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Applicability Synergy Of Disruptive Technology And Financial Performance Of Pharmaceutical Companies.

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Abstract

The study examined the synergistic applicability of disruptive technologies on the financial performance of companies, with special regards to the roles of technological innovations play on the financial outcomes of pharmaceutical companies. Globally, pharmaceutical companies hugely invest in disruptive technological innovations and so the need arises to study the multiplier relationship between this development and the financial consequences of these companies, to find out whether these innovations have any significant synergistic benefits to the advancement or abatement of financial numbers. To achieve these objectives, Big Data Analytics, Internet of Medical Things (IoMT), 4D Bio-Printing, Artificial Intelligence, and Gamification were considered as the proxies for disruptive technologies, and their influences on the financial fortunes of the studied companies. To evaluate the degree of relationship, a descriptive research design was adopted, with data gathered through a 5 point scaled questionnaire. The data were analysed using multiple linear regression technique. The general result revealed a significant synergistic influence of the application of disruptive technologies on financial performance of companies. The outcome of the study further demonstrates that pharmaceutical companies' financial numbers are synergistically influenced by their ability to adopt disruptive technologies and innovative skills in enhancing operations.

Keywords: Disruptive technology, Fintech, Big data analytics, Internet of Medical Things, 4D Bio-Printing, Artificial Intelligence, Gamification, financial performance.

1.0 Introduction

In the recent years, especially with the emergence of the Covid-19 pandemic, pharmaceutical companies have rapidly evolved by transiting scientific knowledge into curative and health-care products. Munos (2009) stated that worldwide, over a thousand pharmaceutical companies have joined the existing market, contributing considerably to epidemiology and public health resulting in a higher life-to-death ratio. This assertion played out particularly, during the peak of the COVID-19 pandemic.

Today, technological innovations have offered a complete overhaul of how the public access health services. Globalization, coupled with technological innovations have seen the pharmaceutical industry opened to increased accessibility of sophisticated technologies which has led to the need to come up with different approaches to the way pharmaceutical services are offered. In fact, this has led to the emergence of mergers and acquisitions, thus creating global players in the industry. In the financials, costs associated with technological advancements, especially R&D costs, are steadily rising over time, particularly in the pharmaceutical sector, (Mastroeni, Tait, & Rosiello, 2013), resulting in massive health-care expenditures. The problem of rising costs has become a source of debate especially in the short run, as it may be considered to lead to financial losses, due to huge investments in disruptive technologies, but in the long run may result in profitability and growth.

Disruptive technologies are newly developed technologies that create much more value than the existing ones, and have significant roles in improving the quality of life, enhancing global economies, and supporting business models. Disruptive innovations, as coined by the Harvard Business School Professor Clayton Christensen, has impacted a wide range of high-tech industries, initially with the introduction of personal computers and cell phones then progressed to the mobile internet, the cloud, and the internet of things, as well as Artificial intelligence and big data. Disruptive forces in technology, demographics and current realities have entirely changed the natures of things (Banbury & Berry, 2005). Financial Services and Investment organisations are migrating their services to online, web and mobile channels and leveraging data and analytics for product development and sales. Government institutions are moving services to online channels and increasingly adopting e-Governance-Solutions, Insurance companies are considering how to use big data to personalize customers' solutions and improve risk decisions. Utility and Energy companies are leveraging digital channels for customer service and payments. Consumer goods businesses are adopting new direct-to-consumer business models while Retailers are adopting online and e-Commerce channels. Telecoms and the Media continue to struggle with disrupted business models and they continue to look for ways to improve customer experience and enhance revenues and profits. Moreover, the biopharmaceutical industry has evolved into an open innovation ecosystem with disruptive technologies now serving as a primary business strategy for mitigating economic risks (Kim, Lee, Kim, & Shin, 2021). The aspects of disruptive technologies include; Cloud, Online, Artificial Intelligence (AI), Robotics, Drones, 5G, Quantum Computing, Remote Proctor, Human Augmentation, and digital currency. The pharmaceutical sector has begun understanding the capability of working together with disruptive innovations, and is overwhelmed by a portion of the top spenders on pharmaceutical R&D from the advanced nations. Studies have shown that new product discoveries and expansion increase the manufacturers' market share and enhance health economies (Chen, 2006). Developing new health care products can significantly reduce the costs of local medicine and improve health-care systems in general, by increasing the company's competitive advantage, as a result, the product development benefits both the enterprises and the ailing public (Yang, *et al*., 2012). In the last decade, the government implemented a number of reforms in the pharmaceutical

industry with the goals of improving cost effectiveness and productivity in the globally rising market, (Yousefi, *et al*., 2016). Nevertheless, pharmaceutical firms are often impeded by various constraints such as ideological constraints, paradigmatic constraints, financial constraints, technological constraints, networking constraints and innovative marketing constraints, (Naidoo, 2010). Development and growth of pharmaceutical firms in other parts of the world were largely in line with their respective domestic terms as the international community consistently discuss these constraint factors in different areas. Finance, internationalization, technological innovation, raising awareness for adoption of broader Intellectual Property (IP), and having business going concern plans, are all needed to alleviate the constraints to pharmaceutical industry growth and promote long-term sustainability. Because of the importance of pharmaceutical companies in the development of the country's economy, their performance has always piqued the interest of academicians, researchers, entrepreneurs, investors, trade associations, and government agencies.

This study framework examines how pharmaceutical companies can benefit financially from disruptive innovation strategies. The resources and capabilities of a company determine its competitive advantage, which in turn, determines its profitability. This study observes that the relationship between disruptive technological innovations and financial performance is not simple and direct, but complex and multidimensional. This study therefore, presents a unifying structural framework for handling disruptive technologies in view of the companies' resources and capacities while the implications are measured as financial consequences.

2.0 Theoretical framework

The underpinning theories for this study are the Disruptive innovation theory and the Diffusion of innovation theory.

2.1 The Disruptive Innovation Theory (Clayton Christensen, 1997)

Professor Clayton M. Christensen proposed the Disruptive Innovation theory in his 1997 research on the disk-drive industry. The theory outlines how an innovation transforms an existing sector or market by bringing innovations, convenience, affordability and accessibility to a market or sector where complexity and high costs are the norm. A disruptive innovation emerges in a niche market that appears unappealing or insignificant to industry incumbents at first, but the new product or idea eventually transforms the industry.

The theory helps to develop the concept of how local products and services have evolved so much so that traditional institutions and industries have been displaced and replaced with high tech industries. There is no doubt that disruptive innovation has recorded high levels of successes in a variety of industries, with some of the world's highly established companies adopting it. Even within the pharmaceutical industry, some of the well established companies have accepted that disruptive technologies may be the panacea urgently needed for greater success in developing therapies and drugs to prevent and treat human health deficiencies, despite their initial opposition to these innovations.

2.2 Diffusion of innovation theory (E. M. Rogers, 1962)

Rogers' Diffusion of Innovation (DoI) theory asserts that an idea or product gathers momentum for a certain period then diffuses through a certain social system. The resultant effect of this diffusion is that people adopt the new concept, idea, or product as part of a social system. The adoption however, necessitates that something be done differently than before. The idea or concept must be viewed as novel or original in order to be socially adopted; this eventually result in diffusion after a certain period of time. Meanwhile, with the emergence of FinTech, that is, the use of technological innovations and financial automations, adopted in manufacturing, financial services, and even medical sectors, the use

of modern technologies in generating new services and business models has accelerated significantly, and indeed, digital disruptions are causing huge changes in the industries, leaving incumbents with potentially outmoded legacy systems.

2.3 Financial Performance

In many business literatures, financial performance is defined as the process of quantifying a firm's activities and operations which contribute to the attainment of its goals and objectives through satisfaction of its stakeholders, especially the customers, (Effiong & Ejabu, 2020).. Antony and Bhattacharyya (2010), assert that a company's performance is measured by how well it delivers value to its stakeholders and customers. Aminu and Shariff (2015), also described a company's performance as the measurement of how successfully its goals and objectives are met in comparison to its competitors; the accomplishments are the result of efficient, effective and productive business operations.

This study defines financial performance of pharmaceutical companies as the measure of how effective pharmaceutical companies generate revenues and improve profitability by adequately and efficiently exploiting pharmaceutical resources through disruptive and innovative technologies to ensure proper medications, healing and cure for the ailing public, and also provide health-care products and services to their customers. For this study, Returns on Assets (ROA) is used as the financial performance measure.

2.4 Disruptive technological innovations in the pharmaceutical industry

The pharmaceutical sector comprises the manufacturing and the consuming sectors (health professionals that market the drugs to patients). Like in many developing countries, economic, political and technological environments have remained a major obstacle to the pharmaceutical industry in Nigeria. Disruptive technologies and innovations are significantly underutilized within the industry even though many other industries are thriving on it. Industries like finance, telecommunications, healthcare and advertisement have been revolutionized through the use of disruptive technologies. Many studies have revealed the need for innovative and technological approaches in the industry to salvage a state of stagnancy in new drug discoveries especially in the COVID-19 pandemic period. In a paper presentation during the National Academy of Medicine (NAM) conference in 2016, responses from an interview session with twenty-five pharmaceutical professionals selected from various sectors in the pharmaceutical field was summarized, the results include strengths and weaknesses of the current situation, postulations on future paradigms, as well as opinions on ways to bring about transformation in the pharmaceutical industry. Basically, the sectors involved in drug discovery and development are prepared for changes so as to achieve higher success, even though there are variations in such changes.

The NAM paper gave illustration of the future changes in three distinct versions. The first distinct version postulated that the pharmaceutical industry could shift its focus totally to discoveries and deliveries in healthcare products through R&D in drug discovery and development, considering outright and utter knowledge on issues concerning their patients. This would generate prospects for unrestricted innovative disruption in the pharmaceutical sector's medication discovery and development. The second version depicts a deeper traditional disruption, which involves the use of paradigm-shifting technology in pharmaceuticals and clinical research; the third envisions the formation of a unique and sophisticated ecological environment as a result of a new technological innovation business model.

However, one of the most important questions to evaluate is whether the disruptive forces will be internal or external disruptors. Given the stakes and the scope of the sector, it appears that a range of technological innovations can contribute to the efficiency and success of the sector. On the other hand, the contraposition of every new technological invention is that the industry's well-established

companies might fathom out that the innovation has been detrimental to their businesses, leading to impediments. However, subsequent emergence of threats to the successful going concern of such conventional companies may eventually prompt them to embrace the disruptive technological innovation. Nevertheless, companies that involve in disruptive innovative technologies could also face some significant risks, meanwhile, with a mind to create impact through innovative approaches, companies collaborate (merge/acquisition) to fund the huge costs associated with disruptive innovations or source for funding from financial institutions or through any other means, including government or other private entities. Absolutely, disruptive innovation has achieved some significant levels of success in some industries, especially with more securely established corporations that have embraced these innovations. Moreover, while disruptive innovation in the pharmaceutical sector may initially be viewed as a threat to some of the industry's established players, it may ultimately be proven to be the required elixir for successful pharmaceutical discoveries to prevent, treat and cure diseases.

The main determinants of Disruptive innovation in the pharmaceutical industry include Real-time Technology, Big data Analytics, Internet of Medical Things for R&D, Drug Development and Improved Diagnostics, Gamification of Health principles for Patients, Mobile App Development Services (MADS) for Direct Connection with End-Users, 4D Bio-Printing for printing drugs and bio-medics, Artificial Intelligence Systems for interpreting patients' data, identifying and predicting results in a virtual patient, and Cloud Computing for sales and marketing operations. All these factors have fuelled digital disruption, in their own unique ways, in the pharmaceutical industry. For instance, Big Data Analytics and Real-time technology will continue to enhance drug development and improve diagnostics in patients, which in turn directly complement patients' health and improve the quality of life, (Shubham, 2019). More specifically, patients expect more digital experiences for convenience and efficiency in the pharmaceutical industry and by these disruptive innovations, the ongoing pharmaceutical industry reformation is opening doors to new competitions, creative inventions and increased revenue opportunities (Hang & Yu, 2010). The technological advancements are creating opportunities more than ever to meet the patients' needs even at lower costs, and that leads to digital disruption, (McQuivey, 2013). By this, it indicates that technological infrastructure added with digital innovations amount to digital disruption on a level at which most industries, including the pharmaceutical industry are yet to embrace (Hamel 2003).

Big Data Analytics (BDA)

BDA uses advanced analytic techniques to analyse enormous, heterogeneous data sets, comprising unstructured, semi-structured, and structured data, including data from various sources, proportions, ranges and sizes varying from zettabytes to terabytes, (Chiara & Ancora, 2016). These sets of data are often too massive or complex to be acquired, maintained, and processed in a timely manner by the traditional database system; whereas there is a lot of volume, velocity, and variations in big data applications. Mobile devices, artificial intelligence (AI), social media, and the Internet are driving and pulling data from various sources which become more complicated than traditional data sources. Big data analytics can be utilized in the pharmaceutical industry to streamline multiple complicated pharmaceutical procedures which improve efficiency across the sector. It is also useful in R & D, drug reactions, precision medicine, clinical trials, drug discovery, and sales and marketing to develop useful information needed for pharmaceutical procedures. Businesses may acquire insights from historical and real-time data sources including social media, IoT devices, log files, and patient data using the Big Data. Furthermore, Big Data Analytics can assist in the discovery of hidden patterns in data, which can then be leveraged on to develop useful analysis taking a data-driven approach to a variety of business processes. Investors in pharmaceutics and medical sectors have invested in big data about $4.7billion,

(Naveen, 2019). To reap the benefits of Big Data, corporate executives must keep up to date on the technology and its applications.

Internet of Medical Things (IoMT)

The Internet of Things (IoT) is a network structure of physical items (or "things") that are infused with sensors, network devices, application software and other technological applications to link, interact and exchange data with other internet devices and systems. The complexity of these devices range from common domestic items to sophisticated industrial machineries and equipment. Internet of Medical Things (IoMT) however, is a collection of medical equipment and apps that use online computer networks to link to healthcare IT systems. Machine-to-machine communication, which is the foundation of IoMT, is enabled by medical devices outfitted with Wi-Fi. IoMT devices connect to cloud systems like Amazon Web Services, which store and analyse collected data. Healthcare IoT is another name for IoMT. IoMT systems include; patient monitoring remote, for patients with severe conditions or long-term diseases; patient prescription tracking orders, and the location tracks of patients admitted to hospitals. Pharmaceutical companies are cooperating with tech businesses to develop devices that can track and monitor numerous chronic and lifestyle problems using real-time data. With the IoT, healthcare industry is expected to reach 136 billion USD by 2021 (Shubham, 2019)

4D Bio-Printing

Recently, as a fourth dimension technology, ‘time' has been combined with 3D bio-printing, resulting in 4D bio-printing,' in which printed objects (biocompatible responsive materials or cells) can change their shapes or functionalities over time in response to an external stimulus. 3D bio-printing has found significant use in a variety of technical and healthcare sectors. Nevertheless, it solely considers the printed object's initial state so 3D bio-printing is static and inanimate. From the rigid and static 3D structures, scientists can now create constructs (Bio fabrication) that can change shape in response to a variety of stimuli such as temperature, pH, Ca2+ concentration, swelling behaviour, electric-field, humidity, magnetic-field, or light among others, ushering in a new era in tissue engineering as well as other biomedical fields (Kelly, *et. al*, 2020). 4D bio-printing offers a lot of potential in tissue engineering and medication delivery. The bio printing is paving the way for new developments in medication research as well as other fields such as robotics and bio-sensing. When it comes to medication manufacturing, 4D bio printing can achieve drug delivery control, precise drug doses, and on-demand structure fabrication.

Artificial Intelligence (AI)

Artificial intelligence means human intelligence simulation by machines, particularly computer systems and robotics by using automated algorithms to do tasks that previously required human intellect. In the last five years, AI has revolutionized the ways and manners by which scientists identify novel therapies, develop new drugs, combat diseases, improve clinical data and trials and more. Pharmaceutical companies may now evaluate patient data to better understand human physiological patterns with the use of AI. They have also been able to use AI-driven solutions to identify and forecast results in a virtual patient.

Gamification

To increase participation, gamification incorporates game concepts into nongame environmental settings, such as an online community, internet website, company's intranet, or a learning management system. Gamification aims to engage customers, employees, and partners in order to encourage them to collaborate, share, and interact. Gamification can assist healthcare marketers deliver wellness motivation, boost health literacy, promote behavioural change around medication, adherence to lifestyle support (such as diet and exercise monitoring), and motivate individuals who might not otherwise engage with their healthcare.

For the purpose of this study, the conceptual framework represents the relationship between the disruptive technologies and financial performance in the pharmaceutical sector.

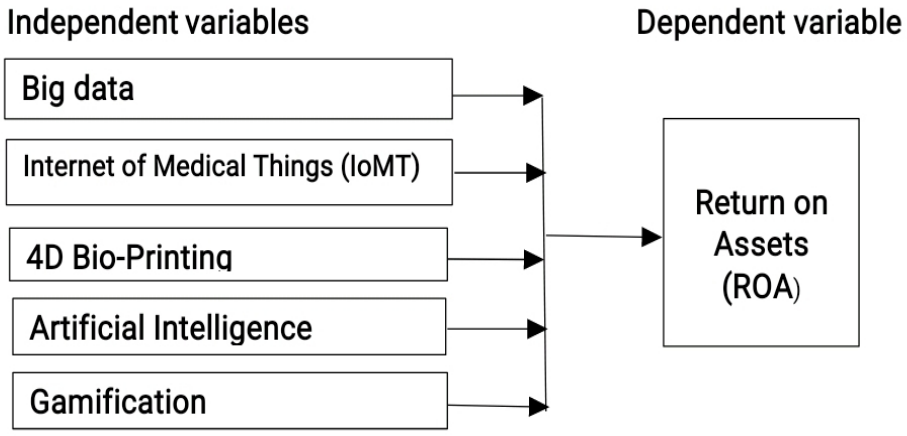

Figure 1. Conceptual framework of disruptive technologies an financial performance

3.0 Methodology

The descriptive research design was adopted in this study. This design was used to ascertain the relationship between Big Data Analytics, Internet of Medical Things (IoMT), 4D Bio-Printing, Artificial Intelligence, Gamification and financial performance of pharmaceutical companies. The target population were the professionals and technical workers of GlaxoSmithKline (GSK) Nigeria, Plc. and May & Baker, Nigeria Plc. (MAYBAKER). These companies were selected because they are the leading manufacturing pharmaceutical companies registered on the Nigerian Stock Exchange. Questionnaire on a 5-point scale was used as the research instrument to measure responses. The study sample consisted of 150 respondents drawn from the pharmaceutical companies. The data collected were analysed using the multiple linear regression statistical technique. To test the hypotheses as regards the effect of disruptive technologies (Big data analytics (BDA), Internet of Medical Things (IoMT), 4D Bio-Printing (4DBP), Artificial Intelligence (AI), Gamification (GAM) on the financial performance (Returns on Assets (ROA) of the pharmaceutical companies, the regression model was adopted:

ROA = f (DISRUPTIVE TECHNOLOGIES)
ROA = f (BDA + IoMT + 4DBP + AI + GAM)
$ROA = b_0+b_1BDA +b_2IoMT + b_34DBP + b_4AI +b_5GAM+ \mu$
Where:

RoA = Returns on Assets
BDA = Big Data Analytics
IoMT = Internet of Medical Things

4DBP = 4D Bio-Printing
AI = Artificial Intelligence
GAM = Gamification
μ = Error term.
b_o = Regression intercept.
b_1, b_2, b_3, b_4 & b_5 = Regression coefficients

4.0 Results and discussion of findings

Table 1: Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.550[a]	.303	.035	.35212	2.155

a. Predictors: (Constant), GAM, AI, BDA, DBP, IoMT
b. Dependent Variable: ROA

The model summary in Table 1 indicates that r is .550, meaning that there is a positive and an averagely significant relationship between disruptive technologies and financial performance of pharmaceutical companies. The R-Square of 0.303 implies that the independent variables can explain 30% of the variations in the dependent variable. In other words, BDA, IoMT, 4DBP, AI, GAM can predict and control up to 30% of the outcomes of Returns on Assets (ROA) of the pharmaceutical companies. The variation shows a less than average indication in the potency of the Returns on Assets to be influenced by the selected disruptive technological factors. In addition, the table revealed a Durbin-Watson result of 2.155 which is approximately 2 (the standard level of acceptance for the score). This implies that serial autocorrelation is absent in the independent variables.

Table 2: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.543	5	.309	2.523	.032[b]
	Residual	17.611	144	.122		
	Total	19.153	149			

a. Dependent Variable: ROA
b. Predictors: (Constant), GAM, BDA, DBP, AI, IoMT

Table 2 presents the results of ANOVA which revealed the explanatory power of "Big data analytics, Internet of Medical Things, 4D Bio-Printing, Artificial Intelligence and Gamification on Returns on Assets. The F-ratio statistic has a p-value of 0.032 at 95% confidence level, showing that the model has a significant predictive power on returns on assets of the studied pharmaceutical companies. We therefore reject the null hypothesis which states that there is no significant influence of disruptive technologies on the Returns on Assets of pharmaceutical companies.

Table 3: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.189	.759		6.836	.000
	BDA	.213	.098	.179	2.169	.032
	IoMT	-.111	.069	-.134	-1.614	.109
	DBP	-.120	.065	-.148	-1.845	.037
	AI	.102	.086	.096	1.186	.238
	GAM	-.157	.091	-.140	-1.734	.045

a. Dependent Variable: ROA

4.1 Discussion of results

Table 3 presents the disaggregated results of the individual independent variable on the dependent, revealing the extent and degree of association and correlation. The result captures the empirical influence of disruptive technologies on the financial performance of pharmaceutical companies. The table presents the relationship between disruptive technologies, (Big data analytics (BDA), Internet of Medical Things (IoMT), 4D Bio-Printing (4DBP), Artificial Intelligence (AI), Gamification (GAM)) and financial performance (Returns on Assets (ROA)) of the pharmaceutical companies.

The estimated result on Big Data Analytics reveals that the coefficient of the effect of BDA on ROA is positive (β=0.213, P<0.05 at 0.032). This indicates that a unit increase in BDA will on the average leads to a 21.3% increase in financial performance of the pharmaceutical companies, meaning that there is a positive relationship between BDA and ROA; hence, the higher the investment in BDA, the higher the expected returns on asset and vice versa. The calculated P-value is (0. 032) < P (0.05), showing that BDA has a significant effect on (ROA). From the result therefore, BDA has a positive and significant influence on ROA. This result confirms the findings of Oti, Effiong, & Arzizeh, (2012). This result also agrees with the findings of Zakaria & Hanane (2020), which indicated that Big Data Analytics positively influence financial performance and market value. The findings of this study contributed to the empirical proof that big data analytics can help pharmaceutical companies improve their efficiency and viability in a variety of ways, because the technology allows them to better serve their customers and conduct businesses more successfully.

The estimated result on Internet of Medical Things reveals that the coefficient of IoMT on ROA is negative (β=-0.111, P>0.05 at 0.109). This indicates that a unit increase in IoMT will on the average leads to a 11.1% decrease in financial performance of the pharmaceutical companies; meaning that there is a negative relationship between IoMT and ROA. Hence, the higher the investment in IoMT, the lower the returns on asset and vice versa. This is an indication that pharmaceutical companies that invested in IoMT does not generate a meaningful financial returns on their initialling investments, as higher investment costs in IoMT lead to lower financial returns. The challenge could be that the companies might not have the required capacity and the required technical know-how to efficiently access and utilise IoMT infrastructures to derive the enormous benefits. The calculated P-value (0.109) > P (0.05), shows that IoMT has no significant influence on ROA. This result is at variance with the findings of Kelly, Campbell, Gong & Scuffham, (2020), on the implications of IoT on health care delivery. The

findings of their study revealed that IoT-based health care has a great potency to bring about improvement in the health sector. Additionally, the result differs from the conclusion of the Business Fortune Insight, (2020), which indicated that the global IoMT market is meant to rise due to the increase in awareness of technological advancements in IoMT devices, lifestyle changes and the launching of new products, based on sophisticated technologies.

The estimated result on 4D Bio-Printing reveals that the coefficient of 4DBP on ROA is negative (β= -0.120, P<0.05 at 0.037). This indicates that a unit increase in 4DBP, will on the average, leads to 12% decrease in financial performance of the pharmaceutical companies; meaning that there is a negative relationship between 4DBP and ROA. Hence, the higher the investment in 4DBP, the lower the returns on asset and vice versa. The calculated P-value (0. 037) < P (0.05); shows that 4DBP has a significant influence on ROA. From the result therefore, 4D Bio-Printing (4DBP) has a negative significant effect on ROA. The finding is compatible with the discovery of Hasan, Baten, Kamil & Parveen, (2010), who argued that technological innovations are intellectual properties and thus contribute significantly to banks' distribution channels. This result is corroborated by Effiong, (2010).

The estimated result on Artificial Intelligence reveals that the coefficient of AI on ROA is positive (β= 0.102, P>0.05 at 0.238). This indicates that a unit increase in AI will on the average leads to a 10.2% increase in financial performance of the pharmaceutical companies; meaning that there is a positive relationship between AI and ROA. Hence, the higher the investment in AI, the higher the returns on assets and vice versa. The calculated P-value (0. 238) > P (0.05), shows that though AI have a positive effect on ROA, the relationship is not significant. From the result therefore, Artificial Intelligence (AI) has a positive non-significant effect on ROA. This result is opposed to the findings of Benson, (2020), on the study of AI and the profitability level of banks in Nigeria. The findings revealed a significant positive relationship between ROA and AI internet banking services.

The estimated result Gamification reveals that the coefficient of GAM on ROA is negative (β= -0.157, P<0.05 at 0.045). This indicates that a unit increase in GAM will, on the average, leads to 15.7% decrease in financial performance of the pharmaceutical companies; meaning that there is a negative relationship between GAM and ROA. Hence, the higher the investment in GAM, the lower the level of returns on asset and vice versa. The calculated P-value (0. 045) < P (0.05), showing that GAM has a significant influence on ROA. From the result therefore, Gamification (GAM) has a negative but significant effect on ROA. This result is in tandem with the study of Stefanel & Goyal, (2018), who concluded that firms that successfully use gamification as a key tool to better understand their customers and create personalised solutions will increase their competitive advantage and profitability.

The F-statistic of the model reveals a result of 0.032, which indicates a significant predictive power of the disruptive technologies model in the determination of the financial fortunes of pharmaceutical companies. This implies that financial performance is not resistance to changes in technological innovations in the pharmaceutical companies, indicating that the advancement in the application of disruptive technological innovations will normally result in improved financial performance. This result supports Salim & Sulaiman, (2011), who studied the effect of organizational innovation on company performance. It was revealed from their findings that organizational innovation has a significant impact on firm's performance. The result of the study by Hatak, Kautonen, Fink & Kansikas, (2016), on the significant interplay between innovativeness and commitment and their effect on financial performance, is also in tandem with the findings of this study. Equally, the result of Muharam, Andria & Tosida, (2020), who studied the influence of disruptive technology in moderating the relationship between process and market innovation and the financial performance of Indonesian pharmaceutical companies,

revealed that disruptive technology moderates the relationship between process innovation and financial performance, but has no significant relationship with market innovation and financial performance.

5.0 Conclusion and recommendations

The findings of the study revealed that Big Data Analytics, 4D Bio-Printing and Gamification have significant influence on financial performance, while Internet of Medical Things and Artificial Intelligence have no significant influence on financial performance. Big Data Analytics has positive relationship with financial performance, which indicates that higher investments in this technological innovation leads to higher returns on asset of the company. The relationship between 4D Bio-Printing and Gamification with financial performance is negative, indicating that higher investments in these technological innovations lower the financial performance of the company. This relationship can however be short termed, as it could be as a result of initial investment costs. In the long run, the investment could yield some returns leading to higher profitability. Progression in the rate of diseases, sickness, and death are major unsolved challenges driving the companies in the drug manufacturing industry to revamp the industry by developing innovative curative medications through technological innovations. Improvement in R&D discoveries, drug development and productions including technologically driven sales and marketing enhance a more efficient and viable pharmaceutical procedures, for better pharmaceutical products and services, all things being as expected. The result of the general model of this study revealed that disruptive technologies significantly affect the financial performance of pharmaceutical companies; meaning the higher the investments in disruptive technological innovations the higher the financial success of the companies. This study concludes that disruptive technologies are capable of influencing the financial outcomes and the financial numbers of pharmaceutical companies.

Consequent from the findings and conclusion of the study, the following recommendations are advanced: The financial success of any technological innovation depends on the powerful connection between creative ideas, processes and products, vis-a-vis the social framework of their relevance. It is therefore recommended that the pharmaceutical companies should embrace technological innovations to drive Research and Developments (R&D), and other pharmaceutical procedures; Companies in the pharmaceutical industry must design effective adoption and execution strategies to tap from the enormous financial benefits embedded in disruptive technological innovations. They must plan for the necessary infrastructure and connection with enterprise systems. Companies must anticipate these issues and devise a thorough strategy to handle them; Pharmaceutical companies should aspire to become business leaders in the pharmaceutical world by investing in new disruptive innovations to compete successfully, rise and advance in the digital wave while saving massive financial resources and time; Collaborations and viable networks formation which are lacking currently among companies in the pharmaceutical industry is necessary and vital to harness collaborative funding amongst the partners. The collaborations should also extend to the tech companies to create technologies that can discover, monitor and proffer innovative solutions to the various chronic diseases and ailments.

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