the healthcare industry. AI is being used to improve efficiency and effectiveness in healthcare. Still, challenges remain, such as privacy and data protection and healthcare workers' hesitancy to replace their work with technology. This study aimed to see opportunities for using AI in the health sector and understand existing problems, such as

barriers to significant initial investments. This study used a qualitative approach and focused on the author's understanding based on secondary sources and personal experience. The study results shown that AI can assist health workers in making diagnoses and providing more efficient health services. However, it still has to be used as a tool and cannot replace the role of health workers as a whole.

Noy and Zhang (2023) examine the productivity effects of a generative artificial intelligence technology – the assistive chatbot Chat GPT – in the context of mid-level professional writing tasks. In a preregistered online experiment, we assign occupation-specific, incentivized writing tasks to 444 college-educated professionals, and randomly expose half of them to Chat GPT. Our results show that Chat GPT substantially raises average productivity: time taken decreases by 0.8 SDs and output quality rises by 0.4 SDs. Inequality between workers decreases, as Chat GPT compresses the productivity distribution by benefiting low-ability workers more. Chat GPT mostly substitutes for worker effort rather than complementing worker skills, and restructures tasks towards idea-generation and editing and away from rough-drafting. Exposure to Chat GPT increases job satisfaction and self-efficacy and heightens both concern and excitement about automation technologies.

3.0   Methodology

The cross-sectional survey method, a form of quasi-experimental design, is considered most appropriate for this study. A cross-sectional survey can be thought of as analogous to the taking of a snapshot of some situation and analyzing it (Baridam, 2001). The population studied in this work comprises all the employees in the public hospitals in Port Harcourt, Rivers state, Nigeria. The sample of study consists of two public hospitals located in Port-Harcourt metropolis (University of Port Harcourt Teaching Hospital (UPTH), and Braithwaith Memorial Hospital (BMH). The non-probability method of convenient sampling has been used and most easily accessible members were chosen as subjects.

The "Questionnaire" was the main instrument for collecting primary data in this study. The questionnaire was adapted from a mixture of instruments for measuring various aspects of the study (Nachimayas & Nachimayas, 2008). The study includes developing a questionnaire to fulfill its objectives. Before sending questionnaire to the whole sample, four respondents reviewed its items to check whether all the questions were understood. The final questionnaire incorporates their suggestions. The authors collected the information between May and June 2023.

280 questionnaires were distributed personally among the members of staff of the hospitals in May 2023. Repeated visits were made and 259 questionnaires were received back with a response rate of 92.5%. The statistical tool utilized in this study was the "Spearman Rank Order Correlation Coefficient" (rs) to establish relationships. Significances of the relationships were established from the SPSS output viewer at a level of significance of 0.05 (and at a default level of 0.01 set within SPSS) as reported by the SPSS output viewer.
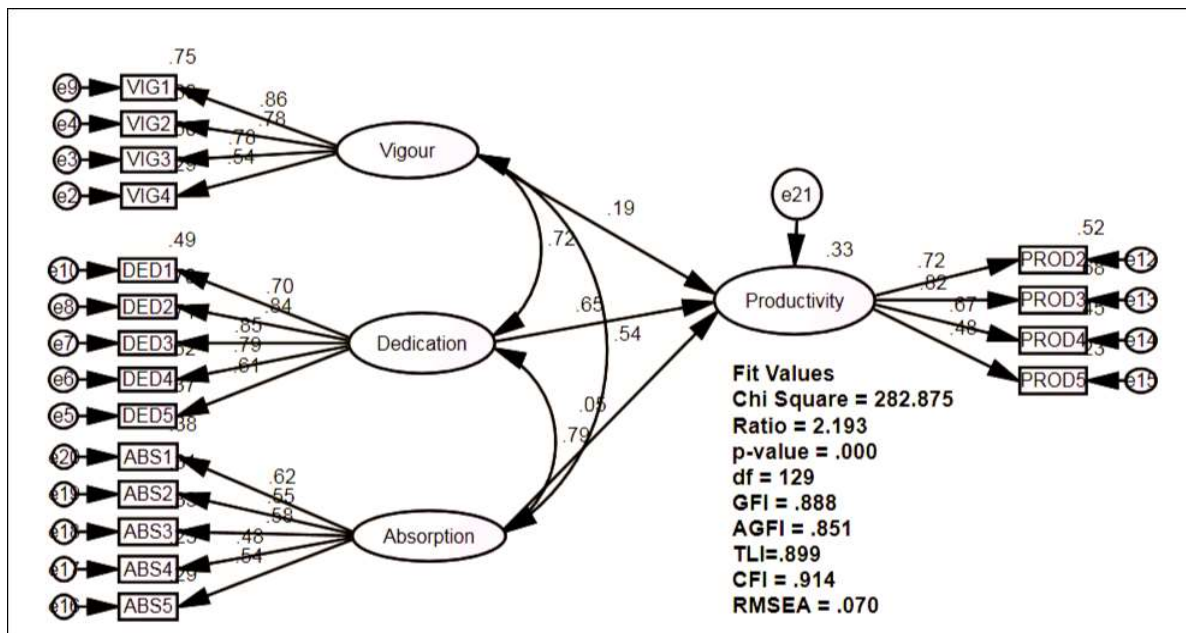
4. Results

Table 1   Demographic characteristics of the sample

	Category	Frequency	Percentage (%)
Public Hospitals	University of Port Harcourt Teaching Hospital (UPTH)	175	67.57
	Braithwaith Memorial Hospital (BMH)	84	32.43
Gender	Male	154	59.46
	Female	105	40.54
Status	Single	72	27.80
	Married	187	72.20
Education	Professors	8	3.09
	Associate Professors	15	5.79
	Assistant Professors	33	12.74
	Specialist / Consultants	37	14.29
	Nurses	66	25.48
	Medical Officers	100	38.61

The results of respondents' demographic characteristics are presented in Table 1. As it can be been in the table, 154 (59.46%) of the participants are male, while 105 (40.54%) are female. On marital status profile, the majority of the participants (72.20%) are married while the remaining 72 (27.80%) are still single as at the time of this study. In terms of education, this study has 8 (3.09%) professors, 15 (5.79%) associate professors, 33 (12.74%) assistant professors, 37 (14.29%) specialist/consultants, 66 (25.48%) nurses, and 100 (38.61%) medical officers. The respondents from the University of Port Harcourt Teaching Hospital (UPTH) were 175 (67.57%) while Braithwaith Memorial Hospital (BMH) had 84 (32.43%) participants. Moreover, the reliability analysis was conducted on all variables using Cronbach's alpha. The findings revealed that the Cronbach's alpha values are satisfactory ranging from 0.755 to 0.882. Specifically, artificial intelligence achieved a Cronbach's alpha value of 0.882. The dimensions of artificial intelligence were also reported at high reliability Cronbach's alpha; Chatbot (0.812), AI Diagnostics (0.867), Automation (0.758). Similarly, employee productivity recorded a Cronbach's alpha value of 0.755. Therefore, it can be concluded that the values of Cronbach's alpha for all variables are acceptable and satisfied the minimum requirement as suggested by Pallant (2007).

Factor analysis was also conducted on all variables to ensure that each set of items are measuring what they are supposed to measure. It was also conducted to ensure the existence of convergent and content validity. As all the measures were adapted from previous studies, confirmatory factor analysis (CFA) instead of exploratory factor analysis (EFA) is done. The procedure for conducting the analysis was done using AMOS 18 through the measurement model which comprises all items together in one model. The results indicated that the factor loading for all items ranged from 0.48 to 0.86. Based on these results, it can be said that all items achieved the recommended value as suggested by Hair el al. (2010). Therefore, factor analysis is satisfactory for all constructs.

To test the hypotheses of this study, the regression table which was generated from structural model was used. As shown in Table 2, all of the hypotheses are supported. Specifically, H1 which states that Chatbot has positive effect on employee productivity is confirmed (β = 0.192, t-value = 2.219, p< 0.05). The findings also reveal that AI Diagnostics has positive effect on employee productivity, the relation is statistically significant and positive (β = 0.653, t-value = 2.806, p < 0.05), therefore, H2 is accepted. Moreover, the positive effect of automation on employee productivity is supported (β =

0.051, t-value = 3.025, p < 0.05), Hence, H3 is accepted. Finally, the results indicate that overall artificial intelligence has significant positive effect on employee productivity (β = 0.354, t-value = 4.565, p < 0.05), therefore, H4 is supported. Overall, this study found that artificial intelligence explains 33% of overall variance in employee productivity.

Table 2: Research Findings

	Hypothesized Effect	Std. Beta	S.E.	C.R.	P	Support
H1:	Chatbot has positive effect on employee productivity.	0.192	0.062	2.219	0.001	Yes
H2:	AI Diagnostics has positive effect on employee productivity.	0.653	0.140	2.806	0.005	Yes
H3:	Automation has positive effect on employee productivity.	0.051	0.104	3.025	***	Yes
H4:	Overall artificial intelligence has positive effect on employee productivity.	0.354	0.078	4.565	***	Yes

5 Discussions and Conclusion

The rationale of this study was to examine the effect of artificial intelligence and its dimensions with automation on employee productivity at public hospitals in Port Harcourt, Rivers State, Nigeria. The findings indicated that artificial intelligence has a significant positive effect on employee productivity. It is also found that all dimensions of artificial intelligence (chatbot, ai diagnostics, and automation) have significant positive effects on employee productivity. AI technologies are being used or trialled for a range of purposes in the field of healthcare and research, including detection of disease, management of chronic conditions, delivery of health services, and drug discovery. AI technologies have the potential to help address important health challenges, but might be limited by the quality of available health data, and by the inability of AI to possess some human characteristics, such as compassion.

The use of AI raises a number of ethical and social issues, many of which overlap with issues raised by the use of data and healthcare technologies more broadly. A key challenge for future governance of AI technologies will be ensuring that AI is developed and used in a way that is transparent and compatible with the public interest, whilst stimulating and driving innovation in the sector.

The impact of technology on work and workers is multifaceted and complex. Technology is not homogenous and at least should be thought of in terms of enabling and replacement technologies, and the impact of technology on work and workers also should be considered as a process that occurs over time (Schulte & Howard, 2019), and decisions must increasingly be made under uncertainty about future digital and other developments (OECD, 2019a). AI technologies continue to spread through our societies, transforming many aspects of daily life at an incredible pace. From environmental conservation to medical imaging and to supporting people with disabilities, most of these hold great promise in advancing societies and addressing existing problems. The utilization of AI-driven tools and techniques at work and in the workplace also offers several advantages to workers and employers, be it better health and safety precautions, increased productivity, or optimization of shift schedules.

Overall, this study provides empirical evidence that artificial intelligence has a significant positive effect on employee productivity. Therefore, employers should put sufficient emphasis and invest more in artificial intelligence and also frequently evaluate the progress of their employees to ensure the welfare of their organizations. Besides, employers across public hospitals are advised to conduct frequent surveys from time to time to clearly understand the level of artificial intelligence adoption among their employees and their satisfaction about work environment. Such activities would enable them to develop the suitable strategies for overcoming any issue. For example, the acquisition of talents is a good strategy to ensure effective recruitment. Moreover, providing sufficient resources those including financial, physical, or materials are necessary to reinforce employee productivity. It is also suggested that employers should adopt the two-way communication strategy between them and their employee to allow the employee share some ideas about their jobs and any issues that may affect their productivity. With such emphasis, it is believed that the adoption of artificial intelligence will help the employee to be more engaged in their works and have higher inspiration to be productive.

Although the current study has presented some useful insights into the causal relationship between artificial intelligence and employee productivity, it can be acknowledged that there are some limitations and suggestions to be considered in future researches. First, the participants of this study are only limited to the staff of the two public hospitals in Port Harcourt. This may hinder the generalizability of the findings of this study to other industry contexts. Therefore, future research should replicate this study by sampling employees from different industries with larger sample sizes. Second, this study has relied on a cross-sectional design where the data was collected from participants using survey method. Given this limitation, it is suggested that future research should investigate the antecedents of employee productivity using longitudinal research designs and methodologies. Finally, this study examined only one antecedent to employee productivity, hence, future research is suggested to test the effect of other human resource practices on employee productivity such as work specialization and leadership style.

References

Acemoglu, D., and Restrepo, P., (2016). "The Race between Machine and Man: Implications of Technology for Growth, Factor Shares and Employment." *American Economic Review* 108 (6): 1488–542*.*

Acemoglu, D., and Restrepo, P., (2017). "Robots and Jobs: Evidence from US Labor Markets." NBER Working Paper no. 23285, Cambridge, MA.

Adamu, M. B. (2022). The COVID-19 effects on automation, remote working and labor productivity in Nigeria.

Adi, E., Anwar, A., Baig, Z., & Zeadally, S. (2020). Machine learning and data analytics for the IoT. *Neural computing and applications*, *32*, 16205-16233.

AI HLEG (2019). *A Definition of Ai: Main Capabilities and Scientific Disciplines.* Brussels: High-Level Expert Group on Artificial Intelligence, European Commission.

Aravala, A., Kumar, A., Devarakonda, S., & Suman, G., (2020). Impact of Artificial Intelligence on productivity of the employees. *International Journal of Innovative Research in Technology, 7(1),* 492-496.

Arpita. (Dec 24, 2020). How AI Chatbots Are Digitizing Patient Care. Solution Suggest. https://solutionsuggest.com/ai-chatbots-digitizing- patient-care/

Autor, D. (2015). Why are there still so many jobs? The history and future of workplace automation', Journal of Economic Perspectives, 29(3), 3-30.

Baily, M. N., Farrell, D., Greenberg, E., Henrich, J. D., Jinjo, N., Jolles, M., & Remes, J. (2005). Increasing global competition and labor productivity: Lessons from the US automotive industry. *McKensie Global Institute, November*, 7.

Balogh, E.P., Miller, B.T., & Ball, J.R., (2015) editors. Improving diagnosis in health care. Washington, DC: National Academies Press.

Baridam, D.M. (2001), Research methods in administrative sciences. (2nd ed). Port Harcourt. Paragraphics.

Bessen, J., (2016). *Learning by Doing: The Real Connection between Innovation, Wages, and Wealth.* New Haven, CT: Yale University Press.

Bloom DE, Khoury A, Subbaraman R. (2018). The promise and peril of univer- sal health care. Science; 361(6404): eaat9644.

Brian J. Douthit, Xiao Hu, Rachel L. Richesson, Hyeoneui Kim, and Michael P. Cary (2020). How artificial intelligence is transforming the future of nursing. American Nursing. https://www.myamericannurse.com/how-artificial-intelligence-is-transforming-the-future-of-nursing/

Brown, J., Elliott, S., Christensen- Hughes, J., Lyons, S., Mann, S., & Zdaniuk, A. (2009). Using human resource management (HRM) practices to improve productivity in the Canadian tourism sector. *Electronic Article, University of Guelph*, 1-15.

Brynjolfsson E, McAfee A. (2014) The second machine age: work, progress, and prosperity in a time of brilliant technologies, New York: Norton & Company; c2014.

Cato, S. T., & Gordon, J. (2009). Relationship of the strategic vision alignment to employee productivity and student enrolment. Research in Higher Education Journal, 7, 1-20

Cato, S. T., & Gordon, J. (2009). Relationship of the strategic vision alignment to employee productivity and student enrolment. *Research in Higher Education Journal*, 7, 1-20.

Chai, M. J. Y., & Gooi, C. S. Y. (2019). *Intelligent automation uptake and labor productivity in United Kingdom* (Doctoral dissertation, UTAR).

Chang, C. Y., Hwang, G. J., & Gau, M. L. (2022). Promoting students' learning achievement and self-efficacy: A mobile chatbot approach for nursing training. *British Journal of Educational Technology*, *53*(1), 171-188.

Cioffi, R., Travaglioni, M., Piscitelli, G., Petrillo, A., & De Felice, F. (2020). Artificial intelligence and machine learning applications in smart production: Progress, trends, and directions. *Sustainability*, *12*(2), 492.

Cohen, M. C. (2018). Big data and service operations. *Production and Operations Management*, *27*(9), 1709-1723.

Collins, L., Fineman, D. R., & Tshuchica, A. (2017). People analytics: Recalculating the route. In, 2017 Deloitte Global Human Capital Trends. Deloitte University Press.

Confalonieri, R., Coba, L., Wagner, B., & Besold, T. R. (2021). A historical perspective of explainable Artificial Intelligence. *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*, *11*(1), e1391.

Craglia M, Annoni A., Benczur, et al. (2018) Artificial Intelligence – A European Perspective. Luxembourg: Publications Office of the European Union.

Dall T, West T, Chakrabarti R, Reynolds R, Iacobucci W. (2018) update. The complexities of physician supply and demand: projections from 2016 to 2030. Washington, DC: IHS Markit; 2018.

Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, *6*(2), 94-98.

Deloitte and The Manufacturing Institute. 2011. "Boiling Point? The Skills Gap in U.S. Manufacturing." Report. http://www.themanufacturinginstitute.org//media/A07730B2A798437D98501E798C2E13AA.ashx.

Densen, P., (2011). Challenges and opportunities facing medical education. Trans Am Clin Climatol Assoc., 122:48–58.

Dilsizian, S.E., & Siegel, E.L. (2014). Artificial intelligence in medicine and cardiac imaging: harnessing big data and advanced computing to provide personalized medical diagnosis and treatment. Curr Cardiol Rep., 16:441.

European Agency for Safety and Health at Work (EU-OSHA) (2021). Impact of artificial intelligence on occupational safety and health – Policy brief. Luxembourg: Publications Office of the European Union.

Fan, X., Chao, D., Zhang, Z., Wang, D., Li, X., & Tian, F. (2021). Utilization of self-diagnosis health chatbots in real-world settings: case study. *Journal of medical Internet research*, *23*(1), e19928.

Ferreira, A., & Du Plessis, T. (2009). Effect of online social networking on employee productivity. *South African Journal of Information Management*, *11*(1), 1-11.

Filitrault, P., Harvey J. & Chebat, J.C., Service quality and service productivity management practice. *Industrial Marketing Management, 25*(3), 1996, 243-255.

Flavián, C., Pérez-Rueda, A., Belanche, D., & Casaló, L. V. (2022). Intention to use analytical artificial intelligence (AI) in services–the effect of technology readiness and awareness. *Journal of Service Management*, *33*(2), 293-320.

Ford, M., (2016). *The Rise of the Robots: Technology and the Threat of a Jobless Future*. New York: Basic Books.

Fortin M, Bravo G, Hudon C, Vanasse A, Lapointe L. (2005). Prevalence of multimorbidity among adults seen in family practice. Ann Fam Med., 3(3):223–8.

Fortin M, Lapointe L, Hudon C, Vanasse A. (2005). Multimorbidity is common to family practice: is it commonly researched? Can Fam Physician.; 51(2):245.

Gummesson, E. (1998). Productivity, quality and relationship marketing in service operations. *International Journal of Contemporary Hospitality Management*, *10*(1), 4-15.

Gupta, H., Yadav, A. K., Kusi-Sarpong, S., Khan, S. A., & Sharma, S. C. (2022). Strategies to overcome barriers to innovative digitalisation technologies for supply chain logistics resilience during pandemic. *Technology in Society*, *69*, 101970.

Hair, J. F., Jr., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2010). Multivariate Data Analyisis (7th edition) Upper Saddle River, N.J: Pearson Prentice Hall.

Hassmiller, S.B., & Cozine, M., (2006). Addressing the nurse shortage to improve the quality of patient care. Health Aff (Millwood)., 25(1): 268–74.

Hazarika, I., (2020). Artificial intelligence: opportunities and implications for the health workforce. *International Health*; **12**: 241–245. doi:10.1093/inthealth/ihaa007

Hernandez-Peña, P., Poullier, J.P., Van Mosseveld, C.J.M., et al., (2013). Health worker remuneration in WHO Member States. Bull World Health Org., 91(11): 808–15.

Herrendorf, B., Rogerson, R., and Valentinyi, Á., (2013). "Two Perspec- tives on Preferences and Structural Transformation." *American Economic Review* 103 (7): 2752–89.

Hill, C., Jones, G., & Schilling, M. (2014). *Strategic management: theory: an integrated approach*. Cengage Learning.

Institute of Medicine (2001). Crossing the quality chasm: a new health system for the 21st century. Washington: National Academies Press; 2001.

Jiang F, Jiang Y, Zhi H, et al., (2017). Artificial intelligence in healthcare: past, present and future. Stroke Vasc Neurol., 2(4): 230–43.

Jovanović, M., Baez, M., & Casati, F. (2020). Chatbots as conversational healthcare services. *IEEE Internet Computing*, *25*(3), 44-51.

Kumar, Y., Koul, A., Singla, R., & Ijaz, M. F. (2022). Artificial intelligence in disease diagnosis: a systematic literature review, synthesizing framework and future research agenda.*Journal of Ambient Intelligence and Humanized Computing*, 1-28.

Mantoux, Paul. 1928. *The Industrial Revolution in the Eighteenth Century: An Outline of the Beginnings of the Modern Factory System in England.* New York: Harcourt.

McKinsey Global Institute. (2017). "Jobs Lost, Jobs Gained: Workforce Transitions in a Time of Automation." Report, McKinsey & Company. https://www.mckinsey .com/mgi/overview/2017-in-review/automation-and-the-future-of-work/jobs-lost-jobs-gained-workforce-transitions-in-a-time-of-automation.

Mehmood, S., Ahmad, I., Arif, H., Ammara, U. E., & Majeed, A. (2020). Artificial pancreas control strategies used for type 1 diabetes control and treatment: a comprehensive analysis. *Applied System Innovation*, *3*(3), 31.

Meskó, B., Hetényi, G., & Gyo˝rffy, Z., (2018). Will artificial intelligence solve the human resource crisis in healthcare? BMC Health Serv Res., 18(1): 545.

Miailhe, N. & Hode, C. (2017). The Third Age of Artificial Intelligence *Field Actions Science Reports,* Special Issue 17, pp 6-11.

Moore, P. (2019). OSH and the future of work: Benefits and risks of artificial intelligence tools in workplaces. EU-OSHA Discussion Paper. Available at: https://osha.europa.eu/en/publications/osh-and-future-work-benefits-and-risks-artificial-intelligence-tools-workplaces/view

Morales, C., Cory, C., & Bozell, D. (2001).*A comparative efficiency study between a live lecture and a Web-based live-switched multi-camera streaming video distance*

learning instructional unit. Proceedings of the 2001 Information Resources Management Association International Conference, Toronto, Ontario, Canada, 63-66.

Nachmias- Frankfort, C. & Nachmias, D. (2008). Research methods in the social sciences. 7th Ed. Worth Publishers.

Nahavandi, D., Alizadehsani, R., Khosravi, A., & Acharya, U. R. (2022). Application of artificial intelligence in wearable devices: Opportunities and challenges. *Computer Methods and Programs in Biomedicine*, *213*, 106541.

Nguyen, T. H., Waizenegger, L., & Techatassanasoontorn, A. A. (2022). "Don't Neglect the User!"–Identifying Types of Human- Chatbot Interactions and their Associated Characteristics. *Information Systems Frontiers*, *24*(3), 797-838.

Nollman, M. R. (2013). Sustainability Initiatives in the Workplace and Employee Productivity (Master Thesis), Southern Illinois University Carbondale.

Noy, S., & Zhang, W. (2023). Experimental evidence on the productivity effects of generative artificial intelligence. *Available at SSRN 4375283*.

Obdulio, D. L. (2014) . How management can improve corporate culture in order to have an effective work environment. Trade Publication, 75(8), 14.

OECD (2019a). OECD Employment Outlook 2019: The Future of Work. Paris: OECD Publishing.

OECD (2019b). Going digital: Shaping policies, improving lives. Paris: OECD Publishing.

OECD (2019c). Artificial Intelligence in Society. Paris: OECD Publishing.

Paranjape, K., Schinkel, M., Panday, R. N., Car, J., & Nanayakkara, P. (2019). Introducing artificial intelligence training in medical education. *JMIR medical education*, *5*(2), e16048.

Parasuraman, R., Sheridan, T.B., & Wickens, C.D., (2000). A model for types and levels of human interaction with automation. IEEE Trans Syst Man Cybernetics A Syst Humans, 30(3): 286–97.

Paśko, Ł., Mądziel, M., Stadnicka, D., Dec, G., Carreras-Coch, A., Solé-Beteta, X., ... & Atzeni, D. (2022). Plan and Develop Advanced Knowledge and Skills for Future Industrial Employees in the Field of Artificial Intelligence, Internet of Things and Edge Computing. *Sustainability*, *14*(6), 3312.

Piana, V. (2001). Productivity. Retreived on 4ᵗʰ September, 2015 from: http://www.economicswebinstitute.org/glossary/prdctvt.htm

Prudy, M., & Daugherty, P., (2017). Why artificial intelligence is the future of growth. Accenture Institute for High Performance. Available at: https://www.accenture.com/t20170524T055435__w__/ca-en/_acnmedia/PDF-52/Accenture-Why-AI-is-the-Future-of-Growth.pdf

PwC (2019). Seeing Is believing. PwC. Available at: https://www.pwc.com/gx/en/industries/technology/publications/economic-impact-of-vr-ar.html

Rai, A. (2020). Explainable AI: From black box to glass box. *Journal of the Academy of Marketing Science*, *48*, 137-141.

Rasmussen, Wayne D. 1982. "The Mechanization of Agriculture." *Scientific American* 247 (3): 76–89.

Rogers, A.E., et al., (2004). The working hours of hospital staff nurses and patient safety. Health Aff (Millwood), 23(4): 202–12.

Romero, C. B., Opoku, O. A., Syabariyah, S., Astuti, D. A., & Asif, I. (2023). Exploring the Benefits and Challenges of Artificial Intelligence (AI) in Nursing. *Engineering Science Letter*, *2*(01), 9-12.

Rossi, F. (2016). *Artificial Intelligence: Potential Benefits and Ethical Considerations* [Online]. European Parliament Legal Affairs Briefing. Available: https://www.europarl.europa.eu/RegData/etudes/BRIE/2016/571380/IPOL_BRI(2016)571380_EN.pdf.

Samoili, S., M., L. C., Gómez, E., De Prato, G., Martínez-Plumed, F. & Delipetrev, B. (2020). *Ai Watch. Defining Artificial Intelligence. Towards an Operational Definition and Taxonomy of Artificial Intelligence.* Luxembourg: Publications Office of the European Union.

Santoso, F., Farhan, A., Castillo, A. L., Malhotra, N., Saputra, F., Kurnia, K. A., ... & Hsiao, C. D. (2020). An overview of methods for cardiac rhythm detection in zebrafish. *Biomedicines*, *8*(9), 329.

Sels, L., De Winne, S., Delmotte, J., Maes, J., Faems, D., & Forrier, A. (2006). Linking HRM and small business performance: An examination of the impact of HRM intensity on the productivity and financial performance of small businesses. *Small Business Economics*, *26*(1), 83-101.

Sharma, M. S., & Sharma, M. V. (2014).Employee Engagement to Enhance Productivity in Current Scenario. *International Journal of Commerce, Business and Management, 3*(4), 595-604.

Smit, S., Tacke, T., Lund, S., Manyika, J, & Thiel, L. (2020). The future of work in Europe: Automation, workforce transitions and the shifting geography of employment. Discussion Paper – McKinsey Global Institute. Available at: https://www.mckinsey.com/featured-insights/future-of-work/the-future-of-work-in-europe

Thillaivasan, D., & Wickramasinghe, C. N. (2020). Conceptualizing the Impact of AI and Automation on Leadership, Human Capital and Organizational Performance. *Journal of Business and Technology*, *4*(1-2).

Tonsaker, T., Bartlett, G., & Trpkov, C., (2014). Health information on the internet: gold mine or minefield? Can Fam Physician, 60(5): 407–8.

Vardi, M. Y. (2012). Artificial Intelligence: Past and Future. *Communications of the ACM, 55*(1), pp 5.

Wang, K., Khoo, K. S., Leong, H. Y., Nagarajan, D., Chew, K. W., Ting, H. Y., ... & Show, P. L. (2022). How does the Internet of Things (IoT) help in microalgae biorefinery?. *Biotechnology advances*, *54*, 107819.

World Health Organization (2016). Global strategy on human resources for health: workforce 2030. Geneva: World Health Organization.

World Health Organization (2016). Working for health and growth: investing in the health workforce. In: Report of the High-Level Commission on Health Employment and Economic Growth. Geneva: World Health Organization.

Wright, A. (2004). *Reward management in context*. CIPD Publishing.

Xu, L., Sanders, L., Li, K., & Chow, J. C. (2021). Chatbot for health care and oncology applications using artificial intelligence and machine learning: Systematic review. *JMIR cancer*, *7*(4), e27850.

Zayum, S., Aule, S., & Hangeior, S. (2017) Performance Appraisal and Employee Productivity in Plateau State Internal Revenue Service, Nigeria. Journal of Public Administration and Governance, 7(4), 24-37

Zhang, Z., Wen, F., Sun, Z., Guo, X., He, T., & Lee, C. (2022). Artificial intelligence-enabled sensing technologies in the 5G/internet of things era: from virtual reality/augmented reality to the digital twin. *Advanced Intelligent Systems*, *4*(7), 2100228.