**Research Title**

"Bio-innovation and Business Development; Sustainable Competitive Advantage in the Pharmaceutical Industry"

**National College of Ireland**

**Project Submission Sheet**

**Student Name:** EMİNE BUSRA DAG

**Student ID:** 221347119

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**Lecturer:** Thomas McCabe

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**Abstract**

**Aim:** The research aims to analyze how bio-innovation can help the pharmaceutical industry sustain its competitive advantage while considering the integration of sustainable business models and changes in consumer preferences that will have an impact on innovation and ethics.

**Method:** This research was conducted using primary quantitative data obtained through a structured survey questionnaire given to 138 respondents. The questionnaire had demographic, targeted questions in context with medication usage, preference towards innovation, and perception towards sustainability in the pharmaceutical sector. The collected data was analyzed for trends, preferences, and potential strategies to be taken up by pharmaceutical companies for an increase in competitive positioning via bio-innovation and sustainable practices.

**Findings:** Existence of strong consumer demand for effective and innovative products; the R&D area is the most important one to invest in if a company wants to be competitive. While brand trust and sustainability ranked, environmental and ethical considerations were lower in the hierarchy of what is valued. While brand trust and sustainability ranked, environmental and ethical considerations were lower in this hierarchy of values. According to the results, bio-innovation provides an important contribution to gaining and maintaining market leadership in the development of new products. In addition, the green or eco-friendly connotations associated with bio-innovation may significantly improve the reputation of corporations and consumer trust again, providing a ground for long-term success in the drug industry.

**Keywords**: Bio-innovation, sustainability, competitive advantage, pharmaceutical industry

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## Chapter 1: Introduction

The pharmaceutical industry represents the transformative period driven by the rapid development of biotechnology and its sustainability. The bio-innovation represents the application of biological knowledge and techniques that help to develop new products and processes in the form of critical component transformation (Torres and Gómez, 2023). In this context, the research will analyze the challenges of bio-innovation-based business practices to explore new effective strategies and business practices. Further, to identify this, the research will focus on identifying the role of bio-innovation in the pharmaceutical industry in developing new strategies for integrating sustainable business models that help to enhance the competitive advantages. Also, the research will focus on the role of bio-innovation and sustainable business models in the pharmaceutical industry to stay sustainable. Thus, it will also seek to identify how bio innovation can be leveraged to achieve sustainable growth by following environmental and sustainability principles.

### Background

The market dynamics and growing competition represent some of the main features of modern economics, so some resources, such as human capital and knowledge, are emergent. However, as per Milanesi et al. (2020), investing in innovation in pharmaceutical companies can provide multiple advantages and disadvantages, as the key drivers of the business problems are accepting and adapting to the changes in the environment and overall business activities. The innovation represents achieving the advancement in healthcare as well as in the other domains for the future farm equitable industry. Further, it is also analyzed that some of the perceptions that the research and development department in the pharmaceutical industry no longer represents the innovation of products in the market, and which replied with the higher number of similar products with the same effect but without any significant progress. This process will enhance new product development and increase the cost yearly. Further, Jiang (2021) identified the market strategies and competitive advantages extensively while using models such as Porter's five forces, BCG matrix, 4P's of marketing and McKinsey's 7S. These models focus on taking competitive advantages from the business, operations/ organizational structures, industry and consumer relationships. However, SMC believes that no models can help to explain the details of any scenarios in which a drug can take a significant market share from other drugs for the same reasons. Critical industry research and innovation represent the component under the growth sectors by

developing new treatments and medicines that help diseases and improve the individual's quality of life. However, Laermann-Nguyen and Backfisch (2021) identified that the pharmaceutical sector represents various challenges that require focusing on research innovations using strategic methods to maintain long-term success. The poor success rate represents the regularity of new drugs and pharmaceuticals clearance takes time. The environment of government for pricing and reimbursement is used to maintain profitability. On the other hand, the companies are doing research and science drives and meet to handle these problems. But then, outsourcing research and efforts require resources, which is difficult because of the knowledge transfer restrictions and cultural disparity.

Innovation wireless represents scientific information based on cutting-edge technology and various kind of tactics that help to enhance innovation capabilities. As per Haleem et al. (2022), clinical development phase wireless restricted and consumer demand loops are the backbone of this science-driven organization. The pharmaceutical business continues to be an under-studied field to maintain the correlation between innovation and environmental sustainability. In the research context, Lorenzini (2018) identified that waste management is key in many other sectors and represents wide area-based issues. The primary concerns are with how expired pharmaceuticals are packaged and disposed of. Trash management is also waste management, an environmental issue with consequences for the economy and social sustainability. To solve this challenging problem, waste management strategies in this dynamic and intensely competitive factor must be examined. However, Yiyun (2017) stated that if the pharmaceutical industry is to keep innovating, clinical trials must take place in a morally responsible manner. The intriguing procedure provides secure and efficient methods for establishing well-thought-out clinical trials that are based on high moral standards, patient safety, and integrity. The sector's long-term survival depends on maintaining clinical development standards since they increase stakeholder confidence and improve public health. In the industry, ethical considerations are required to guarantee the safety of clinical trial laws. Research and innovation constitute the significant expansion of the pharmaceutical sector because of patient-centred research and development addressing the ethical committee and infrastructure to improve the long-term profitability of the pharmaceutical business (OLUYEDUN, 2022). Bio innovation represents scientific progress and the strategic imperative because of the sustainable competitive advantage in the pharmaceutical industry. Using the biotechnology power and personalized medicine companies can help develop different products,

streamlining the research and development procedure and expanding in the new market. The effective bio innovation integration in the business development strategies using the partnership investment represents the crucial way to maintain the competitive edge for expanding the potential of bio innovation and driving sustainable growth in the pharmaceutical sector.

**Problem Domain**

Biotechnology is a fast-growing industry that deals with the technical applications of organisms and living systems to produce products for healthcare, agriculture, environment, food processing and processing. Additionally De Buck et al. (2016), despite the significant advancement in the global industry of biotechnology, Indian industrial biotechnology represents slower growth in comparison because the current state of Indian industrial biotechnology faces growth barriers and proposes strategies for enhancing its global competitiveness in the industry. The pharmaceutical industry represents the various problems categorized in the research and development cost, competition regulatory requirements and the increasing demand for innovative therapies. Traditional drug development approaches widely represent the less viable due to the long duration, high failure rates and cost. Similarly, complex diseases have high treatments of individual patient profiles that meet the growth expectations for more effective and safer therapies. This environment is required to shift bio innovation because it leverages the advancement of biotechnology genomics and various medicines. However, integrating these cutting as technology in the business models represents a set of challenges, including significant investment property issues and strategic collaboration formatting (Fabris et al., 2020). These issues are critical for pharmaceutical companies aiming to achieve a sustainable and competitive advantage to meet the health care needs {2}.

**Research Aim**

This research aims to identify the role of bio-innovation and the pharmaceutical industry, identify the sustainable business models that relate to it, and determine how they help create sustainability in the pharmaceutical industry.

**Research Objectives**

- To describe the role of bio-innovation in the pharmaceutical industry.

- To identify the sustainable business models and their integration with bio-innovation practices.
- To analyze how the bio-innovation can sustain the competitive advantage in the pharmaceutical industry.
- To explore the application of environmental and social sustainability in the pharmaceutical industry.

**Research Questions**

- What is the role of bio-innovation in the pharmaceutical industry?
- How the sustainable business models integrated with bio-innovation practices?
- How does the bio-innovation create and sustain the competitive advantages?
- What are the applications of environmental and social sustainability in the pharmaceutical industry?

**Research significance**

The research here is essential for various reasons because it helps address the pharmaceutical industry's crucial requirements to use bio innovation for sustainable competitive advantage. Through examining the role of bio-innovation and sustainable business models, the study will provide insights for enhancing the operational efficiency production innovation cycle by reducing costs. Further, it helps to provide the discussion based upon the social sustainability practices and environmental operations to understand the global goals of the industry practices. The study will help to home the research for effective strategic decision-making procedures within the companies to guide that sustainability and the silence in the business practices help to provide the regulatory landscape and competitive pressure. The research will include advancing environmental and social sustainable practices for the pharmaceutical industry. The ethical consideration and sustainability development principles help provide the holistic approach to the farm equitable innovation that provides both the holder and society at a large scale. Therefore, the study's results help provide practical recommendations for industrial re-silence, ensuring long-term viability in the complex and interconnected global marketplace. Identifying and filling the gap between scientific and advanced business strategies can set the way for understanding the sustainable future pharmaceutical industry.

**Research Synopsis**

The research will aim to identify the competitive advantages of bio innovation in the pharmaceutical industry and find how the advantage can be made sustainable. To accomplish this, there are majorly five chapters that help to understand the research goal effectively. The first chapter, known as the Introduction, helps to provide the knowledge related to the reader's interest, overview, aim, objectives and problem behind the research. The second chapter, a literature review, helps define the analysis of published information and research gaps based on a particular area. Chapter 3, Methodology, helps accomplish the research based on principles and methods. This part will help explain what kind of resources the research is used to develop. The fourth chapter is the result and discussion which helps to objectively find the result and discussion based on a given context. The fifth chapter, known as a conclusion, helps provide the study results in a summary format. While it is not only explaining the result it will also help to provide the knowledge related to the importance of the research. Further, this part will help provide some recommendations for specific actions that could be taken based on research analysis.

## Chapter 2: Literature Review

### The scope of biotechnology in the pharmaceutical industry

The biotechnology sector in the pharmaceutical industry represents the exponential and transformative growth advancement of redefining drug development, therapeutics, and diagnostics. As per Lecture (2024), biological technology represents the cellular and biomolecular processes for developing the technology and products that help enhance the quality of life and Health. The traditional discovery of drug methods often involves the lengthy process of trying and identifying errors. On the other hand, Sarsaiya et al. (2019) stated that biotechnological approaches, including DNA technology, monoclonal antibodies, and CRISPR-cas9 gene editing, have streamlined and accelerated the development of new drugs. These technologies help to precisely target the disease at the molecular level, which helps to allow for the development of highly specific and effective therapies for some kinds of side effects. Furthermore, Crommelin et al. (2020), Biotechnology has represented the production of biopharmaceuticals, which include vaccines, gene therapeutics, and therapeutic proteins. For example, the mass production of insulin previously sourced from animals has been embedded using the tree combination DNA technology. In addition, advances in vaccine development represent the rapid growth of mRNA vaccines for COVID-19, a critical role of biotechnology in the global health crisis to manage it more swiftly and effectively. Biotechnology has enhanced the capability of diagnostic tools.

The technologies, including next-generation sequencing (NGS), polymerase chain reaction (PCR), and bioinformatics, allow for early and exact disease detection, genetic predispositions for certain conditions, and personalized medicines. These types of advancements in technology help to facilitate the treatment plan more efficiently for any individual genetic profile, enhance the therapeutic outcome and minimize adverse reactions (Pereira et al., 2017). The pathway of technology approaches helps to explore the usage of biocatalysis (enzymes) for cells to transform biomass into utility chemicals. These are considered the simplest and most convenient methods for formatting industrial products from biomass. On the other hand, Fatehi et al. (2021) stated that biological conversations are relatively mild, including high temperature-based chemical conversion and pressures. This concept is the newest currently, as various commercially used chemicals have long been produced from the bacteria, and they suggest citric acid, ethanol, lactic acid, and acetone butanol. The reasons behind less formation time for products, higher yields of

products, and biocatalysis selectivity have created a recent fascination. However, there are some limitations in the process of fermentation. The demand for novel processing techniques to widen the product scale is strong because of variations in the pathways of microorganisms that restrict product variety. Furthermore, Amann et al. (2019), explained Genetic engineering and recombinant DNA technology help alter the gene code and bring about the required changes in sugar metabolism.

Genetic engineering and bioengineering are two examples of contemporary biotechnological techniques that support the creation of novel microbial species and complex models that focus on enhanced biomass outputs, such as the capacity to consume CO2, perform biomedication, and accumulate lipids (Kataki et al., 2020). Integrating these kinds of disparate technology and computer engineering approaches is essential to achieving the circular economy of biomass-based valuable bioproducts such as APC and biofuels. However, several issues have been brought up about the efficient use of biomass, considering that the majority of biomass obtained from agriculture is burned due to a lack of expertise and access to modern equipment. This has applications in biotechnology, including genetic circuit testing, pharmaceutical trials, platform or validation environments, and metabolic pathway research. According to Chen (2024), some platforms, are biochemical, such as cell-free lysates or purified parts of cell-free systems, or biotechnological, as documented in E. Coli strains. Cell-based systems have historically been used for many different types of prototyping projects. The technological constraints of cell-free systems concerning scalability and processing time have generally given bee systems a major edge over them in the past when it comes to industrial application prototype platforms.

Conversely Brookwell et al. (2021), self-reliant systems in the last decade faced some kind of improvement, such as the engineering of high-yield CFPS systems that changed their paradigm. Further, biotechnology integration in pharmaceutical research has represented a collaborative environment between academia, regulatory bodies, and industry. This synergy helps to enhance innovation and confirm that new technological advancements are translated into safe and efficient clinical applications. Thus, the greatest scope of biology in the farming cuticle industry is represented by the use of and continuous expansion of nature. It relates to drug recovery and biopharmacological production development, which helps advance the diagnostic and personalized use of medicines using regenerative therapies. The ongoing advancement in

biotechnology helps to provide immense potential for addressing complex healthcare challenges, improving patient outcomes, and transforming the landscape of modern medicines. This field helps to evolve the container's pivotal role in shaping the future of healthcare and pharmaceutical innovations.

### 2.2 The Sustainable Business Models in the Practices of the Pharmaceutical Industry

As identified, the pharmaceutical industry is facing various kinds of issues that relate to sustainability in using the business models, the highly regulated environmental and clinical nature of its products, and the product development cycle. However, according to Godina et al. (2020), the adoption of sustainable practices is essential for the long-term viability of the industry, not only for that but also for its social and environmental impact. Sustainable business models in the pharmaceutical industry help to encompass environmental, social, and economic dimensions that aim to balance profitability with responsibility. Furthermore, Ncube et al. (2023) explained that pharmaceutical companies are increasingly focusing on environmental food reduction because it includes minimizing waste, reducing greenhouse gas emissions, and optimizing resources. Green chemistry is, for example, a way of using little or no hazardous substances and waste generation based on the manufacturing process essentially decreased by companies investigating this solution. For instance, Pfizer has rolled out a green chemistry program which is depleting the usage and disposal. In addition, the company is innovatively turning its mode to use renewable energy sources and processes to reduce its contribution to changing climatic conditions. Not only will this help satisfy requirements for regulations, but it also helps decrease costs and improve corporate image efficiencies (Veleva et al, 2018). They include the availability of basic drugs and open relationships with communities, which are often promoted in health equity. A range of initiatives is emerging around the world to provide different models for helping improve affordable access to medicines in low- and middle-income countries. For example, the medicines patent pool (MPP) is collaborating with pharmaceutical organizations for licenses for central drugs to make them more affordable and accessible (Juneja et al., 2017). Further, pharmaceutical organizations are investing in the local healthcare infrastructure and education to support the communities and enhance healthcare outcomes.

By addressing the determinants of social help, the industry helps to contribute to broader societal well-being and build a foundation for long-term success. As per Dane et al. (2024), In economics,

sustainability means creating business models that are financially viable while delivering long-term value to all stakeholders. This includes the innovative pricing strategy, research and development investment, and statistical partnership. Value-based pricing, where drug prices are linked to health outcomes, is an emerging trend. This kind of approach in pharmaceutical companies helps to align the interests of those patients and health care systems who are insured that new treatments are effective as well as affordable for the same duration. Moreover, Pereira et al. (2023), research and development-based continuous improvement is a means of sustaining innovation and addressing those medical requirements. Collaborations with biotech firms, academic institutions, and non-profit organizations, with the help of strategic partnerships, are enhancing their innovation in the development of new therapies and reducing costs. Leading companies are adopting integrative approaches to sustain their core business strategies. This includes including the sustainability goals, regularly measuring and identifying the processes, and accountability at all levels of the organization. For example, Novartis has integrated sustainability into its corporate strategy by committing to carbon nutrition, which helps enhance medicine and address global health challenges (Azarenkova et al., 2024). By aligning sustainability with business objectives, companies are driving innovation to reduce risk and create long-term value for shareholders and society. Therefore, various kinds of challenges occur during the implementation of sustainable business models, such as high costs, regulatory hurdles, and complex supply chains, which are equally substantial. Sustainability practices can lead to operation efficiency that enhances the brand reputation and develops a new market. The growing recognition among these investors and consumers of the importance of sustainability helps drive the demand for more responsible business practices. Sustainable business models in the financial industry are feasible and important for long-term success. By addressing the environmental, social, and economic dimensions, organizations reduce their impact and enhance societal health and insurance financial viability. Thus, there are two types of key approaches Innovation and Integration to handle the challenges and lead the situation to an equitable and sustainable industry.

**Sustainable Business model integration based on Bio-Innovations in the pharmaceutical industry**

For the pharmaceutical industry integration of bio innovation, the sustainable business model is a quintessential strategy, enabling improved environmental stewardship and economic resilience-

yet safeguarding social well-being. According to Diakosavvas and Frezal (2019), bio innovations, as a binding umbrella concept have an important role in the recent technological advancements of biotechnology, biobased manufacturing to green chemistry with transformative potential for developing more sustainable pharmaceutical practices. This helps in reducing the environmental pressures which further enhances sustainability within the industry specifically due to bio innovations. For instance, the green chemistry principle promotes a sustainability drug synthesis process that produces less hazardous waste and reduces energy consumption. Further, Veleva and Bodkin (2018) elements out the boons for adding biotechnological advances in reducing truck production based on non-renewable biological resources. Companies like Amgen that advocate for more environmentally friendly production methods contribute to the biological process that makes biologics with reduced environmental effects. Moreover, bio-based manufacturing technologies improve waste management practices and the biodegradability of pharmaceutical goods (Diakosavvas and Frezal, 2019). Social sustainability is addressed by incorporating bio innovation into the sustainable business model, which promotes health equity and easier access to life-saving drugs. Biotechnology advances health equity by improving and facilitating access to life-saving medications. Personalized medicine, insurance, and treatment plans that are tailored to the unique requirements of the patient are made possible by biotechnology, which improves therapeutic outcomes and reduces medical costs. Bio innovation facilitates the production of vaccines and treatments for infectious diseases on a large scale, which are essential for global Health. Moreover, Kennedy (2018) identified that to make advanced therapy more accessible and affordable, the industry helps to provide population and contribute to the global Health of equity. Economic sustainability is enhanced by bio innovation in terms of cost-effectiveness, efficiency, and market expansion. The biotechnology advancement helps to reduce the cause and the time for particular drug development for the quicker and the most effective introduction of the new therapy on the market. For example, Bajaj et al. (2020), using CRISPR technology for gene editing helps to develop the research and development process, which helps to provide faster therapeutic discovery. In addition, sustainable bio innovation helps open a new market for opportunities in the fields of regenerative medicine and pharmaceuticals, which drives economic growth and competitiveness.

The strategic collaboration between biotech start-ups, academic institutions, and pharmaceutical companies promotes innovation and reduces research and development costs, which helps to

represent the culture for sustainable development. As per Vostriakova et al. (2023), to understand the benefits of integrating bio innovations with sustainable business models, pharmaceutical companies must adopt a holistic approach. This includes setting clear sustainability goals, postering the culture for improvement and continuous innovation, and investing in cutting-edge research. Companies such as Novelties are leading the way by incorporating sustainability into their corporate strategy, which helps to set the ambition targeted for carbon neutrality and invest in innovative bio-innovation solutions. Additionally, Anttila (2023), Companies such as Novoties are leading the way in embedding sustainability into their corporate strategy, setting ambitious targets for carbon neutrality, and investing in innovative biotech solutions to meet the goals. Innovative production strategies are driving the fourth technological revolution in biomanufacturing. Already, the sector is being impacted by new technologies such as metabolic engineering, regenerative medicine, and synthetic biology. Furthermore, Das Gupta et al. (2024) report that some businesses are driving technology reevaluation. Among these companies is LenioBio, a biotechnology firm that helps create ALiCE®, a scalable platform for cell-free eukaryotic expression intended to optimize the synthesis of technical and therapeutic proteins. With the CFPS platform developed by SwiftScale Biologics, a biotechnology company, g/L protein titers can be produced in a single day. A biotechnology firm helps to give CFPS services for proteins delivered from prokaryotic, eukaryotic, and viral hosts, while Kykeon Biotech is a start-up that helps to provide affordable and scalable cell-free production of customizable proteins and cell-free research. The biomanufacturing industry has a $200 billion market value, and before 2025, next-generation manufacturing of products, which includes biopharmaceuticals, is predicted to rise by 8%. There are prospects for the switch to cell-free platform production due to the anticipated development in the value of the bio-innovation manufacturing sector (Brookwell et al., 2021). Integrating bio innovations with the sustainable business model helps represent transformative opportunities for the pharmaceutical industry. By providing technological advancements in biotechnology and green chemistry, companies are reducing the environmental impact and enhancing social equity to ensure economic viability. This kind of holistic approach addresses not only the current challenges but also the industry's long-term success and resilience in the rapidly evolving global landscape.

**Sustainable and Creative Competitive Advantages Through Bio-Innovation in the Pharmaceutical Industry**

The pharmaceutical industry faces various opportunities and challenges while adopting a sustainable business model. As per Ahlnäs and Garcia (2023), traditionally, this sector has been criticized for its environmental impact, from resource-intensive manufacturing processes to extensive packaging waste. On the other hand, one of the key aspects related to the sustainable business model in pharmaceutical industries is reducing the environment for the manufacturing process. The companies are increasingly investing in green technology and renewable strategies to power their operations. This includes optimizing the manufacturing process to minimize waste generation and energy consumption and identifying other alternative biodegradable package materials. The biotechnology industry is evolving with rapid growth in terms of production processes. As per Massabni and da Silva (2019), Artificial intelligence (AI) in biotechnology manufacturing has significantly increased efficiency, accuracy, and creativity. AI technology is used in various toys, from raw material procedures to process optimization, quality control, and supply chain management. Predictive maintenance and real-time mentoring while improving workflow management and product quality. At the same time, machine learning helps to optimize the algorithm of bioprocessing parameters.

The synergy between biotechnology and AI not only stores operational reliability and cost efficiency but also accelerates research and development, leading to sustainable, customized, innovative, and healthcare solutions. Sustainability is another critical area while focusing on the supply chain (da Silva, 2024). The pharmaceutical industry is working to confirm that its supply chain is ethically and environmentally responsible, which includes sourcing rotators from suppliers to adhere to sustainability, which includes the sourcing of raw materials from suppliers to other sustainable practices as well as promoting fair labour standards with the help of the supply chain. Moreover, Milanesi et al. (2020), sustainable business modelling in the pharmaceutical industry helps to extend product life cycle management. This includes products that are not only effective but safe, with minimal environmental impact throughout their life cycle. It includes using hazardous materials for drug formulation, optimizing dosage to minimize waste, and implementing take-back programs for unused medicines.

Furthermore, Dzau et al. (2017) state that pharmaceutical businesses' environmental sustainability is impacted by their social sustainability. The aforementioned initiatives encompass enhancing healthcare accessibility for underserved communities, funding research and development for diseases that disproportionately affect developing nations, and improving research and development for health care delivery. As per the analysis, due to the long duration of the process, it can result in high-cost savings and operational efficiency when developing sustainable business strategies. Using waste energy and raw materials in business more efficiently can reduce production costs and enhance the organization's profitability (Caldera et al., 2017). In addition, implementation includes the company's conscious clients and investors. Thus, the corporate strategies, while increasingly including environmental and social considerations in the pharmaceutical industry, are having difficulties implementing sustainable business models in the use of sustainability in the pharmaceutical industry, which has impacted the environmental and long-term advantages for the stakeholders and investors. This helps to advance the effort to make the future more sustainable and efficient.

**Sustainability of society and the environment in the pharmaceutical industry**

In the current world, the agricultural industry is becoming more conscious of social sustainability and environmental issues because it realizes its role in promoting global health and reducing environmental impact. Based on these projects, funding for a large range of initiatives is based on the aim of impacting the environment. According to De Soete et al. (2017), social sustainability, while becoming a critical face to addressing the disparities, helps ensure that people are accessing the essentials. The farmer cuticle industry is aggressively developing partnerships with international health organizations, non-profits, and government organizations to enhance life-saving drugs. For instance, the usage of the medicine index in organizations is based upon their efforts to enhance the access of low and middle-income countries, which helps encourage them in the industry to enhance and prioritize accessibility and affordability. In terms of recycling, laminated cardboard is another crucial sustainable product for pharmaceutical packaging. However, as per Klemenčić et al. (2023), it helps reduce the recycling paper quality due to the sticky particles affecting the optical properties.

The pharmaceutical industry is becoming increasingly conscious of social sustainability and environmental issues as it realizes its part in promoting global health and reducing environmental

impact. These projects provide funding for a larger range of initiatives aimed at improving public health outcomes, promoting fair access to medications, and lessening the impact on the environment. According to De Soete et al. (2017), the social sustainability of the pharmaceutical business is critical because it addresses health disparities by ensuring that people have access to essential pharmaceuticals. The pharmaceutical industry is aggressively developing partnerships with international health organizations, governments, and non-profits in an attempt to expand access to life-saving drugs. For example, the axis of medicine index ranks companies based on their efforts to enhance the axis of low and middle-income countries, encouraging the industry to enhance and prioritize affordability and accessibility. This is another crucial sustainability role in recycling laminated cardboard in pharmaceutical packaging. However, as per Klemenčić et al. (2023), it is reducing recycled paper quality due to sticky particles affecting the optical properties. This helps to improve the production stages using methods like INGEDE 11 deinking, which helps to enhance the quality of recycled paper. Adopting the circular economy principle and designing recyclable packaging helps mitigate these issues. Optimizing the adhesive and material that is laminated will improve recycling efficiency and sustainability while helping the pharmaceutical industry maintain a high packaging standard while reducing its environmental impact. Further, Amri and Sihotang (2023) stated that social sustainability helps extend community engagement and workforce diversity. The companies are investing in the local healthcare infrastructure, such as training programs and cleaning for healthcare workers in the particularly underserved regions. This activity not only enhances local health outcomes but also helps improve the healthcare system. On the other hand, divorce and an inclusive workforce are essential for addressing divorce patient needs and innovation. Organizations such as Johnson & Johnson and Merck have implemented a comprehensive diversity and inclusion program to promote ethical diversity, race and gender within the organization. Environmental sustainability in the critical industry is primarily focused on reducing the environmental impact of production processes and product life cycle management. A significant area of focus is the adoption of green chemistry practices, which aim to design the chemical product and process it to reduce or eliminate the use of hazardous substances.

Further, Rogers and Jensen (2019) stated that an organization such as GlaxoSmithKline (GSK) represents a substantial investment in green chemistry, which significantly reduces waste and energy consumption during the manufacturing of drugs. Another critical aspect is managing

pharmaceutical waste and emissions. The industry is noticing improvements in waste management practices, including the safe disposal of expired and unused medications, to prevent contamination of the environment. In addition, according to Eshkiki and Homayounfar (2024), various formal organizations are committing to reducing their carbon footprint. For example, AstraZeneca Health is completely ambitious to achieve the target of zero carbon emissions from its global operations by 2025 and ensure its entire value chain is carbon neutral by 2030. For leading pharmaceutical organizations, it is important to integrate sustainability into business strategies by setting the major goals of enhancing accountability and transparency. Novartis has enhanced the significance of sustainability in its corporate strategy by committing to accomplish environmental targets and goals such as attaining carbon neutrality and guaranteeing the accessibility of drugs. These organizations frequently publish sustainability reports that match their objectives with global norms like the Sustainable Development Goals (SDGs) of the United Nations. They provide progress reports. Sustainability in the social and environmental domains is essential to the formal cuticle industry's long-term operations and plans. Pharmaceutical companies can take environmental impact into account while simultaneously contributing significantly to global health by ensuring that drugs are accessible, promoting health equity, and endorsing eco-friendly initiatives. Businesses need to continuously integrate sustainability into their strategy to foresee new challenges and confirm their counterproductive effects on the environment and society.

**Opportunities and Difficulties for Bio-Innovation and Extended Commercial Development**

The pharmaceutical sector may undergo a significant transformation due to the healthcare revolution spearheaded by bio innovation. That trajectory is somewhat shaped by the possibilities and challenges encountered along the transformational journey. According to Pokataiev et al. (2023), one of the main barriers to bio innovation is the high risk and cost of research and development. New biopharmaceutical drug development involves large financial investments, lengthy clinical trials, and regulatory approvals. The inventor and the availability of required funds can determine that this strategy has a greater failure rate and is time-consuming. Strict regulations obstruct the entry of new products into the market by ensuring the efficacy and safety of innovation. Intellectual property (IP) concerns are the primary obstacles. The complicated web of patents, IT addresses, and rights can take years to sift out through court cases, cooperative efforts, and relentless innovation. Some of the challenges in implementing bio innovation in the

pharmaceutical industry can be explained by the opportunities and barriers to long-term commercial success (Dutfield, 2017). Two of the difficulties are the price of R&D and legal constraints. To support environmental growth, technological innovation and sustainable behaviours are needed. These obstacles and opportunities are often made more pronounced by the growing need for sustainable healthcare solutions and cooperative efforts among stakeholders. As per Antikainen (2017), the sector's transition towards sustainable environmental practices is crucial for the growth of long-term global health impacts. Another essential obstacle to integrating sustainable practices in the bio-innovation framework is the focus on profit maximization and overlooking environmental and social impact. Implementing sustainable practices can require a paradigm shift in compassion, sustainable sourcing of raw materials, reducing carbon footprints, and minimizing waste. Below in Figure 1, the new technological paradigm and consequential problems help to evolve the technology and accumulate it for the advancement of technical knowledge and to generate the learning processes as a paradigm to shift the need for efficiency (Coccia, 2017).

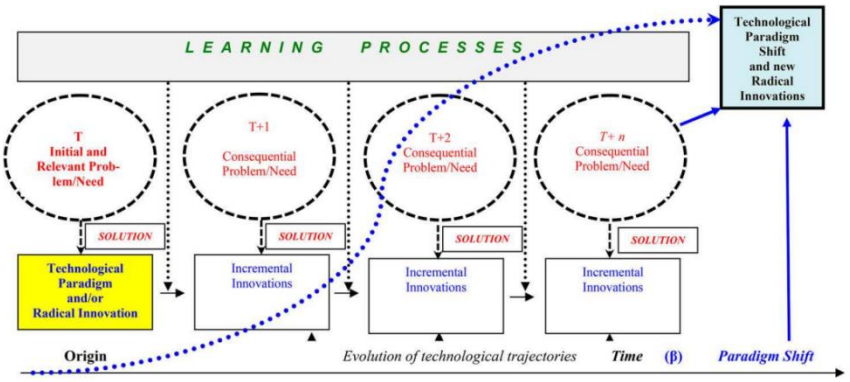


Figure 1: Problem-driven solution for supporting the technological development and competitive advantages

(Source: Coccia, 2017)

These demands of transition are substantial for the investment and change in the corporate culture, which is leading to immediate financial returns. Be challenged while proposing bio innovation and sustainable commercial growth for the environment. The increasing awareness and demand for sustainable healthcare solutions help to provide a fragile ground for innovation. Furthermore, Tiwari et al. (2023), technological advancements such as AI and ML (artificial intelligence and

machine learning) are revolutionizing the research and development process to make it more efficient and cost-effective. These technologies help predict the potential drug candidate, streamline clinical trials, optimize supply chains, reduce costs, and accelerate the time to market. The collaborative efforts between academia and government can play a crucial role in overcoming these obstacles. The public-private partnership while camp pools the resources, drives innovation, and shares risk. The government can support the ecosystem by providing tax incentives, grants, and favourable regulations for creating an environment for sustainable bioination. On the other hand, Adewole (2022) explained that the growing consumer demand for ethically enhanced and environmentally friendly products helps push the industry towards a sustainable environment. Organizations that help to embrace sustainable practices are looking for brand repetition to enhance the game and competitive advantage and tap into the market segment for their brand. Swift's sustainability is not a moral imperative but a strategic business decision for driving the organization's long-term growth. Deadpool theory says innovation has to face challenges and prospects for sustainable commercial growth to brighten itself. By leaving the technological advancement and embracing sustainability practices, fostering collaboration in the family industry can lead to overcoming these challenges and achieving a transformative impact on global health care.

## Chapter 3: Research Methodology

### Introduction

The research methodology chapter represents a researcher's systematic approach to investigate how and why the study is essential. Using this approach the research study focused on the Bio-innovation and Business Development: sustainable competitive advantage in the pharmaceutical industry. This chapter describes the systematic approach research on how bio innovation can poster sustainable competitive advantage with the Pharmaceutical industry. This chapter helps provide the knowledge related to the research design, philosophy, approach, data collection and analysis technique. A process map outlining the orderly and reliable manner in which research will be conducted is provided by the methodology. The utilization of the research technique in this chapter promotes transparency and replicability, which is essential for the validity and verification of the research findings. To understand how innovation and biotechnology contribute to the development of this long-term competitive edge, the methodology employed helps define the study's objectives and questions. Furthermore, this will help build the framework for ensuring the reliability and correctness of the study outputs and contribute to a pertinent conclusion for the corpus of research already carried out in the comic pharmaceutical industry.

A particular study topic's identification and analysis of relevant data are facilitated by the approach and process known as research methodology. Examining the outcomes of certain research-based goals and question-based tools is the purpose of this methodological procedure. Snyder (2019) asserts that it embodies the fundamental elements of the research, such as the research design, data collection and analysis procedures, and the overall framework utilized in the study. The study onion framework (figure 1) is typically employed in this research methodology. A multi-layered, systematic approach to conducting research is adopted with the help of the research onion framework. To address the research topic posed by the study, the researcher can select their theories and methods based on the layers already in place thanks to this highly flexible teamwork. This framework assists in creating and offering a logical study design, ensuring coherence among the tools, techniques, and philosophies. The researcher, who then bases the technique on those layers, often creates the six levels of the research onion structure. The research philosophy, approach, strategy, choice, time horizon, data collecting, and analysis are typically included as the layers. The model is versatile and applicable in a range of settings, which is beneficial to treating

patients with compassion and understanding as opposed to primarily depending on statistics. Each component's example is followed by an explanation of how and where the research methodology fits into the study.

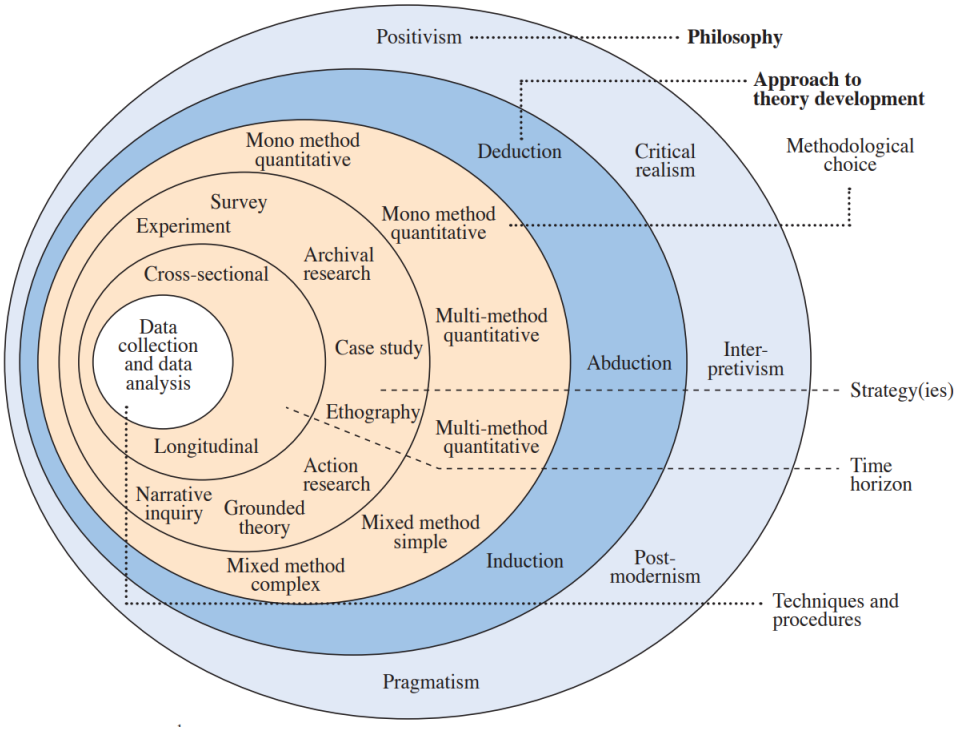


Figure 2: Layer of research onion framework

Source: (Melnikovas, 2018)

**Research Philosophy**

A researcher's methodology is shaped by a collection of presumptions, convictions, and regulations that inform their method for conducting research and developing their research philosophy. In addition, it contributes a worldview, logical stance, and epistemological sense, all of which influence the techniques and protocols of study design. A crucial component of the study approach is represented by each of the three categories: ontology, epistemology, and axiology. According to Al-Ababneh (2020), choosing and defending the best approach for a study is greatly influenced by the research philosophy. The four subcategories of research philosophy are positivism, realism, interpretivism, and pragmatism. Regarding the "Bio-innovation and Business Development; Sustainable Competitive Advantage in the Pharmaceutical Industry," study fits very well with a positivism research philosophy. It is what positivism believes that objectivity, quantification, and

application of scientific methods to understand and explain phenomena are feasible. The case entails the exploration of how bio-innovation brings sustainable competitive advantage in the pharmaceutical industry, grounded on empirical data, measurable outcomes, and evidence-based practices. By adopting this philosophy in the research, one relies on quantifiable data that has been collected using structured surveys for the objective assessment of the effect of bio-innovation on the development and competitive positioning of business ventures. As such, this philosophy corroborates the methodology to exploit statistical data analyses in the quest to find trends, correlations, and causal links so that results may be relevant, replicable, and generalizable. This approach concretizes the insights into how bio-innovation practices drive competitive advantage sustainably, hence guiding pharmaceutical companies in making informed data-driven decisions.

**Research Approach**

The research approach is a comprehensive strategy, or a sequence of actions, to conduct a study. It is helpful to review the procedures, methods, and techniques utilized in data collection and analysis. As per Zalaghi and Khazaei (2016) assert that there are two categories of research approaches: deductive and inductive. The deductive approach assesses the hypothesis in a study where the objectives are data analysis and rebuttal based on the hypothesis. When conducting quantitative research, the deductive approach is usually used to give a structured analysis, test the hypothesis, and produce predictions in response.

On the other hand, data analysis follows research questions when employing the inductive research approach. Facts or observations to broaden the scope and theories to conclude discernible patterns and well-known topics serve as the primary foundation for the inductive research methodology. This method is used in qualitative research to collect detailed data about phenomena using observational, interview, and survey methods. To learn more about the pharmaceutical business's competitive advantage, the inductive research approach uses a secondary data collection method to collect qualitative data. An inductive research approach is used to identify the important and multidimensional patterns, themes, and theories for topics related to bio innovation and its impact on business development. This study uses the inductive approach to generate new assumptions and data based on the information gathered from secondary sources. In the pharmaceutical sector, bio-innovation can also result in a long-term competitive advantage.

## Research Strategy

A research Strategy is a software structure that directs researchers to research according to their objectives. As Mahajan (2018) asserts, the research strategy offers unique techniques, strategies, and plans to remain focused on research challenges. The research onion model represents the research strategy as a third layer that gathers and separates pertinent data. However, the choice of research strategy is determined by the study type and the difficulties the user may encounter using methodological approaches. The research design offers several methods and approaches for the investigation, which aids in determining the research strategy. By separating some data collection and analysis techniques, the strategy aids in giving direction to the entire project. Various sections are used to group the research strategy, such as the survey, case study, action research, grounded theory, literature review, experiment, and archive research.

The questionnaire survey was administered to 138 respondents, including medicine users and professionals in the pharmaceutical sector. Questions were propounded to elicit information on perceptions toward sustainability, green chemistry, and the role that biotechnology could play in ensuring more environment-friendly drug development and production practices. Participants were chosen through random sampling, supplemented by targeted reaching-out activities, to obtain a representative sample. Close-ended questions were included in the survey so that a clear response analysis could be drawn from it. Such helped estimate the degree of importance of each sustainability practice and to further elaborate on opinions and experiences. Data collection was done via online platforms for effective and wide coverage. The importance of the survey lies in its capturing of the various points of view and experiences related to sustainability in the pharmaceutical sector. The data informs current trends, challenges, and opportunities that exist, thus informing industry practices and guiding future research (Mahajan, 2018). It is through such stakeholder opinions that this study can frame effective strategies toward the integration of biotechnology and sustainability for more environmentally friendly and socially responsible pharmaceutical practices.

## Research Choice

Research choice is the process of deciding which research design best addresses the objectives and research questions of the study. It involves considering several factors, such as the objectives, research questions, available resources, and characteristics of the study population. There exist

three primary categories of research choices: mixed choice, multiple choice, and mono choice. When employing the mono method, the research uses only one type of data, such as qualitative or quantitative. However, the mixed approach makes use of both qualitative and quantitative data. Compared to the mixed- and mono-methods, the multi-method is distinct. According to Reynolds and Cameron (2023), the multi-method includes the combination of the mono and mixing techniques. This study centres on mono-quantitative research options to provide thorough, rich information on the nuances of bio-innovation methodologies. Therefore, for mono research, the choice is to collect primary quantitative data utilizing a survey through a questionnaire collected from 138 participants. Quantitative data also allows comparison and benchmarking of different variables, therefore adding to the factorial understanding of industry practices in their totality. The statistical rigour ensures that the findings are generalizable and thus inform strategic decisions, policy formulations, and further research. This approach provides a very strong foundation for the assessment of the impact of sustainability and ethical practices within the pharmaceutical industry.

**Time Horizon**

The study's time horizon indicates how long it will take to complete the data collection and analysis process to address the research questions and objectives. In addition to influencing the research's methods, conclusions, and design, the temporal horizon represents the scope of the investigation. According to O'Laughlin et al. (2018), the two most popular types of time horizons are cross-sectional and longitudinal time horizons. Participants in a cross-sectional study walk at a specific moment in time, and the entire data sample collection process occurs at that same moment. This type of study helps to offer the phenomena at a particular time and allows researchers to evaluate the differences, trends, and relationships between the variables. The cross-sectional Time Horizon is typically utilized for analyzing the characteristics and behaviours of a specific historical period. Longitudinal Time Horizon research is the exact opposite of cross-sectional. For this form of research, numerous data sets are acquired over an extended length of time. The main quantitative research design to be chosen is a cross-sectional study since it allows data to be gathered from a broader sample at a particular time point. This design shows a picture of the current status and patterns in attitudinal, behavioural, or condition fluctuations related to sustainability and ethical practices in the pharmaceutical industry. It is efficient for assessing a relationship and patterns within data without having to be longitudinally traced. Therefore, the cross-sectional design is

practical because it can tap a wide range of perspectives and quickly identify prevalent trends or issues; it is, therefore, appropriate for determining current industry standards and consumer opinions within a relatively short period (O'Laughlin et al., 2018).

**Data collection and analysis**

To address particular problems, the data-collecting process entails gathering, organizing, and evaluating data from multiple sources. The process of gathering data is represented by the evaluation of the outcome. Data is information, and information is knowledge. Igwenagu (2016) asserts that knowledge is the ability to describe information technology in this digital age. Thus, several sources use the data collection process to identify research problems and questions, assess them to provide a precise response and predict trends and probability. Precise data-gathering processes facilitate precise decision-making in business and research integration. Finding the right data type, data source, and data analysis techniques are all part of the data collection process. Data collection for the investigation of the research is the most important and last stage in the process of providing the foundational research knowledge required to put the information together ethically. However, choosing the inclusion and exclusion criteria is one of the biggest challenges the researchers will face when gathering data. The results of the data analysis demonstrate the systematic process of obtaining data from credible sources following the study's objectives.

The primary and secondary data collection methods are typically the two types available to employed in research onion models to yield dependable results for the objectives of our study. The process of obtaining data through human-centred observations is the main focus of the primary data collection technique. New data obtained during the research process that has never been used by another researcher is generated in the Primary data collection method. This study relies on the collection of primary data, as it provides first-hand insights into perceptions held by participants about sustainability and ethical practices in the pharmaceutical sector. This will ensure that the information is more up-to-date and relevant, regarding attitudes, behaviours, and trends, which is very critical to understand the challenges and opportunities within the industry. The primary data offers another perspective compared to what can be derived from secondary sources, thereby improving the accuracy and specificity of the findings. This information first-hand is critical in shaping recommendations and strategies responding to pragmatic concerns and expectations,

hence securing more effective and effective solutions toward improved sustainability and ethics within the industry (Igwenagu, 2016).

The research data analysis technique represents the systematic and logical technique to describing the evaluation and interpretation of uncovered insights, trends and patterns. Data analysis works with words and numeric data to identify the quality research of images, symbols, descriptions and more (Kapur, 2018). Further, various kinds of research data analysis techniques are available for quantitative and qualitative analysis.

Quantitative data collection in this research involved the systematic gathering of numerical data based on structured questionnaires administered to the 138 participants. Closed-ended questions, Likert scales, and rating systems were used to elicit measurable and quantifiable information about the views of the participants about pharmaceutical industries, sustainability, and ethical considerations. The analysis is being carried out using the Excel method which makes it more prominent for the study to draw up graphs and images. It is important because of its ability to deliver objective, concrete insights concerning the focus areas of the study. With excel analysis, it is possible to quantify to what extent there is awareness, trust, or perceived importance related to sustainable and ethical practices in the pharmaceutical sector (Kapur, 2018). It holds up data-driven conclusions about industry trends and stakeholder opinions.

**Ethical Consideration**

The validity and authenticity of the study have a major impact on the success of the research. These ethics are guidelines for conducting the research in a particular way. The primary data study considers first the aspect of ethics in ensuring that the research being carried out is not just credible but also valid. Some important issues that relate to participants concern informed consent, voluntary participation, and confidentiality concerning their responses. The researcher should inform the participants of the purpose of the study and the use of the data obtained, protecting anonymity. In addition, ethical provisions enlighten the participants on aspects such as freedom from coercion or manipulation of any kind. Levelled against this, however, must be the need to retain data securely and pass it around only for research purposes. Accounting for these considerations assists in maintaining participants' trust and research credibility, leading to ethical research practices.

## Chapter 4: Result and findings

### Introduction

The analysis of the data collected views and preferences of the respondents about major aspects relevant to the pharmaceutical industry, such as medication use, investment priorities, and a set of factors driving SCAs. The analysis will have the view of those insights gleaned through the response to address the set objectives of the research, particularly on the role of bio-innovation in the industry. It would hence identify trends and new opportunities for pharmaceutical companies in the marketplace on how to enhance their competitive positioning through innovation and sustainability practices.

### Demographic questions

### Question 1

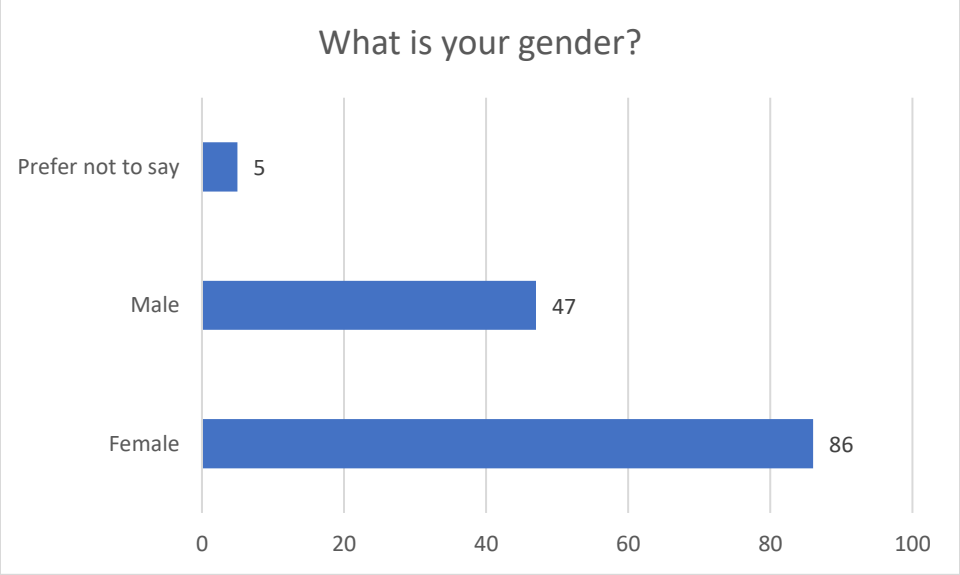


**Figure 3: What is your gender?**

Gender distribution, as captured in the table, has a total of 138 respondents: 86 females, 47 males, and 5 who prefer not to disclose their gender. Since this research sample has more female participants, it is relevant for gaining insights into perspectives on bio-innovation and sustainable competitive advantage for pharmaceutical companies. This demographic data was relevant to your research objectives in the sense that it gave insight into possible trends or differences between

males and females in terms of attitudes displayed toward bio-innovation and sustainability practices within the pharmaceutical sector. Specifically, how sustainable business models are integrated with the practices of bio-innovation and their impact on competitive advantage. Knowing these differences also helps in understanding which particular applications of environmental and social sustainability may be more attractive or more effective across different gender groups in the industry.

**Question 2**

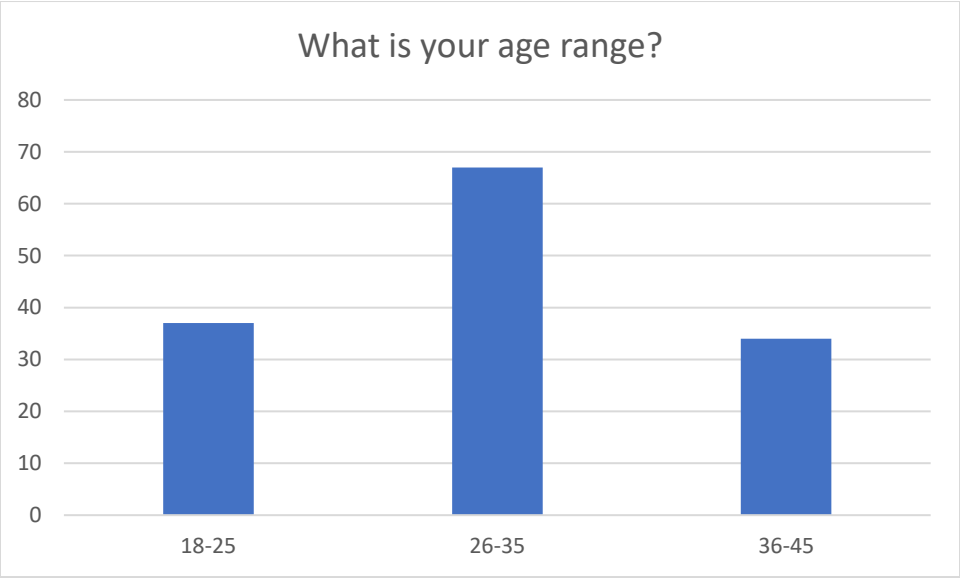


**Figure 4: What is your age range?**

The age distribution of the sample population adds up to a total of 138, further divided into three different age groups. The largest group belongs to the age category of 26-35 years, with 67 respondents; it is followed by 37 respondents in the age group of 18-25 years and 34 in the age group of 36-45 years.

This may mean that most of the respondents are at the beginning to mid-career stage, with a greater proportion within the age bracket 26-35 years, which might have implications for the way they think about bio-innovation and sustainable business models in the pharmaceutical sector. Being at this specific age, they will find it easier to comprehend the new trends in technology and sustainability that have only recently become prominent, hence likely driving the association of bio-innovation with business practice.

Knowing the age distribution is important in analyzing the role that bio-innovation plays in sustaining competitive advantage, as the views of younger professionals on innovation and sustainability might differ from those of their older counterparts. This may show age-related trends or preferences, a factor considered important in tailoring strategies in keeping with the values and expectations of the different age segments within the pharmaceutical sector.

**Question 3**

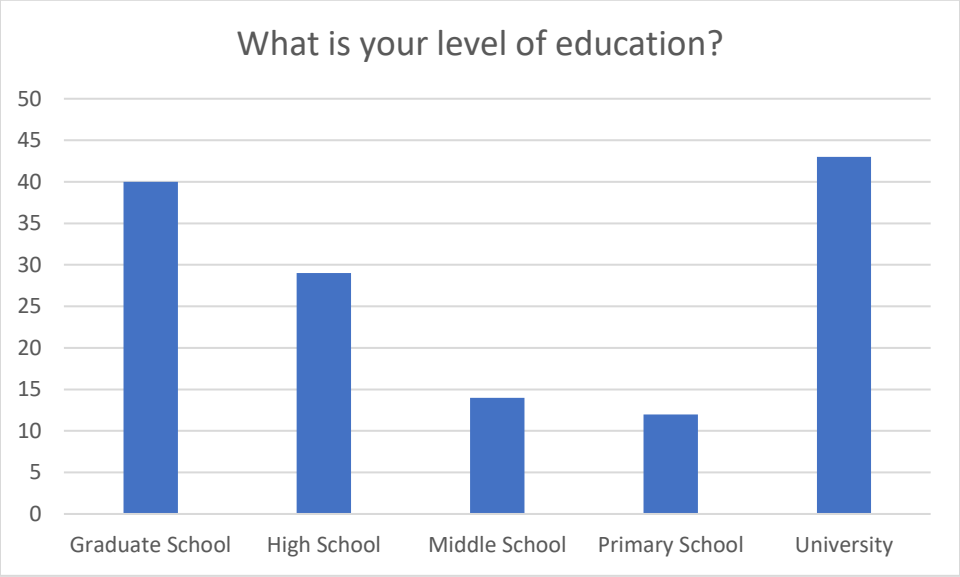


**Figure 5: What is your level of education?**

The educational level for your research sample has 138 respondents grouped into five educational levels. Most of them are university graduates and graduate school attendees totaling 40, so it is a highly educated sample group. This implies that probably a significant proportion of your respondents boasts of advanced knowledge and understanding of the subject matter at hand in this study, such as bio-innovation and sustainability in the pharmaceutical industry.

Moreover, 29 of them finished high school, 14 finished middle school, and 12 finished primary school. Such educational levels mentioned above give a wide range of different perspectives: from highly academically educated to more fundamentally educated subjects. In that respect, the fact that most respondents have university and graduate school levels of education may be particularly relevant for the analysis of bio-innovation and sustainable business model integration, as their grasp of the related science and business principles will likely be better. On the other side, lower

education level contributors add practical dimensions that help in explaining the applicability and effectiveness of those innovations in real-world scenarios.

**Subjective questions**

**Question 4**

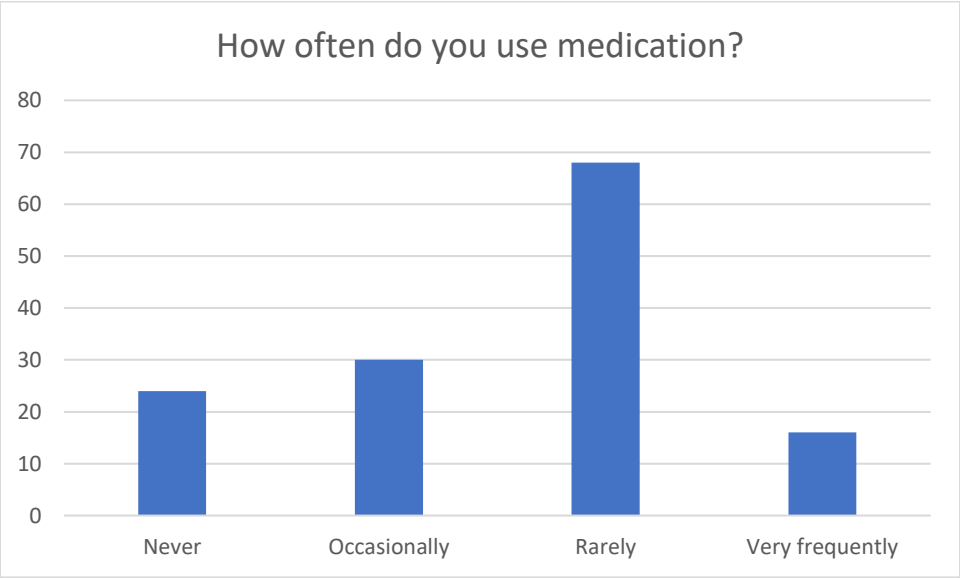


**Figure 6: How often do you use medication?**

The data on the use of medication among your respondents reveals that the majority only use them "rarely," while 30 use them "occasionally," 24 "never" use medication, and 16 use them "very frequently." This points to different levels of dependence upon pharmaceutical products, where most either use little or none at all.

This fact supports the first research objective which describes the role of bio-innovation in the pharmaceutical industry. If this datum were to be related to the first research objective, which is to describe the role of bio-innovation in the pharmaceutical industry, it would suggest that there is a window of opportunity for bio-innovative solutions to solve the heterogeneous needs of these consumer segments. When it comes to nonusers or those who occasionally use medications, bio-innovation could focus on either preventive health solutions or medicinal products with fewer side effects to entice regular use. On the other hand, this could also mean that bio-innovative developments translate to more effective treatments with better efficacy, hence reducing the frequency of use among frequent users.

**Question 5**

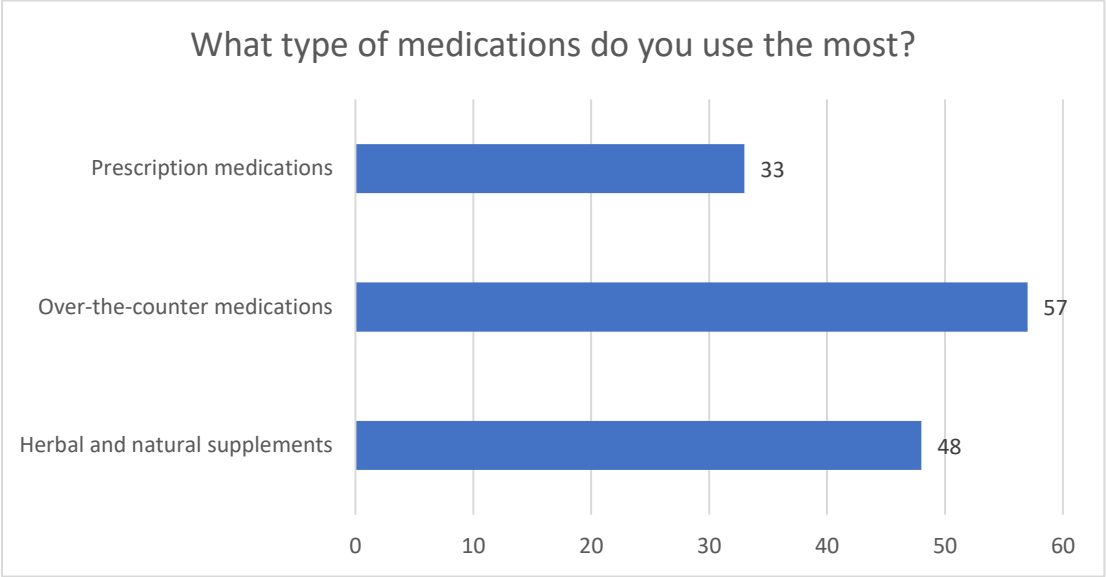


**Figure 7: What type of medications do you use the most?**

On the type of drugs that most respondents use to a greater extent, the data indicate OTC medications as the highest, followed by 57 responses. This is followed by herbal and natural supplements and then prescription drugs, which had 48 and 33 users, respectively. A very important interest among respondents for such a distribution is OTC medication and herbal supplements, which might be viewed as more accessible and closer to being a natural mode of health sustenance. The higher prevalence of herbal and natural supplement use highlights growth in consumer preference towards products with the perceived benefit of being safer or perhaps more sustainable.

Therefore, the data about the second research objective, which is identifying the sustainable business models and their integration with bio-innovation practices, would perhaps suggest to the pharmaceutical companies that it is important to develop bio-innovative sustainable practices in developing not merely OTC but also Herbal products. This means positioning the focus on developing an eco-friendly, natural-based solution that would lead to attraction towards consumers based on preference for sustainability, but then ensuring the products developed have the same level of efficacy as traditional medication.

**Question 6**

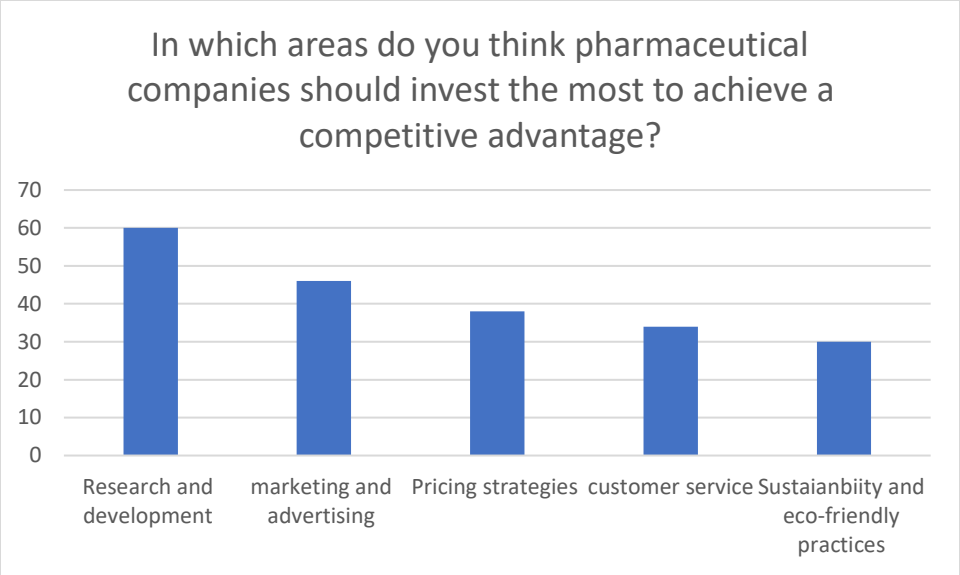


**Figure 8: In which areas do you think pharmaceutical companies should invest the most to achieve a competitive advantage?**

These data show that of the respondents, 60 consider that pharmaceutical companies should invest most in research and development (R&D) if they are to achieve a competitive advantage, 46 consider that time should be focused on marketing and advertising, 38 on pricing strategies, and 34 on customer service. This is related to the third objective which focuses on analysing how bio-innovation can sustain a competitive advantage in the pharmaceuticals industry. It turned out that there is a very strong preference for R&D investment. Dealing with the development of new biological products and processes that can address unmet medical needs or improve existing treatments, is intrinsically linked to R&D. This would mean that with such a strong preference towards R&D, leading-edge bio-innovative products could be introduced by pharmaceutical companies, securing a sustainable competitive advantage in the market.

Effective marketing and advertisement are also potent ways of very strongly supporting bio-innovation by explaining to consumers and health caregivers the key differentiation of new products. Investment in these areas, coupled with strategic pricing and good customer service, will ensure that products of this bio-innovative kind find their way not only to the market but to the hands of consumers, hence truly supporting a competitive company position.

**Question 7**

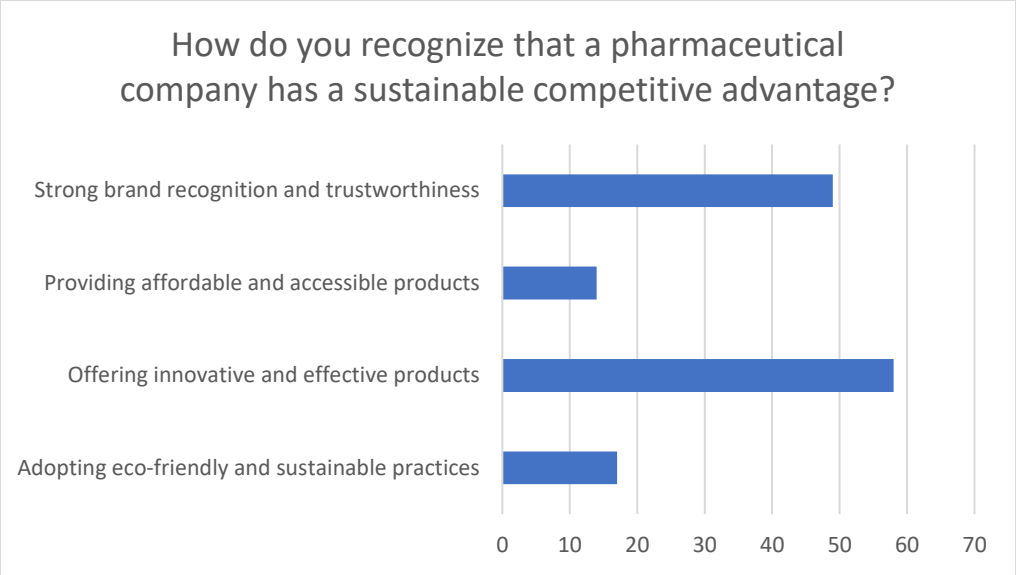


Figure 9: How do you recognize that a pharmaceutical company has a sustainable competitive advantage?

In the responses on what a pharmaceutical company does to recognize sustainable competitive advantage, 58 respondents ranked "offering innovative and effective products" as their number one choice. This is followed by 49 responses for "strong brand recognition and trustworthiness." Other options received fewer responses: "adopting eco-friendly and sustainable practices".

Finally, concerning the third objective—analysing how bio-innovation can sustain competitive advantage in the pharmaceutical industry—it is proper at this juncture to say that this data forms a reaffirmation of the importance of innovation in maintaining a competitive edge. By definition, bio-innovation connotes developing new and effective biological products and processes, which go in line with what most respondents perceive to be indispensable in sustaining competitive advantage.

Furthermore, it is a way to enhance solid brand awareness and reputation through bio-innovative practice. This might be because firms are more likely to be recognized as industry leaders where they have always brought new innovative products to the market. Eco-friendly practices are identified by fewer of the respondents, so putting them within bio-innovation may give more power to corporate reputation, binding sustainability together with leading-edge innovation for long-term competitive advantage.

**Question 8**

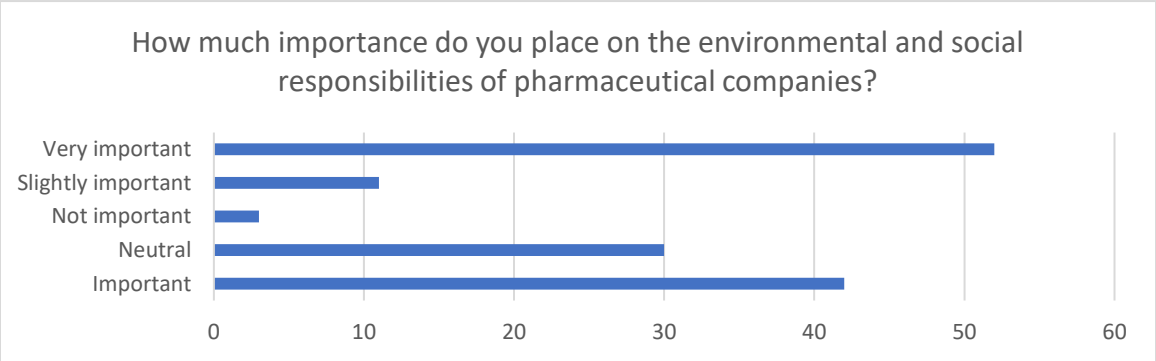


Figure 10 Importance of environmental and social responsibilities in pharma companies

This bar chart shows the opinions of the respondents on the level that environmental and social duties are important to pharmaceutical companies. This survey question is related to the fourth objective of the research. Most of the respondents believe that these are very important, as 52 participants have selected "Very important" and 42 participants have marked "Important." A smaller number of the respondents, 30, are "Neutral," whereas a very small number, 11, has marked this as "Slightly important," and only 3 marked it as "Not important." The data indicates that most of the respondents strongly look upon the ethical and social duties of pharmaceutical companies concerning the environment and social matters. The relatively low numbers within the lesser importance categories reflect a consensus towards the importance of these responsibilities. It is found that sustainability, public health, and corporate reputation, involve them in social and environmental responsibilities. Techniques for ethical sourcing, production, and waste management assure less environmental damage. Social responsibilities like granting access to healthcare foster community trust, which ultimately aids in the success of their firm.

**Question 9**

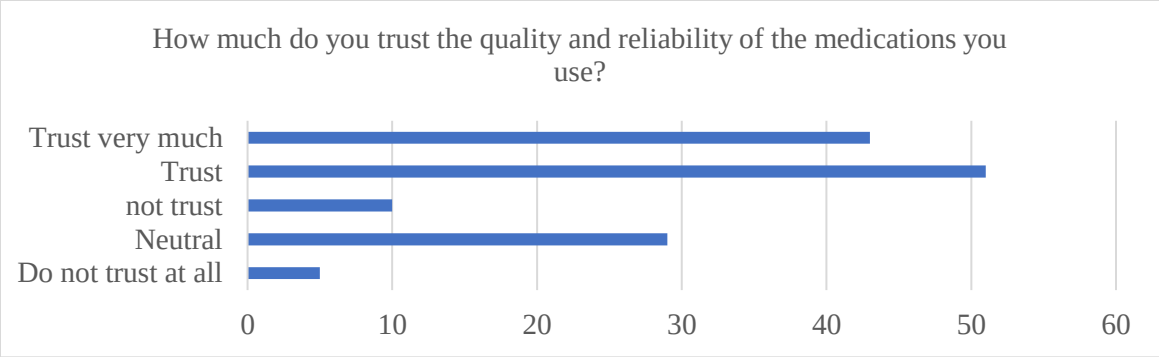


Figure 11 How much do you trust the quality and reliability of the medications you use?

This survey question “Level of trust in quality and reliability of medications used” is not directly related to the main objectives of the research but it has a great importance for the research. The largest group of those responding indicated that they "Trust" the medications, showing overall strong confidence in pharmaceutical products. The next highest number, 38, were those who "Trust very much," further underscoring how high the level of trust from the majority is. A large minority, 30 respondents, were "Neutral," showing neither strong trust nor distrust. A smaller group of 10 answered with "Do not trust," while 2 said "Do not trust at all." There is a sizable minority that either expresses scepticism or remains neutral, highlighting areas in which the pharmaceutical business could seek to establish or strengthen confidence. However, a sizable portion of the population does not have much faith in the effectiveness and dependability of medications. This data indicates that as medications provide patients with suitable therapy at a lower risk, one must have faith in their quality and dependability. Instilling confidence in medication adherence reduces difficulties, improving public health in the process. This ensures the integrity of pharmaceutical procedures and healthcare systems.

**Question 10**

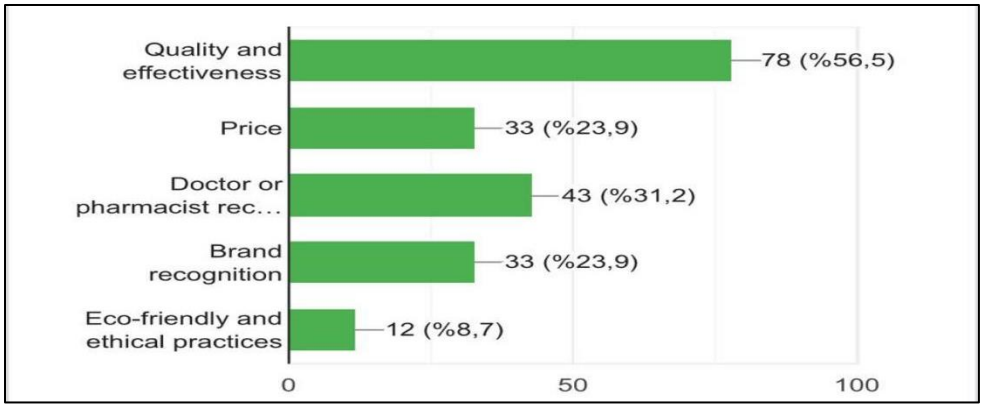


Figure 12: What are your reasons for choosing a particular pharmaceutical brand?

The bar chart represents the factors that influence consumer decisions when choosing pharmaceutical products this is related to the first objective. "Quality and effectiveness" are the highest factor, as 78 respondents answered for this factor, accounting for 56.5% of the total. "Recommendation by a doctor or pharmacist" is the next in order of priority, considered important by 43 respondents and commanding 31.2% of the share, thereby proving the fact that medical professionals can make a big difference. "Price" and "Brand recognition" have been chosen by 33 respondents each for 23.9% of the total. This shows that price and brand familiarity are major deciding factors. Eco-friendly and Ethical practices" come last, with 12 respondents only, which accounts for about 8.7% of the share. This indicates that though consumers are very concerned with the efficacy and recommendations of the products, less attention is paid to environmental and ethical practices. Though this awareness can be gaining momentum in other sectors, pharmaceutical companies could use this as a way to position their quality with ethics to attract more people.

**Question 11**

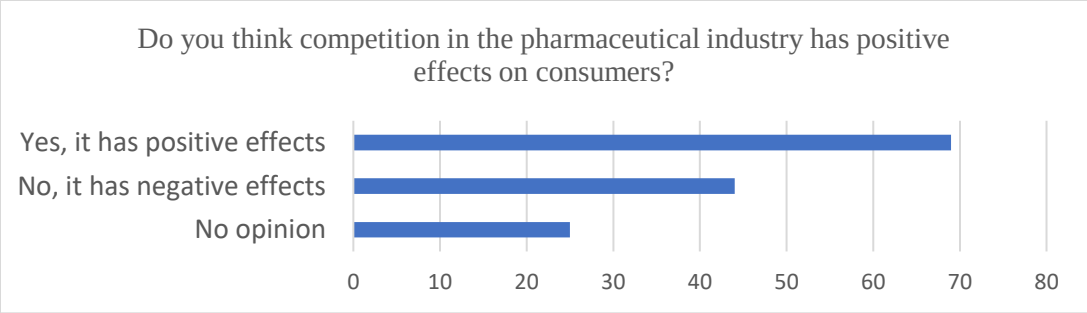


Figure 13 Do you think competition in the pharmaceutical industry has positive effects on consumers?

The bar chart shows the perceptions of the respondents concerning competition in the pharmaceutical industry and its effects on consumers and this is related to the third objective of the research. A large number of proportions, 70 respondents, believe that the effects of competition are positive on consumers. This can be interpreted to mean that indeed, many people see competition as having a drive for better quality, lower prices, and innovation in the industry for the benefit of the consumer. A surprising number, 50, however, view competition as bad; these would be those who may think that firms in their drive to maximize profits will be dangerous to consumers either from safety or less ethical business practices. Another 30 had no opinion, which reflects a sector of the public that is perhaps apathetic or ill-equipped with the necessary knowledge to answer. In particular, while the data indicates an overall positive view of competition in the pharmaceutical market, it also shows concerns and uncertainties amongst a significant minority; therefore, competitive practices will have to be managed with care to ensure consumer benefits.

**Question 12**

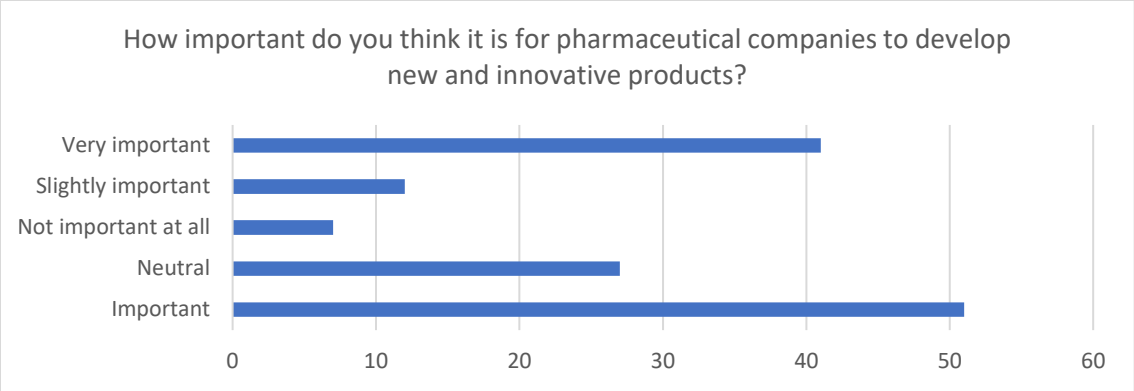


Figure 14 How important do you think it is for pharmaceutical companies to develop new and innovative products?

This bar chart explains the perceptions of respondents about the extent to which pharmaceutical companies need to develop new and innovative products which is related to the first objective of the research. A majority of respondents (55) find it "Very important," which reflects further upon a heightened belief that innovation has to play its role in this industry. Another 48 respondents believed it to be "Important," further underpinning the fact related to yes, there needs to be continuous product development to address the current and emerging healthcare needs. Fewer, 25, however, were "Neutral;" strongly neither for nor against the need for innovation. Fewer, 8, acknowledged it was "Slightly important;" and a yet smaller group of just 4 respondents believed it to be "Not important at all." This thus suggests that although the overwhelming majority of individuals agree with the need for innovation in the pharmaceutical sector, a small minority either does not consider it an important element or does not voice their opinion about its relevance. Such findings emphasize that the expectation is that pharmaceutical companies have to be at the forefront of developing new treatments and solutions that improve public health.

**Question 13**

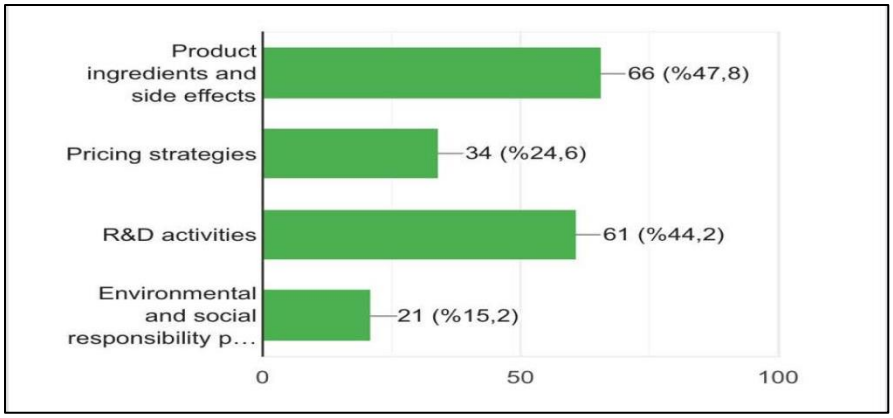


Figure 15: In which areas do you think pharmaceutical companies should be more transparent?

The bar chart indicates what are the main areas or aspects according to the respondents, where pharmaceutical companies should become more transparent and this question is related to the second objective of the research. As, the most critical area is "Product ingredients and side effects," with 66 (47.8%) respondents wanting pharmaceutical companies to be clearer on this aspect, pointing obviously to the concerns related to safety and informed decision-making. Another key area is "R&D activities," with 61 respondents who would like more insight into the development and testing of drugs. This could be understood as a demand for insight into how innovations are made. Another 34, or 24.6%, showed interest in "Pricing strategies," pointing to possible concerns over the affordability and fairness of drug prices. Lastly, 21, or 15.2%, stated that "Environmental and social responsibility practices" need higher transparency; though this area was less mentioned compared to the others. Indeed, in general, the data show that next to the themes of safety and development transparency, there is also a large interest in pricing and ethical practices.

**Question 14**

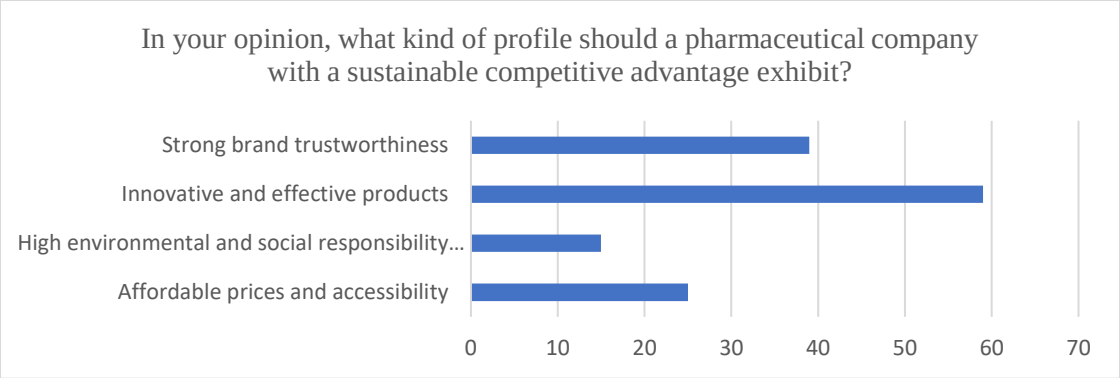


Figure 16 What kind of profile should a pharmaceutical company with a sustainable competitive advantage exhibit?

The bar chart indicates various qualities the pharmaceutical company should possess to maintain a sustainable competitive advantage this survey question has supported the third objective of the research. Outlined is that the highest-rated attribute is "Innovative and effective products," with 61 responses to its importance, thus indicating how continuous innovation is necessary for market leadership. Another highly valued factor is "Strong brand trustworthiness," observed in 48 responses, thus indicating that it is essential for consumers to have confidence in a brand for it to retain a competitive edge. On the other hand, 30 respondents held the view that "Affordable prices and accessibility" were important; hence, companies have to balance innovation with reduced prices. Lastly, "High environmental and social responsibility awareness" is rated as important by 21, which might mean that sustainability is realized but is conceptualized as not so critical against product innovation and brand trust. After all, innovation and trust are two pillars that could be deduced from the data to attain long-term success in the pharmaceutical industry.

**Summary**

The findings from this analysis are, therefore, for demographic and subjective data related to the trends in the pharmaceutical industry: bio-innovation, business sustainability, and competitive advantage. Some of the major findings that came out of this research in this respect include the identification of the major drivers of innovation as R&D, brand trust and transparency, and heterogeneous preferences of consumers for drugs. It also analyzes ways in which pharmaceuticals can integrate bio-innovation with sustainability, give priority to R&D, and maintain ethical practices to attain and sustain competitive advantage in the market.

## Chapter 5: Discussion

### Introduction

The discussion is an in-depth interpretation of the research findings vis-à-vis the objectives of the study, intending to obtain meaningful conclusions on the role of bio-innovation in the pharmaceuticals industry. Based on respondent data regarding the use of medicines, preference for innovation, and issues of sustainability, the discussion revolves around how such implications would guide the strategies for maintaining competitive advantage. This section also combines literature that supports the finding, showing implications on bio-innovation, R&D investments, and ethical practices as drivers shaping the pharmaceutical future.

### Discussion on Objective 1

Based on the above findings, it indicates that the majority of the respondents use the drug "rarely," and minor ones use it "occasionally," "never," or "very frequently." This establishes a varying degree of dependence on pharmaceutical products. The data provides opportunities for bio-innovative solutions to come up with different varieties of products for different consumer needs concerning the first objective of the study, which is to describe the role of bio-innovation in the pharmaceutical industry. In cases of non-users or occasional users, bio-innovation could focus on more preventive health solutions or medications that have fewer side effects to increase the frequency of use. In the case of heavy users, bio-innovation could result in more potent treatments that would reduce the need for frequent medication, therefore increasing the ability of the industry to serve divergent consumer markets. These findings support the opinion of Sarsaiya et al. (2019) who have argued that Biotechnological technologies such as DNA technology, monoclonal antibodies, and CRISPR-cas9 gene editing have simplified and hastened the discovery of novel medications. These technologies enable the exact targeting of diseases at the molecular level, allowing for the creation of extremely targeted and effective remedies for certain types of adverse effects.

The major findings reveal that the majority of respondents agree with the need for innovation in the pharmaceutical sector, a small minority either does not consider it an important element or does not voice their opinion about its relevance. Such findings emphasize that the expectation is that pharmaceutical companies have to be at the forefront of developing new treatments and

solutions that improve public health. As Pereira et al., (2017), supported this by describing that technological developments improve therapeutic efficacy, reduce side effects, and customise treatment plans for each unique genetic profile. Whereas, other findings show that "Quality and effectiveness" are the highest factor, as 78 respondents answered for this factor, accounting for 56.5% of the total. This indicates that though consumers are very concerned with the efficacy and recommendations of the products, less attention is paid to environmental and ethical practices. Though this awareness can be gaining momentum in other sectors, pharmaceutical companies could use this as a way to position their quality with ethics to attract more people. As described by Ncube et al. (2023), who believed that pharmaceutical companies are increasingly focusing on environmental food reduction because it includes minimizing waste, reducing greenhouse gas emissions, and optimizing resources. This means setting clear goals for sustainability, encouraging ongoing innovation and growth inside the company, and providing financing for cutting-edge research.

**Discussion on Objective 2**

Based on the above findings, it is observed that The data indicates that OTC medications are the most commonly used by respondents, followed by herbal and natural supplements, and then prescription drugs. This suggests a significant interest in OTC medications and herbal supplements, likely due to their perceived accessibility and natural health benefits. The higher prevalence of herbal supplement use highlights a growing consumer preference for products seen as safer and more sustainable. About the second research objective, which involves identifying sustainable business models integrated with bio-innovation practices, the data suggests that pharmaceutical companies should focus on developing bio-innovative, eco-friendly, and natural-based solutions. By doing so, they can attract consumers who prioritize sustainability while ensuring these products maintain the efficacy of traditional medications. This approach would align with consumer preferences and enhance the company’s competitive edge in the market. These findings support the view of Pereira et al. (2023), who have stated that collaborations with biotech corporations, academic institutions, and non-profit organisations, through strategic alliances, are increasing creativity in the discovery of novel therapeutics while lowering costs. Leading firms are using integrative ways to maintain their primary business strategy. This involves

including sustainable goals, routinely assessing and identifying processes, and ensuring responsibility at all levels of the organisation.

The results show that there is a sizable minority that either expresses scepticism or remains neutral, highlighting areas in which the pharmaceutical business could seek to establish or strengthen confidence. This data indicates that as medications provide patients with suitable therapy at a lower risk, one must have faith in their quality and dependability. As described by Diakosavvas and Frezal, (2019), biotechnology advances health equity by improving and facilitating access to life-saving medications. Personalized medicine, insurance, and treatment plans that are tailored to the unique requirements of the patient are made possible by biotechnology, which improves therapeutic outcomes and reduces medical costs. Kennedy (2018) identified that to make advanced therapy more accessible and affordable, the industry helps to provide population and contribute to the global Health of equity. Instilling confidence in medication adherence reduces difficulties, improving public health in the process. This ensures the integrity of pharmaceutical procedures and healthcare systems.

**Discussion on Objective 3**

According to the above findings, it is identified that data presented shows that 60 respondents believe that competitive advantage through R&D is the best area pharmaceuticals should pursue, followed by marketing and advertising, then by pricing strategies, and then customer service. This relates very well with the third research objective, which borders on how bio-innovation can sustain a competitive advantage in the pharmaceutical industry. The high preference for R&D reflects its pivotal role in the development of new biological products and processes as a prerequisite to remaining competitive. In turn, such bio-innovative products would also call for efficient marketing and advertisement to ensure their permeation into the levels of consumers and health service providers. If this is combined with well-planned and strategic pricing, together with good customer service, then the possibility is that this can firmly secure and hold a competitive position in the market. In the words of Diakosavvas and Frezal (2019), bio-innovations, as a broad umbrella concept, play an important role in recent technological advancements in biotechnology, biobased manufacturing, and green chemistry, with transformative potential for developing more sustainable pharmaceutical practices. This contributes to the reduction of environmental stresses, which improves industry sustainability, particularly through bio-innovations.

The above findings indicate that 58 of the respondents believe the key to a pharmaceutical's sustainable competitive advantage lies in "offering innovative and effective products," followed by 49 believing in "strong brand recognition and trustworthiness." There are only a limited number of them opting for "adopting eco-friendly practices." This shows that the third research objective has been attained and proved that bio-innovation is very important in sustaining competitive advantage. The development of new and effective biological products aligns firms with innovation expectations from consumers, which is paramount in competitive advantage sustainability. Besides, innovation continually enhances brand recognition and reputation, entrenching firms as industry leaders. According to Vostriakova et al. (2023), pharmaceutical businesses must take a comprehensive approach to understanding the benefits of combining bio-innovations with sustainable business models. This includes establishing explicit sustainability goals, promoting a culture of improvement and ongoing innovation, and investing in cutting-edge research. Companies like Novelties are leading the way by incorporating sustainability into their corporate strategy, which helps to establish the goal of carbon neutrality and investing in novel bio-innovation solutions.

The key findings from the survey are that "Innovative and effective products" far outdistance any other attribute of a company to sustain a competitive advantage, showing the relentless pressure to innovate for market leadership. "Strong brand trustworthiness" followed in importance, meaning consumers want to trust. "Affordable prices and accessibility" came lower, which means a balance has to be made between innovation and cost. As stated by Dane et al. (2024), value-based pricing, where drug prices are linked to health outcomes, is an emerging trend. This kind of approach in pharmaceutical companies helps to align the interests of those patients and health care systems who are insured that new treatments are effective as well as affordable for the same duration. Other finding shows that "High environmental and social responsibility awareness" is ranked as less important than innovation and trust, though it is recognized. As in the opinion of Azarenkova et al., (2024), by aligning sustainability with business objectives, companies are driving innovation to reduce risk and create long-term value for shareholders and society. AI and biotechnology work together to create a synergy that lowers costs and increases operational dependability while accelerating research and development to provide innovative, tailored sustainable healthcare solutions.

A large number of proportions, 70 respondents, believe that the effects of competition are positive on consumers. This can be interpreted to mean that indeed, many people see competition as having a drive for better quality, lower prices, and innovation in the industry for the benefit of the consumer. This is supported by Milanesi et al. (2020), who argued that the pharmaceutical industry aims to maintain ethical and environmental standards across its supply chain. This means purchasing rotators from vendors who use sustainable business practices, as well as purchasing raw materials from them and leveraging the supply chain to promote fair labour standards.

**Discussion on Objective 4**

The data indicates that most of the respondents strongly look upon the ethical and social duties of pharmaceutical companies concerning the environment and social matters. It is found that sustainability, public health, and corporate reputation, involve them in social and environmental responsibilities. As defined by De Soete et al. (2017), social sustainability ensures that individuals can satisfy their fundamental needs even as it gains importance as a way to address inequalities. Techniques for ethical sourcing, production, and waste management assure less environmental damage. Social responsibilities like granting access to healthcare foster community trust, which ultimately aids in the success of their firm. Bajaj et al. (2020), examined that sustainable bio innovation helps open a new market for opportunities in the fields of regenerative medicine and pharmaceuticals, which drives economic growth and competitiveness.

Based on the findings, it is likely that customers are more concerned with a pharmaceutical product's recommendations and efficacy than with its environmental or ethical implications. As a result, it would be a strategy that promotes brand loyalty and is in step with evolving customer expectations. As stated by Eshkiki and Homayounfar (2024), businesses can constantly include sustainability in their business planning to anticipate emerging issues and verify the negative consequences they will have on society and the environment. Through advancing health equity, facilitating more access to medications, and supporting environmentally responsible efforts, pharmaceutical corporations may significantly improve global health while also considering the consequences on the environment.

**Summary**

The discussions identified bio-innovation as a critical enabler of continuing competitive advantage within the pharmaceutical industry. Key findings identified R&D, innovation, and brand trust, but also pointed to consumer interest in sustainability. Therefore, the practice of bio-innovation merges with ethical and environmental responsibilities to the best of its ability to improve market leadership and consumer trust.

## Chapter 6: Conclusion

### Chapter overview

This is the last chapter of the study which focuses on providing the entire conclusion for the study showing the findings being achieved by conducting a thorough analysis in the research using the primary method of questionnaire and also conducting the analysis in the second chapter of the study by studying the various research scholars studies. The questionnaire responses were collected from 138 participants which are medicine users and pharmaceutical professionals having significant knowledge about the pharmaceutical industry.

### Conclusion

Biotechnology has transformed the pharmaceutical industry in several aspects of drug development, therapeutics, and diagnostics. DNA technology, monoclonal antibodies, and CRISPR-Cas9 have just started to rationalize drug discovery, making specific targeting possible with effective therapies. Production of biopharmaceuticals such as insulin and mRNA vaccines is a contribution of biotechnology toward world health. Diagnostic tools also improved with next-generation sequencing and PCR, now being used for the early detection of diseases and personalized medicines. Biocatalysis alone and, therefore, enzyme-driven transformations already offer an effective route to chemicals from biomass, though there are still further challenges one would have to face in fermentation processes. The role of genetic engineering and bioengineering delivers new microbial species and boosts output yields from biomass. Only a combination of biotechnology and computer engineering will pave the way toward developing the 'circular economy' model for industrial applications at scale. Through collaborative efforts, academia, industry, and regulatory bodies drive innovation in drug recovery, production of biopharmaceuticals, and personalized medicine, which shall be the future of healthcare.

The pharmaceutical sector faces challenges that relate to sustainability, regulatory issues, and new product development. For any business to remain viable in the long run, it has to adopt sustainable practices by balancing profitability with environmental and social responsibility. Organizations work hard to minimize their impact on the environment, entailing waste reduction, gas emissions, and resource usage. For example, Pfizer's green chemistry and renewable energy programs lower costs and improve corporate efficiency. Data analysis showed that 58 of the respondents indicated

"offering innovative and effective products" as their number one advantage. One route is then followed by 49 responses for "strong brand recognition and trustworthiness.". Other options received fewer responses, such as "adopting eco-friendly and sustainable practices.". Other activities underway that make drugs more affordable and accessible in poor countries include the Medicines Patent Pool. Other examples of sustainable business models include value-based pricing and R&D investments to ensure treatments are effective and affordable. Such collaborations between biotech companies and academic institutions on projects present opportunities for innovations that bring down related costs. As exemplified by Novartis, the issue of sustainability as being very significant in its corporate strategy drives efficiency in operation, brand reputation, and market growth despite challenges such as high costs and complicated supply chains.

It can be concluded that making bio-innovation part of pharmaceutical business models promotes environmental stewardship, economic resilience, and social well-being. Bio-innovations have huge potential to contribute towards more sustainable practices emanating from green chemistry and bio-based manufacturing. An example is the green chemistry program implemented by Pfizer aimed at decreasing hazardous waste and energy use. On another front, advanced biotechnology capabilities make for much-improved waste management and biodegradability. Socially, biotechnology contributes to health equity with better access to life-saving drugs and the discovery of customized medicine treatments. The largest group of the respondents indicated that they "Trust" the medications, showing overall. have a high level of confidence in pharmaceutical products. Closely following with 38, were those who trust very much, which further underlines how high the level of trust from the majority is. Economically, it fuels cost-effectiveness and market expansion through bio-innovation, as the drug development process is boosted through the use of the technique of CRISPR. On the economic front, these atypical collaborations of the biotech companies with academia spur innovation while giving a bonus of reduced R&D costs. A company like Novartis is leading in sustainability by setting carbon neutrality targets for itself and breaking a leg for biotech solutions to accelerate it. AI and machine learning in biotech drive efficiency and creativity for businesses. Again, some of the sustainable industry practices such as ethical supply chains and extended product life cycle management are effective cost reducers and profit enhancers for the industry. In summary, the coming together of bio-innovation and sustainability could be a means to environmental, social, and economic success and resilience in a long-term capacity for the pharmaceutical industry.

The pharmaceutical industry has increasingly focused on social and environmental sustainability to help improve health around the world while reducing this impact on the environment at the same time. Social sustainability initiatives relate to setting up collaboration with international organizations, governments, and non-profits to increase access to life-saving medicine in low- and middle-income countries. This focus also involves increasing community health outcomes and promoting fair access to medications. Moreover, work is underway to optimize sustainable packaging laminated cardboard to further improve the quality of recycling. This is despite challenges such as sticky particles that affect paper properties. Most of these factors are considered very important to the majority of the respondents, as 52 participants have selected "Very important" and 42 participants marked "Important." Of the total respondents, a smaller number, 30, is "Neutral," whereas only a very small number 11 has Marked this as "Slightly important. Green chemistry ensures environmental sustainability through reduced hazardous substances and waste in the manufacture of drugs. Such investment in green chemistry is placed by key companies such as GlaxoSmithKline and AstraZeneca that target carbon neutrality in their operations. Johnson & Johnson and Merck are promoting workforce diversity and inclusion to meet patients' needs and drive innovation. This place, therefore, is held within the organizational business strategies by sustainability for long-term success. Companies such as Novartis would align goals with global standards, like the SDGs. Taking care of the dimensions of social and environmental parameters, pharmaceuticals drive better health and sustainability amidst new challenges. However, the analysis showed that the last to be considered are "Eco-friendly and Ethical practices and 12 respondents answered. only accounted for about 8.7% of the share. That clearly defines that though consumers were the efficacy and recommendations of the products are very important to them, so less attention is attached to this are environmental and ethical practices.

Bio innovation has huge challenges and opportunities for the pharmaceutical sector. The high R&D costs, long-duration clinical trials, and strict regulations are some of the major barriers. An interest in intellectual property and maximization of profit may act as drag factors going forward toward sustainable practice. Technology is doing its bit to make drug development more efficient and cost-effective; AI and ML create breakthrough changes. Public-private partnerships and government support can offset these challenges to a large extent by sharing resources and innovations. It becomes a business strategy where sustainability is key to following through on consumer demand for ethical and environmentally friendly products. Embracing these practices

and fostering collaboration can drive truly transformative improvements in global healthcare. Data analysis showed that the greatest number of proportions, 70 respondents, think that the effects of competition are positive for consumers. This can be interpreted to imply that indeed, many people view competition as something with a drive for greater quality, better price, and innovation in the industry and this is for the benefit of the consumer.

**Recommendations**

***Integrate Sustainable Practices Across Operations***: The pharmaceutical industry should give top priority to integrating sustainable practices in its operations. It should implement green chemistry concerning less hazardous substances and wastes, optimize energy use through renewable sources of energy, and enhance waste management. Companies can take a cue from Pfizer in its green chemistry program as it helps not only in building better stewardship of the environment but also reduces operational costs. Develop sustainable packaging solutions and enhance the efficiency of recycling processes to further reduce environmental impact.

***Strengthen Public-Private Partnerships***: The high R&D cost and rigid regulations call for strong collaboration between the public and private sectors. It may further hasten innovation while reducing costs by sharing resources and expertise through collaborations with academic institutions, governments, and not-for-profits in the process. This could mean that the development of new technologies and more efficient drug discovery processes can take place, including access to medicines within low- and middle-income countries.

***Future Scope***: More research should focus on aligning advanced digital technologies and biotechnology with the context of pharmaceutical sustainability. Studies should further include the potential effects that AI and machine learning could have on increasing the efficiency in drug development and cost reduction, meanwhile checking the efficiency of green chemistry in shrinking environmental footprints. It would be also useful to explore more deeply how public-private partnerships can further facilitate the acceleration of innovation and improvement in global health equity. Besides, this will help research the trending issues in personalized medicine and how these will affect the future in terms of pharmaceutical practices, enabling insights into the ways that this can take developments further for sustainability and interest to the patient.

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