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"Exploring the Impact of Cloud Computing and Power BI Dashboards to Improve Pharma R&D Practices"

Submitted in partial fulfilment of the requirements for the award of M.Sc. in Digital Transformation (Life Sciences) at Griffith College Dublin, is entirely my own original work. This dissertation has not been previously submitted, either in whole or in part, for any other degree, diploma, or academic qualification.

All data sources and references have been appropriately cited, and where the ideas or work of others have been used, due acknowledgement has been made.

Candidate Signature: _ 

Date: 24th August 2025

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LIST OF ABBREVIATIONS

Abbreviation	Full Form
AI	Artificial Intelligence
BI	Business Intelligence
ETL	Extract, Transform, Load
GAMP	Good Automated Manufacturing Practice
GxP	Good Practice
HIPAA	Health Insurance Portability and Accountability Act
IoT	Internet of Things
IIoT	Industrial Internet of Things
PAYG	Pay-As-You-Go
R&D	Research and Development
SQL	Structured Query Language
TAM	Technology Acceptance Model
STS	Socio-Technical Systems
TOE	Technology-Organisation-Environment Framework

ABSTRACT

The pharmaceutical sector is rapidly becoming digital as it requires prompt innovation, collaboration, and compliance with regulations. The conventional research and development frameworks are frequently based on siloed frameworks and manual processes, and are generally unable to sustain surging amounts of multifaceted biomedical data. This work attempts to address this issue by exploring the potential of cloud computing and Power BI dashboards to enhance data accessibility, scalability, decision-making, and overall research efficiency within pharmaceutical R&D. The purpose of the study was to understand the effects of technologies on R&D practices, what hinders the adoption of these technologies and how these technologies can be integrated effectively. The study utilised mixed methods by combining quantitative survey data from professionals in the pharmaceutical industry with the qualitative opinions of these pharmaceutical professionals as collected through semi-structured interviews. The approach enabled not just quantifiable trends but also rich contextual insight.

Findings revealed widespread scepticism in survey results, with most respondents disagreeing that cloud computing improved accessibility, scalability, or cost savings, and expressing low confidence in Power BI's decision-making and forecasting capabilities. However, interview participants offered a more balanced perspective, highlighting tangible benefits such as enhanced collaboration, real-time data access, and improved trial monitoring when the tools were implemented effectively. Both data sources confirmed that integration of cloud and BI tools generated synergistic value, but adoption was hindered by regulatory, technical, and organisational barriers, including training gaps and cultural resistance. The study contributes to academic knowledge by bridging a gap in research that rarely explores the combined impact of cloud and BI integration in a regulated industry context. Practically, it provides an actionable adoption framework and recommendations for organisations, particularly small and mid-sized firms, to strengthen readiness, governance, and user engagement. By aligning technological potential with organisational change, the findings offer a roadmap for more efficient and digitally enabled pharmaceutical R&D.

Keywords: Cloud Computing, Power BI Dashboards, Pharmaceutical R&D, Digital Transformation, Data Governance

CHAPTER 1: INTRODUCTION

1.1 Introduction to the Study

Pharmaceutical companies are in the process of undergoing digital transformation, and the research and development (R&D) field is more concerned due to the large quantities of complex data. Conventional systems tend to be inflexible and not scalable, making data analysis over time difficult to perform and keeping pace with the changing requirements of R&D operations today challenging. In turn, to mitigate its effects, the widespread adoption of cloud computing technologies and business intelligence (BI) tools, such as Microsoft Power BI, is becoming increasingly popular to facilitate data accessibility, promote collaboration, and support informed decision-making (Ullagaddi, 2024). Cloud systems enable secure storage and sharing of data at a distance, and Power BI allows for real-time data visualisation and analysis. Combining these technologies promises significant enhancements to the efficiency of operations for small and mid-sized biotechnology companies, facilitating the fast-tracking of innovation (Suddala, 2022). This research also discusses how pharmaceutical R&D operations can benefit from utilising both cloud computing and Power BI dashboards to enhance the efficiency, accuracy, and collaborative potential of these tools and operations, as well as to address the challenges of technological adoption in regulated environments.

1.2 Background and context

The pharmaceutical industry is also facing a radical transformation driven by digitalisation, with a focus on developing drugs faster, ensuring conformance with regulations, and achieving cost-effectiveness. The core of the transformation can be found in cloud computing, which offers scalable infrastructure, real-time analytics, and secure data handling capabilities. These properties are now crucial components of contemporary pharmaceutical research and development, particularly as this industry struggles to manage increasing amounts of complex biomedical information (Ullagaddi, 2024). Additionally, indicate that nearly 90% of pharmaceutical enterprises worldwide utilise some cloud services, suggesting that cloud adoption is widespread and has a significant impact on the industry's operations. Cloud-based systems, such as Microsoft Azure, provide a strong foundation for controlling data workflows and are further validated according to Good Automated Manufacturing Practice (GAMP) and GxP (a set of quality guidelines and regulations) recommendations due to their in-built validation facilities. Distributed R&D teams working on these platforms enable collaboration with cross-geography and cross-functional teams, eliminating data redundancy. Moreover, the use of Environmental parameters and production lines can be observed in real-time due to

devices integrating the Internet of Things (IoT) and Industrial IoT (IIoT) within cloud eco-systems. This would not only enhance quality assurance but also reduce process delays and product recalls, in which case, compliance and patient safety are of paramount importance (Vijayaraj *et al.*, 2024). In combination with cloud-based tools, Business Intelligence (BI) tools such as Microsoft Power BI can help transform raw data into valuable insights. Power BI dashboards installed in cloud eco-systems, enabled by ETL applications like Azure Data Factory and SQL, allow pharmaceutical companies to view operational data, measure their performance goals and gain insights through real-time data analytics (da Costa Santos, 2022). As an illustration, this can be seen in the example of Adamed, one of the most popular pharmaceutical companies, which successfully utilised Power BI in conjunction with Azure technologies to minimise forecasting errors to less than 5%, demonstrating the practical strength of the systems (Vijayaraj *et al*., 2024).

A combination of cloud platforms and BI tools makes up a synergetic combination that increases the efficiency of R&D in pharmaceuticals. Cloud-based data integration provides an easy, safe, and expandable deployment of multi-source data for visualisation and fast decision-making. Moreover, the Power BI interface enables the detection of anomalies, creation of real-time reports, and generation of automated insights, allowing companies to respond to market changes more quickly (Recharla and Chitta, 2022). The role of the cloud is further characterised by the possibility it provides to drive analytics with artificial intelligence, which enables experimentation and hypothesis testing to occur faster. The pay-as-you-go (PAYG) mode of cloud-based services is particularly beneficial for small and medium-sized biotech companies, allowing them to access complex computing resources without incurring substantial capital expenditures (Sachdeva *et al.*, 2024). Further, such transformation of manual trial-and-error methods into AI-enablement, data-driven R&D generated new challenges: disjointed legacy developments and analytics capabilities, which can be resolved using the advantages of cloud eco-systems: interoperability, scalability and standardised frameworks (Vankayalapati, 2022). Overall, pharmaceutical R&D is evolving due to the merger of these tools of cloud computing and BI, which includes Power BI. These technologies have not only increased transparency, agility, and innovation in data but also facilitated a more collaborative and cost-effective process of drug discovery, development, and regulatory compliance.

1.3 Problem statement

The pharmaceutical development industry is under tremendous pressure to develop faster while conducting research and development simultaneously, all while dealing with increasingly

complex data, regulatory compliance, and cost reductions. The classic R&D models are primarily built on siloed data systems and manual interpretation, which are prone to inefficiencies, slow drug development processes, and reduced data transparency (Vankayalapati, 2022). As the volume of biomedical data continues to rise due to clinical research, genomics, and other sources of data generated by Internet of Things-enabled devices in the lab. Similarly, the need to use scalable digital solutions with intelligence to automate operations and make real-time decisions becomes increasingly dire via enhanced biomedical data. Cloud computing has become a game-changing technology, offering on-demand storage, scalability in computing, and access to global data, which enables pharmaceutical companies to transition from traditional, on-premise systems to flexible, collaborative ecosystem platforms (Vijayaraj *et al.*, 2024). Nevertheless, although most large pharmaceutical companies have adopted cloud use, small-to-mid-sized organisations have found it challenging to utilise the power of the cloud thoroughly, particularly in incorporating information analytics tools into their research and development frameworks. However, there is a lack of empirical studies on the effects of cloud-supported Power BI dashboards in enhancing R&D decision-making, the accuracy of forecast models, and regulatory compliance (Recharla and Chitta, 2022). There are no standardised frameworks and measurable results, and these gaps create an inadequate sense of the real-world effect of these technologies. The proposed research will investigate how cloud computing, particularly the utilisation of Power BI dashboards, can transform the way pharmaceutical R&D is conducted, facilitate data-driven decision-making, and mitigate operational bottlenecks in the drug development lifecycle.

1.4 Research Aim and Objectives

The research aims to explore the impact of cloud computing and the Power BI Dashboards Tool on improving pharma R&D Practices.

1.4.1 Research Objective

- To explore how cloud computing contributes to improved access to data, system scalability, and cost-effectiveness within pharmaceutical R&D processes.
- To assess the role of Power BI dashboards in enhancing data interpretation, workflow transparency, and decision-making efficiency in pharma research environments.
- To investigate the synergistic impact of cloud-based platforms and BI tools on improving data management, decision accuracy, and research efficiency.

- To identify the technical, ethical, and operational barriers that pharmaceutical organisations face when implementing cloud and BI technologies.
- To propose an actionable framework for the adoption of integrated cloud and Power BI systems within pharmaceutical R&D teams.

1.4.2 Hypothesis

The integration of cloud computing and Power BI dashboards enhances data accessibility, strengthens interdepartmental collaboration, and improves decision-making in pharmaceutical research and development.

1.5 Justification and Significance of the Study

The research is well-timed and relevant, as the pharmaceutical industry is undergoing a high rate of digitalisation and increasing demands to accelerate the drug discovery process and reduce development costs. However, their full potential is underutilised due to uneven implementation practices, regulatory ambiguities, and limited results on the collective effects they have on drugs. This study contributes to a better understanding of the potential benefits of real-time data access, improved collaboration, and big data analytics through the use of cloud technologies and Power BI dashboards, which can significantly enhance the R&D activities of any organisation. The results will be beneficial to small and mid-sized companies in the pharmaceuticals and biotechnology industries interested in cost-efficient yet effective digital means of keeping their processes competitive and compliant. Academically, the research contributed to the current body of knowledge by uncovering an essential gap in the literature, as it empirically examines the operational and strategic value of conceiving Cloud BI integration in pharmaceutical research. In practice, it provides a practical model that organisations can use to overcome implementation failures and align digital tools with research-related goals. The results of this study can be used to make better decisions, manage clinical trials more efficiently, and distribute resources more effectively, all of which can lead to innovation and improved health outcomes at both an organisational and societal level.

1.6 Overview of Dissertation Structure

This dissertation is structured into five chapters that aim to give a thorough analysis of the research topic. In Chapter 1, the study provides the background of the research, states the problem, outlines the research objectives, explains the significance of the research, and presents the general structure of the research. Chapter 2, Literature Review, presents a critical review of the available literature thematically, outlining the current knowledge on cloud computing,

Power BI, and their applications within pharmaceutical R&D. It also identifies areas of research gaps. The research methodology, including the philosophical approach, data collection methods, sampling procedures, ethical considerations, and data analysis techniques used in the present study, is described in Chapter 3, Methodology. In Chapter 4, Results and Discussion, the author presents the results of both quantitative and qualitative data, supported by visualisations and thematic interpretations that align with the research objectives. Lastly, Chapter 5, Conclusion and Recommendations, focuses on the key findings concerning the available literature, providing theoretical and practical implications, and makes concluding statements that include limitations and recommendations for future research. Such a structure provides a coherent flow and a strong scholarly approach to the research issue.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction to the Literature Review

The purpose of the literature review chapter is to discuss how cloud computing and Power BI dashboards can optimise the pharmaceutical research and development (R&D) practices. In particular, the study examines the contribution of these technologies to improvements in data accessibility, scalability, decision-making, and the overall efficiency of research, as well as the adoption barriers and enablers regarding the adoption of these technologies in the context of the pharmaceutical industry. This review aims to critique the current body of literature on cloud computing, business intelligence (BI) tools, as well as their role and use in pharmaceutical research and development. This review will lay the groundwork for comprehending the synergetic effect of these technologies and identify the research gap that prevents the optimal application of these technologies in small and mid-sized pharmaceutical firms. The thematic framework of the current review is organised in the following key directions: cloud computing and its impact on the data accessibility and scalability, the implications of Power BI dashboards usage on decision making functionality, as well as incorporation of these solutions to improving the efficiency of R&D. The factors that inhibit and encourage adoption will also be mentioned to offer a viable implementation structure.

2.2 Cloud Computing and Data Accessibility in Pharmaceutical R&D

The adoption of cloud computing shifted from single bioinformatics pilots to ubiquitous infrastructure in less than ten years. According to statistics provided by International Data Corporation, in 2019 alone, the United States had already spent US$124.6 billion on public cloud, and an analyst estimate indicates a global market size of US$623 billion by 2023 (Banimfreg, 2023). The industry survey reveals that 90 % of large life-science firms have already established mainstream use of the cloud. At the country level, the Irish pharmaceutical cluster is evolving, with firms recognising cloud connectivity as a prerequisite for Industry 4.0 retrofits, such as installing IoT sensors on production lines and streaming data in real-time to Azure or AWS for processing (Kaippully, 2024). This technological transition is reflected in the broader literature on change, specifically in the evolution of discovery workflows supported by AI and blockchain-protected supply chains, which rely on cloud backends to provide compute elasticity and global presence (Sugandha, 2023). Drug discovery produced standard increases in scale of terabyte-sized multi-omics datasets. The response of public cloud providers is a curation of ready-to-use research collections, such as the AWS Registry of Open Data, which exposes GenBank, Ensembl, and the 1000 Genomes Project as S3 buckets that can

be mounted directly into analysis pipelines (Banimfreg, 2023). Banimfreg lists over sixty SaaS, PaaS and IaaS services, including Galaxy on AWS and serverless Python workflows, allowing scientists to build their own compute clusters or specialised containers using just a few commands. Tiny biotech start-ups find the pay-as-you-go elasticity especially appealing, as they can only run extensive simulations a handful of days per month, and they do not want to invest money in maintaining local high-performance servers (Banimfreg 2023). At the shop-floor level, data about historians, MES events, and PAT feeds can be gathered in one tenancy on hybrid manufacturing clouds to enhance the traceability of batches and facilitate rapid investigation of deviations (Reinhardt *et al.,* 2020). Similarly, Figure 1 emphasises the anticipated growth of the cloud computing market in the pharmaceutical sector from 2025 to 2033. According to market research, the market size in 2024 is estimated at USD 18.3 billion and is expected to increase at a compounded annual growth rate (CAGR) of 14.6% to USD 62.39 billion by 2033. The trends are depicted as rising in the graph, as the use of cloud technologies to enable pharma R&D to be scalable, data-integrated, and operationally efficient is also increasing. Innovation in cloud infrastructure has been identified as a strategic concept that will revolutionise the pharmaceutical research practices in this way (Straits Research, 2024).

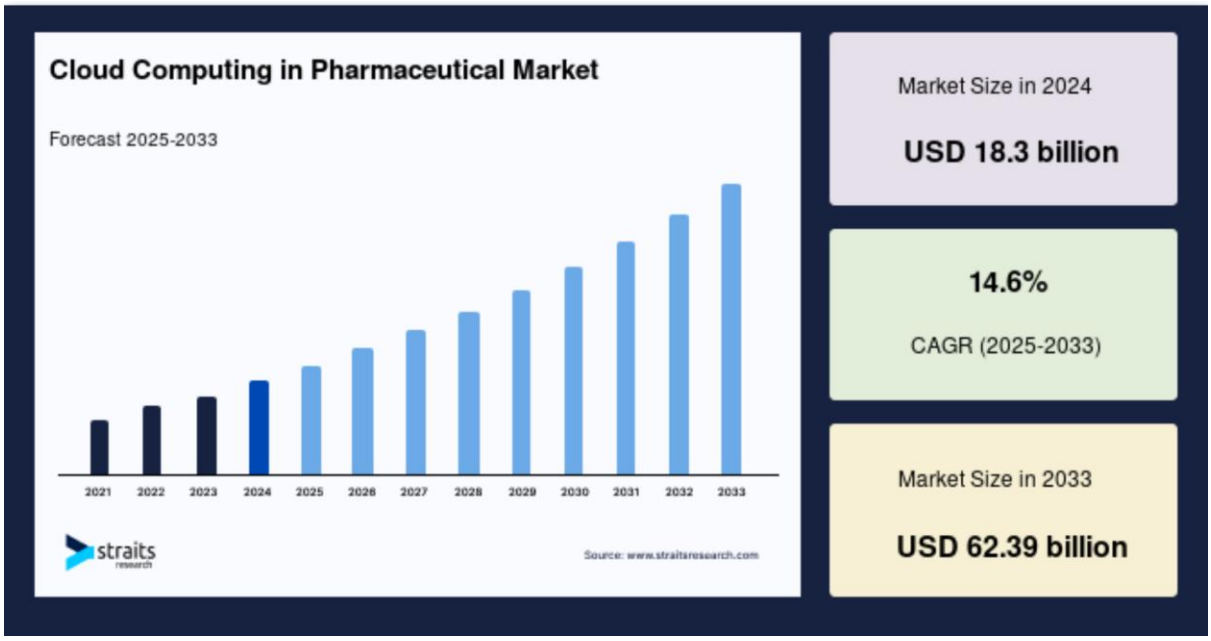

Figure 1: Projected Growth of Cloud Computing in the Pharmaceutical Market

(Source: Straits Research, 2024)

Comparative economic studies between build-versus-rent models show that hosted models provide a lower total cost of ownership when utilisation is less than approximately 70% of on-premise capacity. Cloud brokers and auto-scaling groups also reduce spending by scaling the workload of the virtual machines. Irish plants leverage this flexibility to rapidly spin up compute-intensive chemometric models during the process-development sprint and conserve resources when projects stall, thereby freeing capital to devote to research and development rather than servers. The advantage here is magnified tenfold by hybrid architectures: sensitive formulation data are kept secret within the confines of a reserved tenant, and non-sensitive simulations are released into the open areas of the world—the security is equalled with an OpEx savings of half (Banimfreg, 2023). Therefore, since Figure 2 indicates that cloud computing results in a drastic improvement in the pharmaceutical R&D in terms of cutting the documentation time, risk management effectiveness, and efficiency by 78%, 67%, and 73% respectively. It guarantees a 99.99% completeness of data, global compliance and makes audits more accurate by 92%, which makes it critical to contemporary pharma activities (Mosali, 2025).

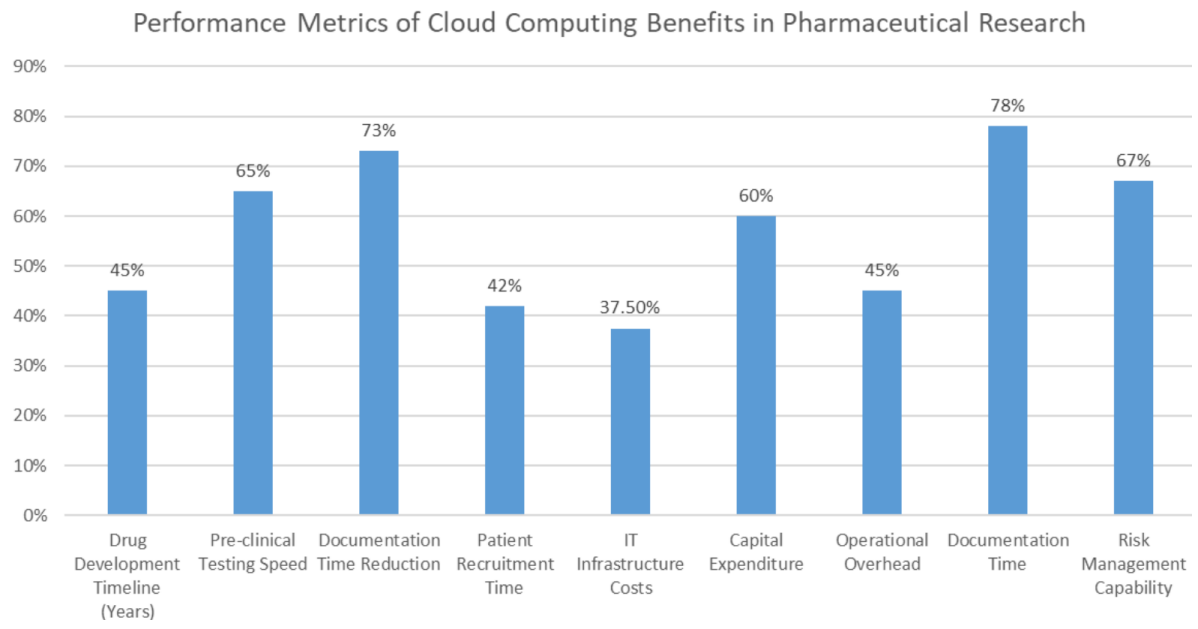

Figure 2: Performance Metrics of Cloud Computing Benefits in Pharmaceutical Research

(Source: Mosali, 2025)

There are no doubts regarding the benefits of adoption as however, a mix of attractors and impediments, as well as compliance, governance, and skills issues, slows down the adoption process. Expectations of GDPR, HIPAA, and PIC/S Annexe 11 on multi-tenant infrastructure

require thorough shared-responsibility matrices. Banimfreg includes privacy, data integration, latency, and portability among the top ten cloud risks, as highlighted by regulators and quality units. Similar issues of protecting their intellectual property and avoiding fakes have led several companies to combine blockchain audit layers over cloud supply-chain data lakes (Sugandha, 2023). The similar conclusions drawn from FAIR-data-management studies demonstrate that further metadata curation work and persistent identifier services are also necessary to support making datasets Findable, Accessible, Interoperable, and Reusable. This also presents overhead costs that need to be weighed against the potential long-term benefits of increased accessibility (Alharbi 2022). Thus, the talent crunch remains severe; both Kaippully and Banimfreg provide cases in favour of cross-functional upskilling programmes to ensure that GxP-compliant cloud pipelines cannot be designed and validated by IT teams alone. The evidence combination indicates that the Truck started with niche experimentation but has now evolved into cloud platforms as core areas of pharmaceutical R&D infrastructure. They can operate in real-time at scale and be accessible worldwide with a new paradigm of analytics, but in the long run, achieving enduring value will require mastering cost governance, hybrid design patterns, and the constantly changing environment of operating outside the compliance map.

2.3 Role of Power BI Dashboards in Enhancing Research Decision-Making

Business Intelligence (BI) tools have assumed a crucial role in handling large and complex datasets, especially in data-intensive industries such as pharmaceuticals. Power BI is a powerful Microsoft technology that is increasingly used to gain valuable insights into R&D operations, clinical trials, and supply chain processes. The BI dashboards fill this gap, providing managers with the tools to transform KPIs and measures into visual descriptions that enable quicker decision-making (Zingde and Shroff, 2020). Equally, in dynamic research settings, conventional reporting solutions cannot be adjusted to the pace and detail necessary, and solutions such as Power BI will be essential to help realise digital transformation. Dashboards are not only becoming a reporting tool, but are also becoming the focus of operational intelligence. In pharmaceutical research and development, significant volumes of data are generated on lab devices, IoT devices, and clinician systems. Power BI brings this data to central dashboards (Beem, 2019). The global Business Intelligence (BI) software market will reach a total of $ 29.51 billion by 2025. After this period, it is expected to grow at a 4.34% CAGR to $36.49 billion by 2030. The average amount spent on BI software per employee is expected to increase to USD 7.87 in 2025, indicating a growing dependency of enterprises on data analytics software. The United States is expected to capture the market with a revenue of

USD 14.64 billion, driven by its well-developed technological infrastructure and high penetration rates (Statista, 2025). Osho et al. (2020) demonstrate that Power BI can leverage data warehouses and APIs, incorporating real-time changes into visual representations suitable for non-technical users. These types of flexibility improve the working relationship between interdisciplinary teams. The integration of Power BI with AI models to generate intelligent warnings and automate decision-making processes. This helps R&D leaders track clinical processes, subject recruitment, and reagent use without needing to collate data manually (Daruvuri *et al.,* 2024). In the same regard, its drag-and-drop feature saves a considerable amount of time-to-insight by skipping popular SQL-intensive tools, enabling pharmaceutical companies to focus on science rather than data engineering (Orlovskyi and Kopp, 2020). Power BI is a monitoring interface that can be used to improve the time lag and transparency in the entire development lifecycle.

2.3.1 Real-Time Reporting, Forecasting Capabilities and Adoption Challenges

Drug discovery and development is a field that makes forecasting a core activity; that is why a delay or a misestimation costs millions. Power BI features a dashboarding capability that enables dynamic forecasting through the use of DAX (Data Analysis Expressions), which combines historical data with forecasting models. Real-time dashboards were already implemented during clinical trials to improve inventory management and reduce errors associated with clinical trial management (Goncalves *et al.,* 2023). Dashboards not only facilitate descriptive analytics but can also be used as prescriptive analytics, providing automated advice based on performance parameters to researchers (Zingde and Shroff, 2020). Further, Power BI dashboards incorporating machine learning engines can now be utilised to generate near-real-time estimates of response patterns in patient populations and identify supply chain bottlenecks, particularly in the context of adaptive trial design. These forecasting insights can be used in pharmaceutical R&D to fast-track compound selection, predict the rate of trial dropouts, and optimise sample sizes (Daruvuri *et al.,* 2024). Case studies indicate that in mid-sized pharmaceutical companies, forecasting dashboards have resulted in savings of more than 30 % in planning and errors. In this way, the platform transforms Power BI into a proactive decision support system, rather than a static visualisation tool. Nevertheless, some of the adoption barriers remain (Orlovskyi and Kopp, 2020). Connecting Power BI to legacy lab systems and secure data lakes can involve the use of middleware or custom connectors, which complicates the IT workflow. Although cloud-based instances can address some of the problems, compliance regimes, such as those in the pharmaceutical industry (e.g., GxP,

HIPAA), require validation and audit trails, which Power BI would otherwise not provide (Beem, 2019). Another problem noted is related to user resistance, as domain experts may be unfamiliar with data and use outdated systems based on Excel files. Areas against closing include training needs, dashboard control, and version control (Orlovskyi and Kopp, 2020). Additionally, the quality of data will be a bottleneck, as caution is warranted because poor data organisation upstream may cause dashboards to misinform (Goncalves *et al.,* 2023). As their findings establish, Power BI performance reduces when operating high-volume, real-time streams that are not set to premium capacity (Zingde and Shroff, 2020). When over-utilising ready-made visualisations, the process of pharmaceutical decision-making may be simplified, and the false-positive effect or a misunderstanding of the measures can result in a waste of resources on experimental shifts (Daruvuri *et al.,* 2024). On the whole, the literature reviewed supports the transformative role of Power BI in pharmaceutical R&D, particularly in data consolidation, workflow visualisation, and real-time predictions. However, it can only be implemented successfully if it passes through the hurdles of technical integration, user training, and compliance implementation. These observations justify the exploration of Power BI as a strategic catalyst for decision-making in the pharmaceutical environment.

2.4 Integrated Impact of Cloud and BI Tools on Research Efficiency

Over the last few years, business intelligence (BI) fronted by the combined digital world, cloud computing and business intelligence (BI) tools has transformed the research and development (R&D) process. Typically, a Digital Ecosystem of R&D comprises cloud sources, data environments, ETL mappings, and BI dashboards that operate in tandem to provide a seamless experience for data access, collaboration, and analysis. Cloud environments also offer scalable storage facilities and compute capabilities that, when combined with tools such as BI, can enable research teams to process, analyse, and visualise large volumes of data in a near-real-time manner. As an example, today we have cloud-based ETL architectures that are specifically designed to ingest and transform data into a consolidated data lake. With the use of tools like AWS Glue, Google BigQuery, or Amazon Redshift, analysts can process that data to generate insights faster than legacy on-premises systems. The key aspect of such integration is the application of artificial intelligence (AI), ETL, and interoperability frameworks to cloud native platforms (Tran, 2024). Articles like AI Driven Enhancement of ETL Workflows for Scalable and Efficient Cloud Data Engineering describe how AI models can be used to optimise schema evolution, anomaly detection and automatic workload management, to reduce the latency and significantly improve the scalability of the pipeline (Seenivasan, 2024). Conversely, the

buttermaking process of AI-enabled business intelligence is depicted in Figure 3. It will start with data collection and preparation, and then analytics will include machine learning, NLP, and predictive analytics. The visualisation of these insights occurs through dashboards, causing BI outputs including data-driven insights, recommended actions and automated decisions. This framework provides improvements in making decisions, efficiency, and innovation in drug research and in other regions (Syed and Nampally, 2021). Similarly, studies on AI-powered data warehousing systems demonstrate an increase in ETL performance, analytics forecasting effectiveness, and cost reduction in cloud-enabled services, providing quantifiable BI efficiency (Chaudhari and Charate, 2025). Meanwhile, data sharing between platforms is facilitated by interoperability initiatives, including the sharing of open API standards and cloud-to-cloud data mobility (e.g., Snowflake OpenFlow), which simplify data sharing and provide collaborative, federated research environments (Snowflake Inc., 2025).

Figure 3: AI for business intelligence use cases

(Source: Syed and Nampally, 2021)

The theoretical support for such a synergistic incorporation is typically based on models like the Technology Acceptance Model (TAM) and Sociotechnical Systems (STS) theory. Extended forms of TAM, including constructs such as perceived usefulness (PU), ease of use (PEOU), facilitating conditions, and satisfaction, are effective in modelling the adoption of cloud-based information systems (such as BI tools) by both researchers and practitioners. Facilitating conditions and PEOU were also found to have a significant impact on behavioural intention and system use in one of the latest studies conducted in the domain of educational cloud systems (Wandira *et al.,* 2024). Such extensions guarantee that not only technological features but also contextual elements (e.g., organisation, readiness in terms of infrastructure)

are considered to explain adoption trends. Simultaneously, the Sociotechnical Systems theory states that efficiency can be achieved through the co-optimisation of social (human, organisational) and technical (tools, processes) subsystems. In the context of cloud and BI combined, STS is promoting a unified process that encompasses the connection of BI dashboards, data governance practices, communication, and user education, alongside technical enhancements such as AI-driven ETL. By combining the design, its benefits include improved system reliability, increased end-user satisfaction, and prevention of bottlenecks that hinder efficiency (Thomas, 2024).

The interaction of these points yields several synergistic effects. First, it becomes more effective in research: with less friction within the data pipeline, research can be conducted to make decisions more quickly, with less friction between ingestion and analytics, testing hypotheses, iteration, and evidence-based decision-making. In terms of experimental benchmarks, AI-powered pipelines provide a virtually 60-70% reduction in manual grunt work, such as cleaning, mapping, and detecting anomalies. Scalability, as part of the cloud, enables large-scale simulations and complex BI queries to run in parallel, significantly reducing turnaround time (Islam *et al.,* 2024). Second, interoperability promotes collaboration across domains: FAIR (Findable, Accessible, Interoperable, Reusable) frameworks and open platform connectors will enable collaborative projects, meta-analyses, and data pooling between institutions. Third, digital ecosystems in an integrated environment facilitate the diffusion of innovations: once researchers discover the BI tools to be usable and useful (high PU/PEOU), the adoption process propagates on its own, leading to the emergence of an efficient workflow standardisation (Wandira *et al.,* 2024). Lastly, theoretical models, such as TAM, TOE and STS, make sure that diffusion is sustainable, as they put technology in the context of a supportive policy, infrastructure, and human processes, which prevents technology use as a fractured set of tools and brings long-term ROI to institutions (Gangwar *et al.,* 2015). To conclude, the synergistic combination of cloud platforms and BI tools forms an extraordinary digital environment that can improve the efficiency of the research process, as well as collaboration and innovation. Through an AI-powered ETL pipeline, latency and manpower were reduced, and interoperability frameworks facilitated new bi-directional points of access to federated data. The issue of adoption has a strong theoretical basis, such as TAM extensions and STS models, which guarantee good acceptance of tools and social anchorage. Consequently, groups of researchers can conduct speedier, more cooperative, and scalable work and achieve results that were previously infeasible on the old systems.

2.5 Barriers to Implementation of Cloud and BI Tools in Pharma

Many obstacles in the form of technical drawbacks and infrastructural challenges arise to confront pharmaceutical organisations that seek to employ cloud-based and BI solutions. The use of legacy systems is widespread within multiple businesses, restricting smooth compatibility with modern cloud resources. The migration process requires considerable reworking of a program and database to favour cloud microservices or containers (Ullagaddi, 2024). This is further impeded by stringent validation and compliance standards within GxP models, where revalidation, documentation, and permanent audit trails are essential to each platform change, which tends to increase the cost and size of the deployment frequently as well. Moreover, cloud adoption presents an issue of scalability: high-performance computing workloads, such as large-scale simulations or the refresh of BI dashboards, require finely tailored infrastructure to provide a favourable ratio of throughput and response time latency, otherwise leading to unacceptable latency or a sudden cost increase. Lastly, the disjointed cloud designs, such as public, private, and hybrid clouds, make it difficult to distinguish between data uniformity, security checks, and performance in development, QA, and production environments.

In addition to technical challenges, data governance and ethical concerns pose significant hurdles. Access control and data sovereignty: In cloud management of sensitive clinical and patient data, questions arise regarding cross-border transfer regulations and data sovereignty. This is particularly concerning within data and legislation frameworks, such as the GDPR or the proposed European Health Data Space. The unauthorised replication of clouds may pose serious security threats, as unrestricted data of individuals may be shared across borders without redaction, resulting from poor governance (Singh, 2023). An extensive analysis on data governance argues that various formal systems are required to codify data lineage, access permissions, data quality and ethical standards failing which have an integrity undermining effect and may result in violation of regulations In the pharma industry, things get only more complicated: ensuring transparency, bias reduction, and iterative compliance with ethics are key challenges in using AI and BI in both R&D processes and clinical pipelines . The examples of case studies provided by AstraZeneca demonstrate that ethical AI governance in decentralised teams necessitates clear scoping, calibrated standards, and accountability procedures that can be consistently applied across different teams (Molkander *et al.,* 2022). Likewise, biomedical data initiatives highlight the issue of data sharing that is both responsible and aimed at maintaining patient privacy, while adhering to patient consent models (Sriram *et al.,* 2025). In addition to technical and governance aspects, it brings about human and

organisational resistance as a vital issue. The pharmaceutical world is more pecking and risk adverse where methods which have been time tried and tested are preferred to disruptive innovation The use of cloud and BI tools is often seen by workers as a challenge to their employment or competency in their profession-data analysts worry that they will be rendered obsolete by the use of these tools and IT workers fear they lack the time to handle additional obligations without going through a long retraining process. Internal culture has been cited as a significant factor in cloud implementation time and again. Behavioural inertia, along with established siloed systems, is are serious inhibitor of cross-functional team effort in terms of implementation efficiency at the corporate level and beyond. Additionally, the lack of change management increases resistance: in the absence of evident communication plans, training initiatives, and the sponsorship of the executive team, the employees tend to fall back to the historic tools and reportability methods These opt-outs bring about disjointed analytics, disjointed data environments and systematic absence of faith in centralised BI dashboards (Bahaa-El-Din, 2024).

Validation weaknesses are driven by poor infrastructure and considered a failure when performance problems increase; gaps in data governance reduce regulatory compliance and ethical acceptance; human resistance widens in areas where systems are perceived as threatening or lacking sufficient support. This requires a comprehensive approach to address such problems. The most successful tests of cloud BI ecosystems tend to involve making an early investment in cloud-native infrastructure design, maintaining the deployment of independent validation sandboxes, and leveraging elastic scaling with effective cost management. At the same time, they introduce governance systems that are compatible with regulatory policies and ethical regulations, granting access, traceability, and consent for every data point of contact. From a people-centric perspective, as exemplified by case studies such as AstraZeneca, scalable AI and BI governance must rely on the effective collaboration of units, champions of change, policy communication, and ongoing skill development (Mijkander *et al.,* 2025). To sum up, cloud and BI tools can provide more insight into data and agility within pharma R&D, yet meet multi-layered implementation challenges. Any technical or infrastructure constraints must be overcome by building cloud-ready architectures, through validation processes, and by planning for performance. Ethical or governance issues must be addressed through proven, auditable frameworks. Human aversion must be offset by an organisational culture, change leadership, and user-centred training. Pharmaceutical organisations can only guarantee the ethical, compliant, and sustainable utilisation of current analytics ecosystems by ensuring that the three dimensions are simultaneously addressed.

2.6 Strategic Enablers and Best Practices for Adoption of Cloud-BI Integration

Effective cloud BI integration requires multiple factors that are correlated. First, rationalising top management support, along with a well-explained vision and strategic mission, provides guarantees that will ensure dedication and allocation of resources. Adoption studies using the Technology-Organisation-Environment (TOE) framework confirm the necessity of organisational preparedness, which consists of infrastructure, financial sustainability, and proficient human capital (Owusu *et al.,* 2020; Shin *et al.,* 2024). Uptake is also influenced by relative advantage, compatibility, and system complexity. The cloud-BI solution must have a clear advantage over legacy systems in terms of scalability and cost, and the solutions must be highly compatible with existing workflows. A Century-Long study of conferences that identified 18 factors related to the continued use of cloud-BI in 2024 pointed out that security, scalability, management support, technology readiness, and regulatory compliance were key factors. These results align with other conclusions about small-to-medium-sized enterprises, where commitment to management and technical resources is consistently ranked among the most critical aspects of success (Sultan *et al.,* 2024). These principles have real-life case examples. In the pharmaceutical environment, cloud platforms built on robust validation systems (IQ/OQ/PQ) and ALCOA+ principles have enabled successful usage, providing data integrity with the flexibility for agile use (Ullagaddi, 2024). One more example, based on the Tetra Data Platform, leverages cloud-native BI pipelines to qPCR workflows, providing real-time recording of experimental data and analytics automation, thereby improving experimental workflow productivity (Van Den Driessche *et al.,* 2023). According to case studies in the broader industry, organisations that have deployed big data in cloud-based settings have been found to increase their use in decision-making and gain a competitive advantage with the aid of uniform governance, security, and performance tuning (Abigail, 2022). There are several frameworks and industry guidelines gaining popularity. The TOE model will still offer definitive advice on each of the organisational aspects, environment, and technical issues, as well as what should be planned and implemented in cloud BI systems (Shin *et al.,* 2024). Pharma-E is specialised in risk-based computerised systems validation frameworks, customising IQ/OQ/PQ for dynamic cloud environments. This approach to IQ/OQ/PQ in the cloud aligns with the modern philosophy of ALCOA+ data integrity, achieving compliant flexibility within regulatory requirements (Ullagaddi *et al.,* 2024). In BI deployment practice, a 2024 study identified 18 key variables surrounding BI adoption, including complexity, privacy, compatibility, and regulatory support, and provided actionable directives to guide safe and efficient implementation (Sultan *et al.,* 2024). New Agile-inspired approaches to BI

implementation are also emerging, involving both iterative delivery and organisational involvement to maximise acceptance and utility over time.

Based on the studies, a proposed adoption framework can be established. The start can be represented by executive sponsorship and cross-functional governance. Readiness should be evaluated on technical, human, and environmental levels. The ability of cloud architecture to support the acceptance of compliance and scale-ups in BI workloads should be achieved. Prove pilot, governance-aligned, validated infrastructures; scale to growth with agile BI techniques; monitor and continually optimise; and strengthen the data governance, security, and regulatory alignment in each step (Shin *et al.,* 2024; Gangwar *et al.,* 2015). States and businesses that adhere to such systematic trends experience solid gains. Pharma organisations that utilise AI-enabled BI platforms with verified pipelines are time-saving in lab automation, increase traceability, and enhance regulatory compliance. Institutions conducting research based on QPCR and simulation that benefit from cloud BI report reduced analysis cycles and enhanced collaborative insights (Van Den Driessche *et al.,* 2023). Findings indicated that in non-pharma scenarios, the implementation of cloud BI frameworks by Ghanaian SMEs ensured secure and multi-branch data accessibility, with affordability and user empowerment being of value. To conclude, good leadership, systematic readiness analysis, architecture based on compatibility, adherence to industry regulatory practices, and delivery agility, along with firm governance features, are some of the key success factors in cloud-BI integration (Shin *et al.,* 2024; Abigail, 2022). The implementation of cases, such as pharmaceutical validation models to RT-qPCR analytics, demonstrates how practical competence can lead to studying workable benefits. Frameworks based on TOE, risk-based validation, and agile BI techniques provide safe and scalable integration roadmaps. When combined, those strategic enablers have the potential to lead organisations, including pharmaceutical companies, to efficient and sustainable cloud BI transformation.

2.7 Conceptual Framework and Research Gaps

This conceptual model of the proposed study is organised into three major components: inputs, mediators, and outcomes. These are the independent variables: cloud-based platforms and Power BI tools, which are unified into the R&D digital ecosystem. These tools serve as technological enablers that mediate mechanisms, including data accuracy, collaboration, real-time analytics, and interoperability. This integration is facilitated by strategic enablers, including success factors, theoretical models (TAM, STS, TOE), and industry-specific models. These mediators, in turn, impact the dependent variable, i.e., an increase in research efficiency,

which will be measured in terms of improved decision-making, reduced expenditures, and shorter cycles in the R&D process (Figure 2).

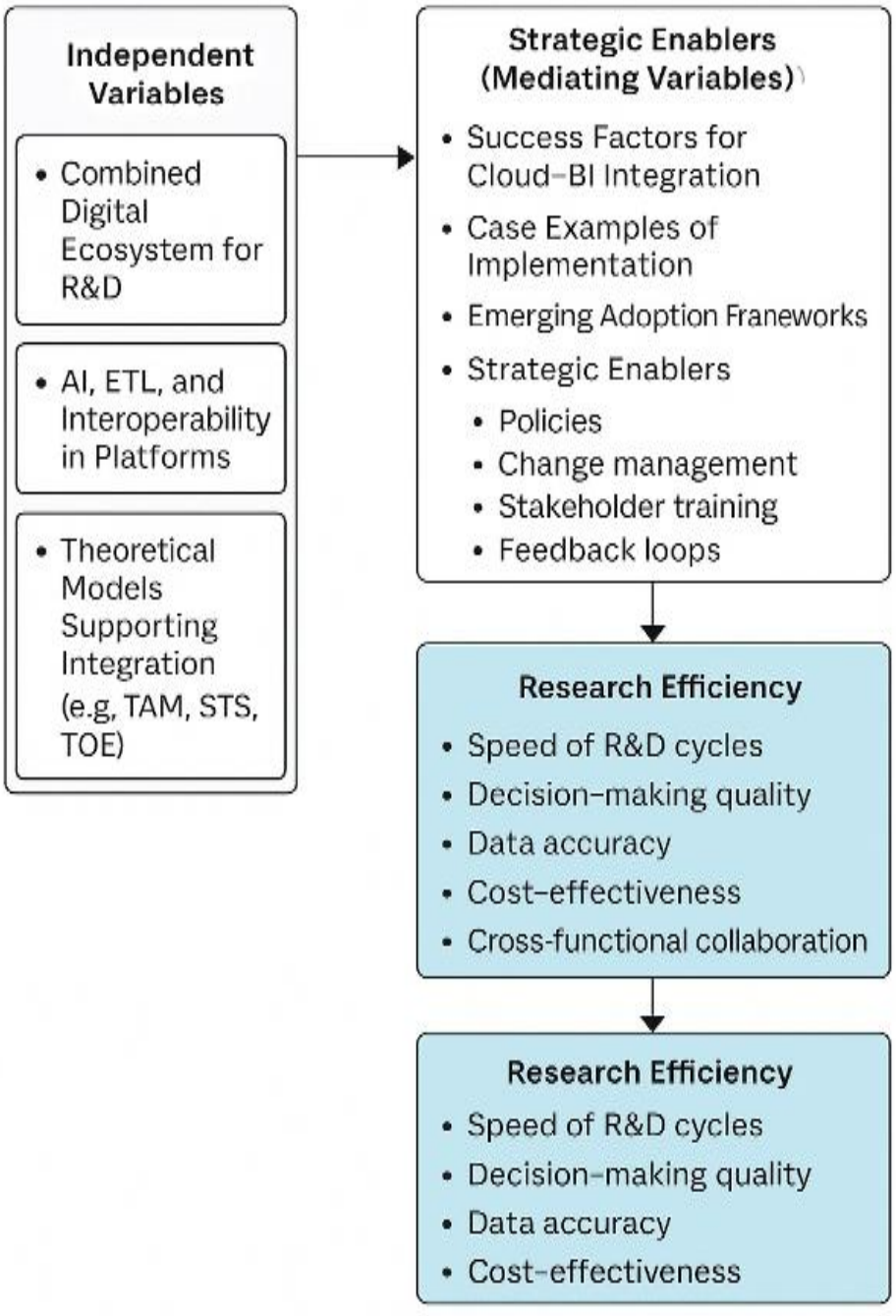

Figure 3: Conceptual Framework

Although cloud computing and Power BI have gained momentum in various sectors of the economy, the literature lacks a comprehensive understanding of the joint effect of cloud computing and Power BI on pharmaceutical R&D, particularly within small and mid-sized companies. The majority of available literature reports on cloud or BI tools in isolation. It fails

to address the reality of the challenge within the context of a regulated industry, such as the pharmaceutical industry. Additionally, there are user resistance, data governance, and compliance issues that are not well addressed in integrated models. Additionally, there is a lack of adequate and practical, theoretically substantiated frameworks guiding the ethical, technical, and organisational implementation of such technologies in the pharmaceutical innovation lifecycle.

2.8 Conclusion

The chapter presents a critical review of the relevant literature in the sphere of cloud computing and Power BI dashboards, as applied to the context of pharmaceutical R&D. It examines their separate and combined effects on research productivity, data access, real-time decision-making, and operational scale-up. The review also found that significant barriers, including technical, ethical, and organisational obstacles, exist to restrain mass adoption, particularly in resource-poor or highly regulated settings. Additionally, it assessed strategic capabilities and emergent frameworks to support implementation. Although academic and industry interest has recently increased, the knowledge on the impact of combining cloud and BI tools on the performance of small and mid-sized pharmaceutical companies remains a clear research gap. It is against this gap that a comprehensive, theory-informed adoption framework with a focus on the pharma R&D lifecycle is warranted.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the methodological framework used in the exploration of how technological advances through cloud-based computing and Power BI dashboards would influence pharmaceutical research and development (R&D) practice. The methodology was also developed to respond to the purpose of the study concerning the need to comprehend both the quantifiable results and the contextual realities concerning digital integration in pharma R&D contexts. In an attempt to attain this, a mixed methods research design was used, which considered a structured survey that incorporated quantitative data analysis and in the form of semi-structured interviews, the qualitative data. The chapter commences with a description of the philosophy of research and the approach to research, and then the research design. It then describes the procedures of data collection, selection methodology, and methodologies to be used in analysing both survey and interview responses. Other sections point out the time limit to take up the study as well as the ethical precautions taken to ensure the research is responsible. This chapter will deliver some transparency and rigour by describing these elements so that the overall research process may have reliability, validity and ethical soundness.

3.2 Research Philosophy

The assumptions about the knowledge development and interpretation are based on the research philosophy of a study. In the current study, positivism is being used as the guiding philosophical position. Positivism is based on the assumption that reality is objective, observable and measurable, and the researchers apply quantitative methods to test the theories through the application of facts and quantitative data (Saunders et al., 2019; Ali, 2024). The philosophy is also suitable for the current study in terms of structured data gathering through the use of surveys and descriptive and inferential analysis that would be used to explore the use of cloud computing and Power BI dashboards in the pharmaceutical R&D practices.

Positivism helps researchers stick to an objective and passive standpoint so that research may serve as objective and repeatable (Creswell and Creswell, 2018). This position reflects the type of large-scale and closed-ended survey questions used, which enables generalisations of the pharmaceutical industry to be made, given that the statistical results are significant. Also, there are some qualitative insights provided via semi-structured interviews, but their presence is rather aimed at enriching the analysis of identified trends, which were identified quantitatively, as opposed to setting the theoretical direction, which continues to adhere to the principles of positivism (Bell et. al., 2022). The reason behind the choice of positivism is that it is applicable

in the exploration of an association between the variables, including cloud adoption, Power BI use, and efficiency in research. These constructs have the advantage of being able to be quantified based on the responses of the participants to the question, where the responses take the form of Likert scales, which can also be used to test the hypothesis and even prove the validity using statistics. In addition, in the studies on technology adoption, positivism is extensively applied in determining the success and perception of digital systems (Venkatesh et al., 2016). Therefore, positivism is the most suitable philosophical foundation for this research as it enables evidence-based and rigorous analysis of the impact of the digital transformation tools on the pharmaceutical research operations.

3.3 Research Approach

The research is deductive, being defined as a type of study in which the existing theories are tested by means of empirical observation and systematic data search. The deductive method is appropriate where the study sets out with predetermined theoretical orientations or explanations and develops a research method to prove the assumptions in a particular environment (Saunders et al., 2019; Kumar and Ujire, 2024). This paper is based on the existing frameworks, including the Technology Acceptance Model (TAM), Technology-Organisation-Environment (TOE) model and Sociotechnical Systems (STS) to investigate the implications of cloud computing and Power BI dashboards on R&D practice in the pharmaceutical industry.

Through a deductive approach to work, the research was expected to test pre-determined variables like the availability of data, the rate of decision-making, and the efficiency of operations, quantified using ordered survey-based queries and ordinal responses. It enables one to validate statistically and identify important relationships between variables that are the focus of positivist research (Creswell and Creswell, 2018). Even though a slight qualitative component (interviews) is applied to augment findings, the general pattern is deductive since these insights are not designed to come up with a theory, but to explain or support quantitative tendencies. Generalisability of the study is also made stronger by the deductive method to allow the researchers to represent the findings about generalised practices of the pharmaceutical industry based on the identified patterns (Bell et. al., 2022). Therefore, the deductive approach leads to a logical coherence of theory, data collection and analysis, and it is therefore the most suitable approach applicable in answering the research questions and research hypothesis in this study.

3.4 Research Design

The research design used in this study is a mixed-methods descriptive research design that aims to understand the extent to which cloud computing and Power BI dashboards impact pharmaceutical R&D practices. Due to combining the measurements of both quantitative (input survey) and qualitative (input interview) scales, a mixed-methods approach allows achieving a more detailed impression of the phenomenon (Creswell and Clark, 2018). In contrast to the quantitative aspect that identifies the pattern and establishes the measure of the correlation between variables, the qualitative component adds depth and contextualization as it allows reflecting on the experience and the perception of the participants in their own words.

The quantitative aspect entailed an explicit online survey including closed-ended and Likert-type questions addressing measurable data among the R&D professionals at several pharmaceutical organisations. This attribute enabled the investigator to carry out a statistical analysis of perceived effectiveness in enhancing accessibility, decision-making, and working efficiency through cloud computing and Power BI dashboards. The qualitative strand involved semi-structured interviews with the chosen members who agreed to continue to participate. These interviews were aimed at implementing the specified information into a more detailed context by accessing insights into adoption issues, implementation strategies, and practice results, providing a clearer background to the survey. Such a layered structure would also comply with best practices in descriptive research, where it would be important to capture both the breadth and depth of information (Saunders et al., 2019).

The design is descriptive so that the investigation into naturally occurring behaviour and attitudes will not be manipulated, and the mixed methods approach enables triangulation since one can see the validity of the study through different data (Bell et. al., 2022). As a whole, this combined approach enables the research to not only measure the effect of digital tools in pharma R&D but also provide the fine-grained organisational and operational insights on what positively and negatively affects successful deployment.

3.5 Data Collection

This paper has used a mixed-methodological research approach that combines quantitative and qualitative research methods and datasets to understand the effect of cloud computing and Power BI dashboards on pharmaceutical R&D processes. Incorporating both statistical and experiential data with the help of this dual strategy contributed to the enrichment of the findings and offered credibility to the information gathered due to the concept of triangulation (Creswell

and Plano Clark, 2018). The quantitative representative had a survey questionnaire that was designed in Google Forms. The questionnaire was placed in the form of several sections, which included participant demographics, cloud consumption interests, and opinions, Power BI adoption, the incorporated effects on the working routine, and obstacles to using. The perceptions were measured with mostly closed-ended questions using a 5-point Likert scale and multiple-choice questions. The survey was shared and disseminated through social media sites like WhatsApp, email, and pharma-related online forums, where the target audience was R&D careers in differing pharma-related environments, including big pharma, biotech startups, and contract research organisations (CROs).

The qualitative part entailed the semi-structured interviews of a purposive sub-sample of survey respondents who reported that they would be willing to engage in follow-ups. The interviews sought to provide deep insights into experiences during the digital transformation process, the difficulties of adopting the process, considerations for regulatory bodies and the overall value of cloud and BI integration. These interviews were done virtually through Zoom or a phone and were recorded with the consent of the participants. The thematic analysis was then done based on these transcribed and coded interviews. By merging two of these approaches, it became possible to see a wider picture of trends, as well as delving into the underlying reality of organisational structures behind the numbers. This methodology guaranteed its generalisability, as well as situational understanding helped in the overall goals of the research.

3.6 Sampling Strategy and Participants

The research utilised a non-probability purposive sampling methodology, as the statistical components in question are perfectly suited to the research that seeks to focus on the specific demographic group due to its expertise and experience (Saunders et al., 2019; Etikan and Bala, 2017). The base of participants was composed of individuals directly involved in pharmaceutical research and development whose activities entail cloud environments and Power BI or other business-intelligence applications. This gave the collected data relevance and made it more informed, as it was based on the practical application of the technologies being investigated. In the quantitative survey, the respondents were identified through social media networks like WhatsApp, pharmaceutical forums and through emails. The screening requirements were present adherence to the pharmaceutical or biotech profession in R&D jobs at the time. The sampling focused on incorporating individuals of various positions, including

data analysts, research scientists, IT managers and quality assurance professionals, to incorporate multidimensional ideas.

In the qualitative interviews, respondents voluntarily opted in; hence, a purposive sub-sample of survey respondents was drawn (Etikan and Bala, 2017). To ensure a representative sample was taken, six participants were identified based on differentiated roles, organisational size, and experience. This enabled the study to elicit wider views about cloud-BI integration, the implementation process and how the users feel about it across the contexts. The interviews, which took place virtually, were conducted over a period of 30 to 45 minutes, and a sample of R&D, regulatory compliance, digital innovation, and operations was interviewed. This two-step sampling was both breadth and depth supporting. The survey helped to develop generalisable trends, whereas interviews made up the context of understanding and organisational processes. The quality of findings was enhanced with the sample diversification, making findings more credible and relevant to the objectives of the mixed-methods study.

3.7 Data Analysis

Both qualitative and quantitative analysis methods have been used in the study, accompanied by the mixed-methods research design. The quantitative survey data and the qualitative interview data were analysed through qualitative statistical analysis and thematic analysis, respectively. The quantitative part was exported to Microsoft Excel and SPSS to conduct the statistical analysis of the answers obtained through Google Forms. Descriptive statistics were employed in describing the demographics of the participants, the level of cloud computing and Power BI adoption and perceived benefits. Cross-tabulations and correlation tests were implemented to investigate interconnections between the variables, like cloud usage and perceived enhancements of decision-making, cost efficiency and collaboration. The Likert-scale responses were used to determine the patterns and trends of these responses that support or refute the stated hypothesis in the research (Bryman, 2016).

In the qualitative element, interviews were transcribed, and their content reviewed and coded through a thematic analysis method (Braun and Clarke, 2021). The first stage was open coding, during which recurrent notions could be identified and further unified in broader themes, including the following: adoption problems, regulation issues, and workflow transformations. Interview-based themes have also been triangulated with survey results to give more insights into the survey results and confirm survey directions. This mixed mode of analysis made the research more accountable as it was solidified through statistical generalisations and

accompanied by the amount of narrative information. The combination of the two methodologies allowed the study to address the research objectives in their entirety, showing both results that could be measured and those that were subjective but practical.

3.8 Time Horizon

This is a cross-sectional time horizon study where the data is collected at only one time, as opposed to having a long-lasting investigation. When investigating participants with the purpose of reflecting their current perceptions, behaviours, or experiences, the cross-sectional approach is deemed suitable in the context of descriptive and exploratory studies (Saunders et al., 2019). Since the nature of this study related to measuring the existing level of cloud computing and Power BI usage in pharmaceutical R&D, the cross-sectional study approach enabled to gathering of the relevant information without using longitudinal monitoring.

The data was collected in a specific period that allows consistency among the factors of context, i.e., organisational priorities, technology trends, and the regulatory environment. Even though the longitudinal study had the capability of offering insights into the variation over time, the cross-sectional approach was appropriate to fulfil the objective of assessing the short-term impacts of digital integration and its challenges in the context of R&D.

3.9 Ethical Consideration

The ethical implications of research were given precedence during the research process, and therefore, the research is sensitive to the rights, dignity, and safety of all research participants. The university has granted ethical permission to start data collection through the general guidelines on research governance. These participants received a Participant Information Sheet, which contained details of the purpose, voluntary nature and scope of the study and a Consent Form was signed by the participants accepting the researcher's permission to participate.

In the case of the quantitative survey, it was anonymous, and no information that could be linked to the participant was recorded. In the case of qualitative interviews, the participants were assured that whatever they said would be anonymised and confined to academic purposes. It was required to include consent forms before taping the interviews, both verbal and written, and the audio recordings and transcripts were kept safe under a password. Participants were told that they could leave the study at any time, and it would have no impact on them. The study also complied with regulations covering the protection of data, such as GDPR, and thus applied confidentiality, its safekeeping, and suitable management of sensitive data (Bryman,

2016). With such measures in place, the research maintained the utmost ethics, encouraging a transparent, trustworthy, and respectful relationship between a researcher and a participant.

3.10 Summary

The chapter has provided a detailed discussion on the research methods that have been used in the study for exploring the impact of cloud computing and Power BI dashboards on the pharmaceutical R&D. A mixed-methods research design was implemented for combining the quantitative insights collected through the survey data along with the in-depth understanding from the interview data. The chapter explained what approaches and philosophical approaches the study has adopted, which was supported by the cross-sectional research timeframe. The study has also considered the ethical stances very carefully by following a set of principles that included informed consent, data confidentiality, data protection and so on.

CHAPTER 4: FINDING AND ANALYSIS

4.1 Introduction

This chapter presents the results of the study and provides a critical discussion by integrating both qualitative and quantitative analyses. The qualitative findings, derived through thematic analysis of interview data, are organised around the main objectives of the study, highlighting key themes such as cloud computing, Power BI dashboards, integration, barriers, and adoption frameworks. The quantitative analysis further complements these insights, offering statistical evidence on perceptions and adoption trends. The discussion critically compares these findings with the existing literature, identifying points of convergence, divergence, and implications for pharmaceutical R&D practices and digital transformation.

4.2 Quantitative data analysis

4.2.1 Cloud Computing's Influence on Data Accessibility, Scalability, and Cost Efficiency

As per the survey analysis, it is identified that the most widespread attitude toward cloud computing in the environment of pharmaceutical R&D is the attitude of scepticism. On the issue of accessibility of data, 88.71% of the respondents strongly disagreed on the subject, although 1.61% agreed, and the proportion of the respondents who strongly agreed that cloud adoption enhances accessibility was also 1.61%.

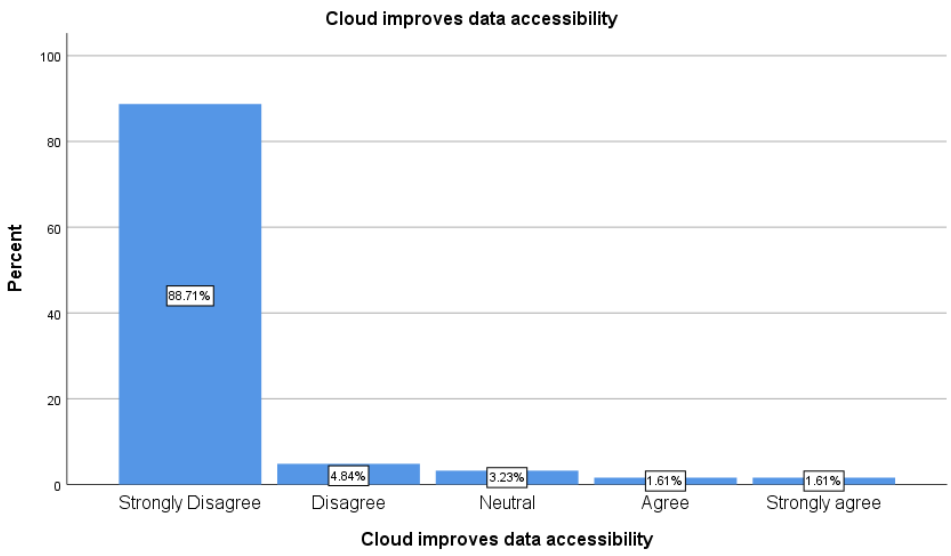

Figure 4: Cloud improves data accessibility.

Furthermore, in the case of scalability, there was a strong disagreement of 35.48% and 40.32% disagreement, leaving only 6.45% in agreement. This represents a carryover to the

infrastructure cost-cutting, where 41.94% strongly disagreed and 35.48% disagreed; however, 3.22% participants agreed.

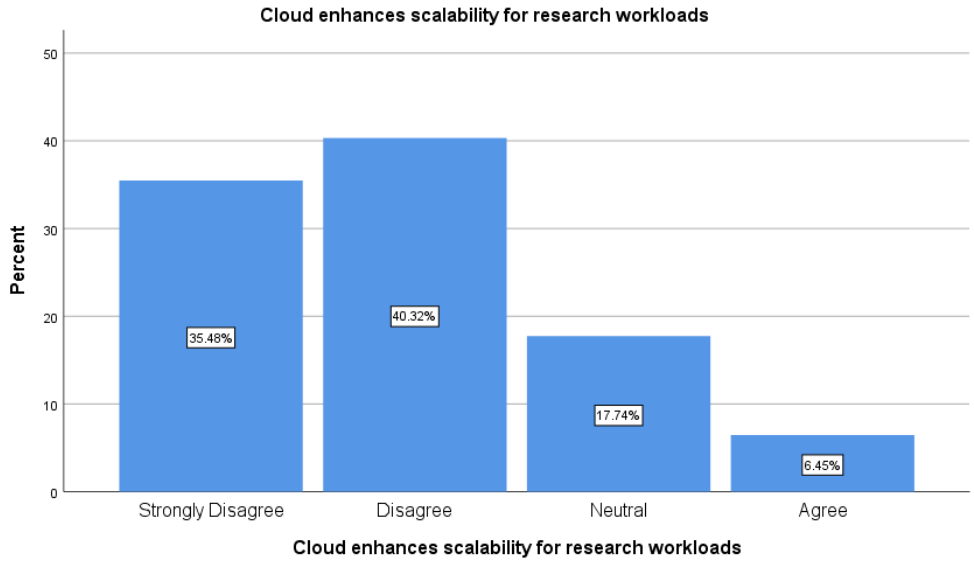

Figure 5: Cloud enhance scalability for research workloads

Moreover, during the analysis, it has been identified that 35.48% participants strongly disagree and 41.94% disagree with the advantage of collaborations through cloud platforms. About the difficulty of compliance and validation, 43.55% agreed that there was a significant difficulty to satisfy compliance requirements, and 38.71% found that there was significant difficulty to validate, which reflects the fact that most of the participants did not notice any significant problem with compliance and validation, but they also did not notice any significant benefits.

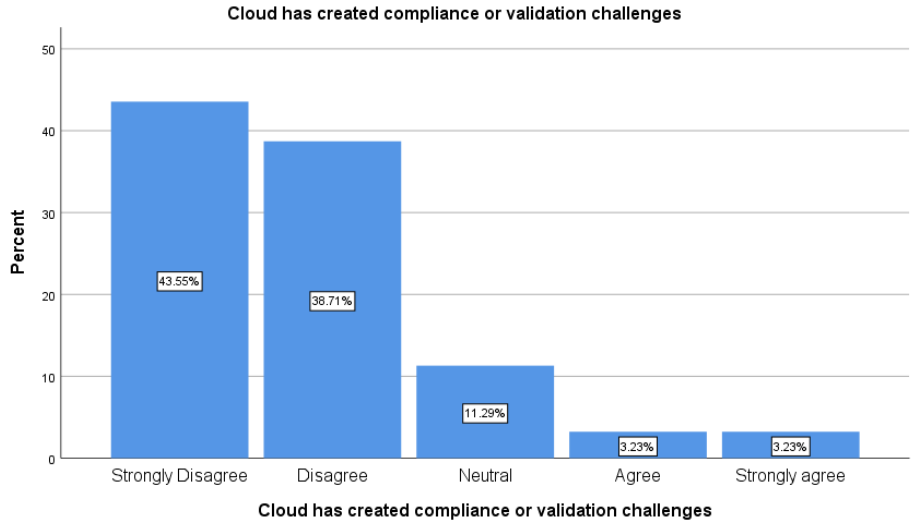

Figure 6: Cloud has created compliance or validation challenges.

One-way ANOVA by inferential analysis revealed that there was consistency in the perceptions of the respondents across the demographic and organisational lines. One-way ANOVA tests showed that all these perceptions were statistically insignificant across job roles, experience of working in the industry sector, or the type of organisations that offered employment. An example is the accessibility of data, which yielded $F(5,56)=0.423$, $p=0.831$; scalability $F(5,56)=0.074$, $p=0.996$; reduction in the cost of infrastructure $F(5,56)=0.543$, $p=0.743$; collaboration $F(5,56)=1.234$, $p=0.306$; and compliance issues $F(5,56)=1.378$, $p=0.246$. These results point out that the negative perceptions do not differ by organisational context because they are widely distributed.

Therefore, it represents that there are contrary to the presumption that cloud computing can improve accessibility, scalability, and cooperation and cut down expenses. Rather, subjects did not support these statements to a large extent, and there was no notable variation between subgroups. This finding is a direct contradiction to the initial portion of the hypothesis of the study, which implies that the perceived advantages of cloud computing are weak and unimpressive within the observed pharmaceutical R&D society.

4.2.2 Effectiveness of Power BI Dashboards in Enhancing Decision-Making, Forecasting, and Workflow Transparency

At the current time, the development and adoption of Power BI dashboards is one of the important aspects because it not only helps to improve transparency but also helps in forecasting and decision-making. As per the analysis, it is identified that there was mixed adoption in which 33.87% represent yes, widely adopted, 48.39% participants represent partially used, and 17.74% respondents recorded No, not used, respectively.

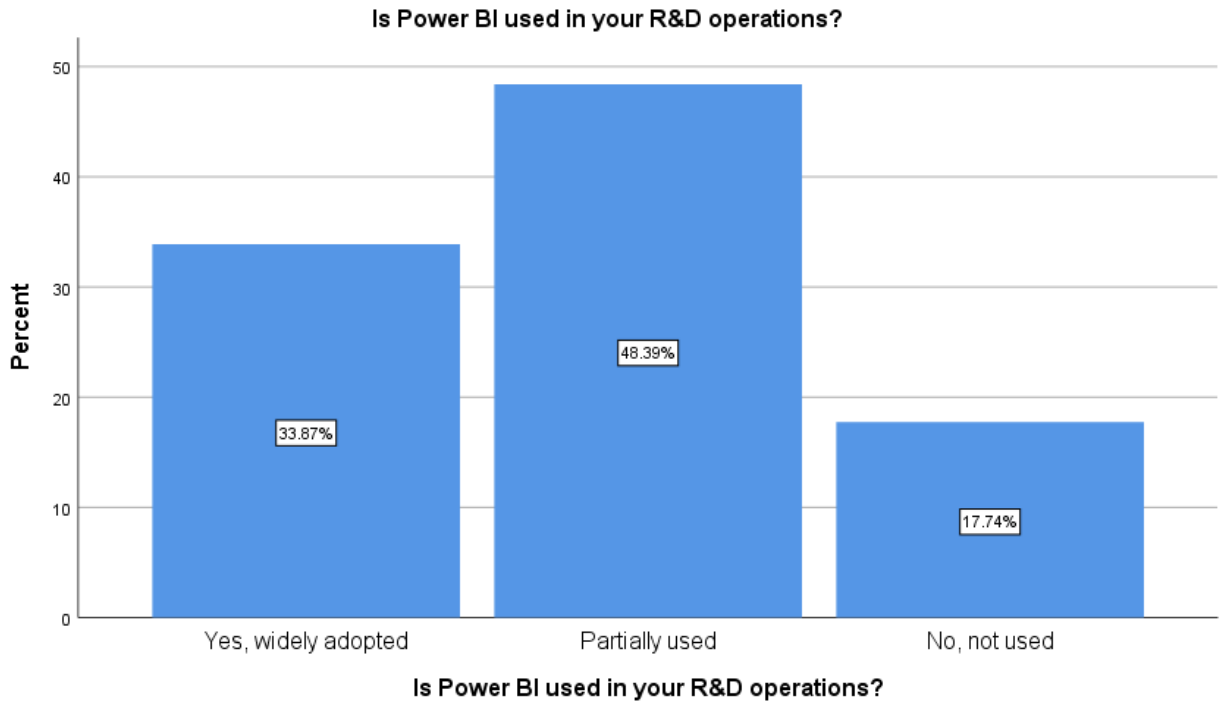

Figure 7: Use of Power BI in R&D operations

Furthermore, concerning usage focus, "If yes, which functions are most frequently used?" revealed monitoring clinical trials 41.94%, Forecasting and trend analysis 35.48%, visualising lab results 14.52% and Regulatory reporting 8.06%.

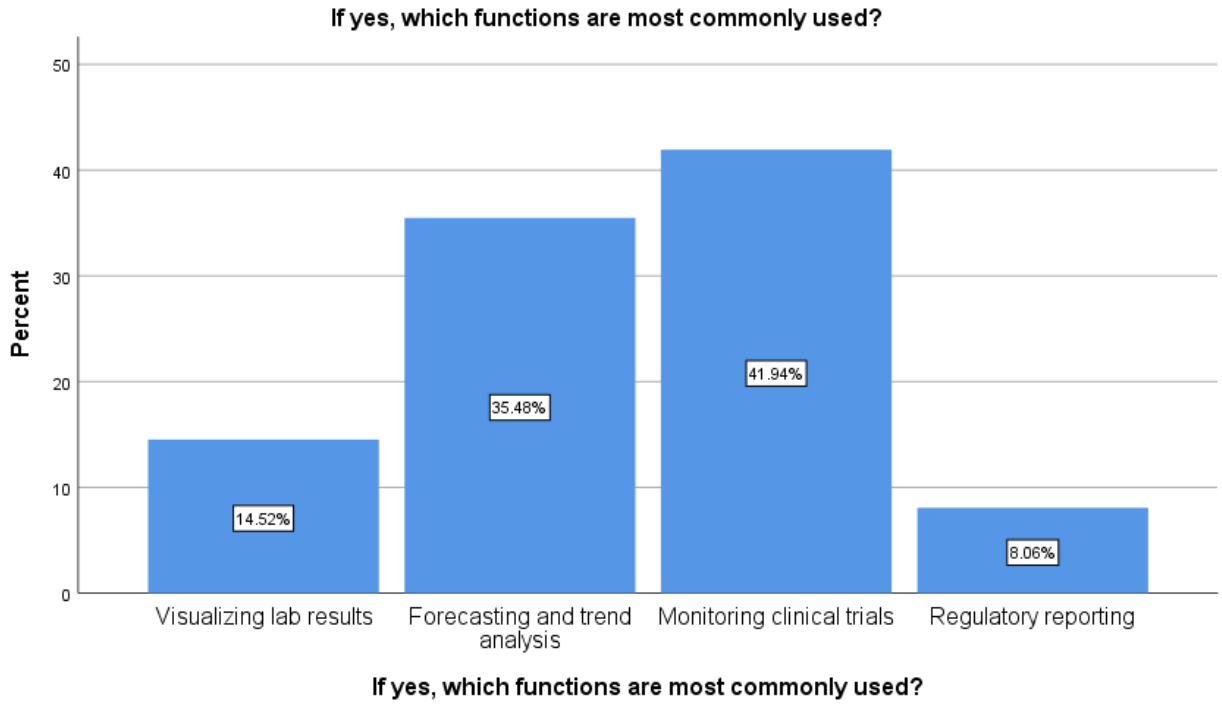

Figure 8: Use of Power BI in R&D Functions

However, as per the analysis, it is identified that views on efficacy were usually negative. On the statement: Power BI helps make faster decisions, Strongly Disagree, 83.87%, Disagree, 11.29%, Neutral, 3.23%, Strongly Agree, 1.61%.

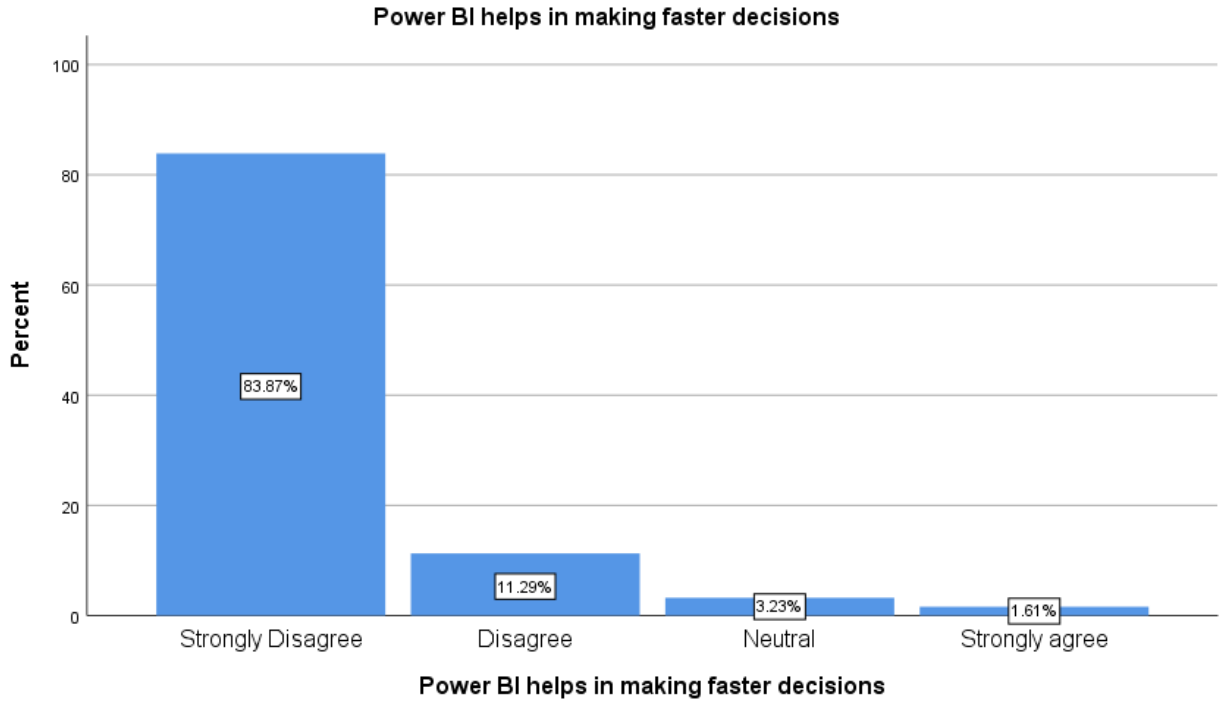

Figure 9: Power BI helps in making faster decisions

Furthermore, in the case of the real-time dashboards update was recorded 45.16% participants strongly disagree, 38.71% disagree, 14.52% are neutral 1.61% agree. Moreover, in the case of "Forecasting with Power BI has reduced trial delays/errors," respondents had Strongly Disagree 47.6%, Disagree 27.0%, Neutral 22.2% and Strongly agree 1.6%.

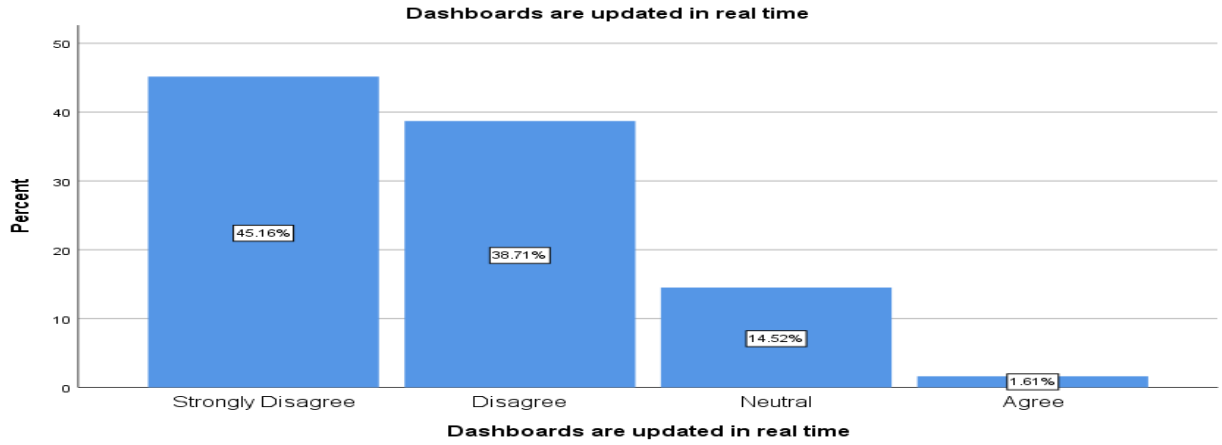

Figure 10 Dashboard updated in real time

Furthermore, as per the analysis, it is identified that the scores on training adequacy were low. 38.1% participants strongly disagree, 41.3% Disagree, 14.3% participants are neutral, and 4.8% agree. In addition, there was low trust, and as per the survey analysis, it is identified that participants strongly disagree (55.6%), disagree (20.6%), neutral (20.6%), and agree (1.6%). According to one-way ANOVA, there was no significant group difference in each of the following Power BI items: use $F(5,56)=0.951$, $p=0.455$; functions used $F(5,56)=0.347$, $p=0.882$; faster decisions $F(5,56)=0.198$, $p=0.962$; real-time updates $F(5,56)=0.602$, $p=0.698$; impact forecasting $F(5,56)$. All these findings are unable to substantiate the hypothesis that Power BI in the surveyed R&D environment significantly enhances speed in making decisions, forecasting relations, or transparency.

One-way ANOVA tests have been utilised to identify whether respondents had different perceptions of Power BI depending on the various categories of their respondents, which included job role, the type of organisation, and previous experience with the industry. The findings represent a non-significant difference, which also shows that there was a widely homogeneous perception between groups. The resulting $F(5, 56) = 0.951$, $p=0.455$ of the test of whether Power BI is used in R&D showed no substantial variance in the adoption among various respondent characteristics. Equally, the most frequently used functions were not distinguished between the groups $F(5, 56) = 0.347$, $p = 0.882$).

Table 1: ANOVA test

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Do you currently work or have you previously worked in a pharmaceutical research and development (R&D) role or team?	Between Groups	.000	5	.000	.	.
	Within Groups	.000	56	.000		
	Total	.000	61			
What is your current job title or role?	Between Groups	1.360	5	.272	.211	.956
	Within Groups	72.060	56	1.287		
	Total	73.419	61			
How long have you worked in the pharmaceutical industry?	Between Groups	1.879	5	.376	.483	.787
	Within Groups	43.557	56	.778		
	Total	45.435	61			
What type of pharmaceutical organisation do you work in?	Between Groups	1.351	5	.270	.443	.816
	Within Groups	34.133	56	.610		
	Total	35.484	61			
Does your R&D team use cloud computing solutions?	Between Groups	1.201	5	.240	.942	.461
	Within Groups	14.283	56	.255		
	Total	15.484	61			
Which cloud provider(s) does your team use?	Between Groups	8.356	5	1.671	1.875	.113
	Within Groups	49.918	56	.891		
	Total	58.274	61			
Cloud improves data accessibility.	Between Groups	1.194	5	.239	.423	.831
	Within Groups	31.644	56	.565		
	Total	32.839	61			
Cloud enhances scalability for research workloads	Between Groups	.319	5	.064	.074	.996
	Within Groups	48.536	56	.867		
	Total	48.855	61			

Cloud helped reduce infrastructure costs.	Between Groups	2.298	5	.460	.543	.743
	Within Groups	47.396	56	.846		
	Total	49.694	61			
Cloud has improved collaboration across teams	Between Groups	4.110	5	.822	1.234	.306
	Within Groups	37.310	56	.666		
	Total	41.419	61			
Cloud has created compliance or validation challenges	Between Groups	6.397	5	1.279	1.378	.246
	Within Groups	51.990	56	.928		
	Total	58.387	61			
Is Power BI used in your R&D operations?	Between Groups	2.379	5	.476	.951	.455
	Within Groups	28.008	56	.500		
	Total	30.387	61			
If yes, which functions are most commonly used?	Between Groups	1.299	5	.260	.347	.882
	Within Groups	41.943	56	.749		
	Total	43.242	61			
Power BI helps in making faster decisions	Between Groups	.475	5	.095	.198	.962
	Within Groups	26.896	56	.480		
	Total	27.371	61			
Dashboards are updated in real time.	Between Groups	1.854	5	.371	.602	.698
	Within Groups	34.484	56	.616		
	Total	36.339	61			
Forecasting with Power BI has reduced trial delays/errors	Between Groups	2.496	5	.499	.585	.711
	Within Groups	47.778	56	.853		
	Total	50.274	61			
Training on BI tools was sufficient.	Between Groups	2.944	5	.589	.809	.548
	Within Groups	40.750	56	.728		
	Total	43.694	61			
Power BI dashboards are trusted by decision-makers	Between Groups	3.189	5	.638	.843	.525
	Within Groups	42.359	56	.756		
	Total	45.548	61			
What has improved the most due to using both tools together?	Between Groups	4.690	5	.938	1.037	.405
	Within Groups	50.681	56	.905		
	Total	55.371	61			
How would you rate your organisation's success in integrating cloud and BI tools?	Between Groups	4.532	5	.906	1.259	.295
	Within Groups	40.323	56	.720		
	Total	44.855	61			
Do you believe your organisation has fully leveraged the potential of cloud-BI integration?	Between Groups	2.320	5	.464	.959	.451
	Within Groups	27.099	56	.484		
	Total	29.419	61			
What support/resources would help with adoption?	Between Groups	7.804	5	1.561	2.104	.078
	Within Groups	41.551	56	.742		
	Total	49.355	61			
Would you be open to a follow-up interview for deeper insights?	Between Groups	.177	5	.035	.377	.862
	Within Groups	5.243	56	.094		
	Total	5.419	61			
Have you seen any case studies or internal examples showing the impact of cloud BI in pharma R&D?	Between Groups	2.043	5	.409	.820	.541
	Within Groups	27.893	56	.498		
	Total	29.935	61			
Does your organisation lack a standardised framework for cloud BI tools?	Between Groups	4.700	5	.940	1.397	.240
	Within Groups	37.687	56	.673		
	Total	42.387	61			
What are the biggest uncertainties in adopting cloud + BI in pharma R&D?	Between Groups	6.507	5	1.301	.898	.489
	Within Groups	81.171	56	1.449		
	Total	87.677	61			
Do you believe Power BI or similar BI tools are ready for regulated pharma environments?	Between Groups	5.177	5	1.035	.981	.437
	Within Groups	59.097	56	1.055		
	Total	64.274	61			
How confident are you in the long-term ROI from cloud + Power BI?	Between Groups	1.202	5	.240	.412	.838
	Within Groups	32.685	56	.584		
	Total	33.887	61			

With regard to effectiveness, the outcome of the question, Power BI assists in making quick decisions, was non-significant ($F(5,56)=0.198$, $p=0.962$), and the question dashboards are updated in real time ($F(5,56)=0.602$, $p=0.698$), as well as showing non-significant output. There were also no differences in perceptions of forecasting benefit ($F(5, 56) = 0.585$, $p =$

0.711) and adequacy of training (F (5, 56) = 0.809, p = 0.548). There was also uniform trust in dashboards with F (5, 56) =0.843, 0.525. Therefore, the analysis suggests that negative or sceptical perceptions of Power BI in creating value around decision-making, forecasting, and transparency in workflow are not exclusive to a particular age group/demographic or an organisation or group. In addition, these perceptions are uniform throughout the pharmaceutical R&D sample, and this fact supports the finding that the uptake of Power BI has yet to result in well-known or statistically differentiated benefits.

4.2.3 Analysis of Cloud BI Integration

During the analysis of the Cloud BI integration, a correlation analysis has been considered, which shows a consistent map of relationships among the cloud attributes, BI capabilities, and the perceived integration outcomes. The similar underlying factor is perhaps most stark in the finding that there is a strong positive relationship between perceptions of the data accessibility of adopting clouds and the perceptions that Power BI was beneficial in helping make faster decisions (r = 0.587, Sig. = .000). Accessibility is also closely linked to the perceived scalability (r = 0.391, Sig. = .002) and the trend of reduction in cost (r = 0.545, Sig. = .000) and collaboration (r = 0.471, Sig. = .000), implying that users who report access improvement also report associated values on other cloud dimensions. The relation between accessibility and the lack/ presence of a standardised structure (r = 0.275, Sig. = .031) also provides support that the opinion regarding accessibility connects with the opinion regarding the structure of the governance.

Table 2 Correlation test

Correlations						
		Power BI helps in making faster decisions	Cloud improves data accessibility	Cloud has improved collaboration across teams	Dashboards are updated in real time	Training on BI tools was sufficient
Pearson Correlation	Power BI helps in making faster decisions.	1.000	.587	.340	.289	.323
	Cloud improves data accessibility	.587	1.000	.471	.111	.054
	Cloud has improved collaboration across teams	.340	.471	1.000	.164	.191
	Dashboards are updated in real time	.289	.111	.164	1.000	.490
	Training on BI tools was sufficient	.323	.054	.191	.490	1.000
Sig. (1-tailed)	Power BI helps in making faster decisions	.	.000	.003	.011	.005
	Cloud improves data accessibility	.000	.	.000	.195	.339
	Cloud has improved collaboration across teams	.003	.000	.	.102	.068
	Dashboards are updated in real time	.011	.195	.102	.	.000
	Training on BI tools was sufficient	.005	.339	.068	.000	.

N	Power BI helps in making faster decisions	62	62	62	62	62
	Cloud improves data accessibility	62	62	62	62	62
	Cloud has improved collaboration across teams	62	62	62	62	62
	Dashboards are updated in real time	62	62	62	62	62
	Training on BI tools was sufficient	62	62	62	62	62

Scalability shows an analogous trend: it is associated with cost savings (r = 0.458, Sig. = .000) and collaboration (r = 0.416, Sig. = .001) and is related to BI outcomes such as shorter decision-making (r = 0.293, Sig. = .021), real-time dashboards (r = 0.265, Sig. =. 037) and improved forecasting (r = 0.290, Sig. = .022 It means that the perceived scalability is linked not only to other cloud advantages but to feasible BI functions. Cost reduction as a factor is also positively correlated with quicker decision-making (r = 0.357, Sig. = .004) and forecasting enhancements (r = 0.282, Sig. = .026) to a familiar pattern of correlation whereby financial and operational benefits go hand in hand. Collaboration also emerges as a facilitator of BI value: it is associated with positive trends in forecasting (r = 0.301, Sig. = .017) and quicker decision-making (r = 0.340, Sig. = .007). It is important to note that compliance or validation concerns themselves are also positively related to both accessibility and scaling, accessibility and compliance issues, r = 0.508, Sig. =.000, and compliance issues are associated with dashboard trust (r = 0.325, Sig. =.010), indicating that those who experienced compliance issues, regardless of whether or not they are specifically articulated based on the survey question, present a particular attitude towards the credibility of dashboards as well.

On Building Intelligence side, there is also strong correlation between real-time dashboards and training adequacy (r = 0.490, Sig. = .000) as well as trust on dashboards (r = 0.480, Sig. = .000) which is indicative of the fact that both perceived competence and trust on the part of the user is closely associated with transparency. Predicted improvements correlate with accelerated decision making (r = 0.381, Sig. =.002) as well as with training (r = 0.386, Sig. =.002), highlighting that training is an imperative predictor of forecasting value, which converts to decision speed. Among the other significant ones related to faster decisions, which are linked to training (r = 0.323, Sig. = .010) and faster decisions in Forecasting (r = 0.381, Sig. = .002). Therefore, these specific correlations represent that the differences in the analysis of variance may indicate the absence of variance between clouds, BI capabilities, training, and trust, and the very correlations within similar entities are significant regarding each one of the criteria. The pattern represents a conditional explanation of the integration outcome; cloud and BI factors co-vary in a way that can facilitate the promotion of better forecasting and decision-making, supposing the presence of organisational enablers, in particular, training and

governance. Imperatively, correlation does not constitute causation, and correlations recognise potential leverage areas like training, in time dashboards, and governance of dropping the results of integration better.

4.2.4 Determinants of BI Adoption and Organisational Readiness

At the current time, BI adoption and organisational readiness are the major aspects. During this analysis, regression test, T-test, and Chi-square tests are conducted. The regression analysis was performed to examine the predictors of whether Power BI is useful in making quicker decisions. The summary of the model reported an R = .663, R2 = .440, and Adjusted R2 = .400. Therefore, the model explained 44% of the variance of faster decision-making. An ANOVA supported confirmation that the regression was statistically important (F(4,57) = 11.178, p = .000). Among the predictors, the Cloud improves data accessibility was the strongest positive contributor (B = .507, t = 4.926, p = .000), showing that accessibility was the most effective contributor in facilitating faster decisions with the aid of BI.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.663[a]	.440	.400	.519	.440	11.178	4	57	.000

Also, sufficient Training on BI tools was a very important factor (B = .188, t = 2.064, p = .044) since practical levels of training had a direct positive impact on the decision-making rewards of BI. The rest of the predictors, such as Cloud has enhanced cross-team collaboration (p = .891) and Dashboards are in real-time (p = .348), were insignificant.

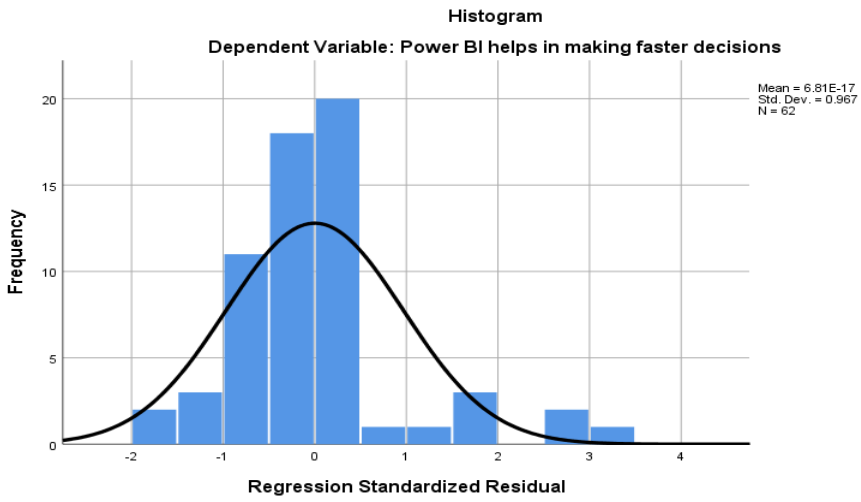

Figure 11: Power BI make faster decisions

This means that although teamwork and dashboard responsiveness are relevant operationally, data availability and proper training are the real factors that will enhance quicker decision-making in this regard.

Table 3: Coefficients table

Coefficients											
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	.086	.223		.383	.703					
	Cloud improves data accessibility	.507	.103	.555	4.926	.000	.587	.546	.488	.774	1.292
	Cloud has improved collaboration across teams	.013	.093	.016	.137	.891	.340	.018	.014	.750	1.334
	Dashboards are updated in real time	.094	.099	.108	.947	.348	.289	.124	.094	.751	1.331
	Training on BI tools was sufficient	.188	.091	.237	2.064	.044	.323	.264	.205	.744	1.345

A second model of regression was run using the dependent variable, "Cloud has enhanced collaboration between teams." The model yielded R = .538, R 2 = .290, and Adjusted R 2 = .240, indicating that collaboration improvement improvements were determined by the post-hoc changes by the predictors by 29 per cent.

Table 4 Model summary

Model Summary									
					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.538[a]	.290	.240	.718	.290	5.816	4	57	.001

The model was large (F (4, 57) = 5.816, p = .001). Some predictors that were significant and represent Cloud improve the accessibility of the data (B = .452, t 2.745, p = .008), Cloud enhances the scalability of research workloads (B = .276, t = 2.238, p = .029), among others. The results suggest that not only accessibility but also scalability are one of key factors that influence enhanced collaboration within pharmaceutical R&D settings. On the other hand, Cloud assisted in minimising infrastructure costs (p = .529), and Cloud has raised compliance or validation issues (p = .987) was not significant, and this indicates that cost reduction and compliance issues are not necessarily related to collaboration outcomes.

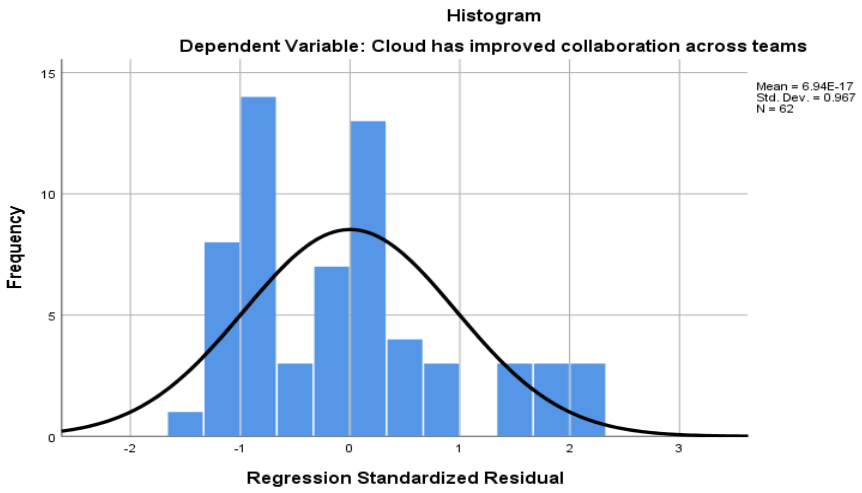

Figure 12 Regression histogram

T-tests on independent samples were carried out to check perception differences between groups. No important difference emerged among those whose R&D teams utilise cloud solutions (M = 1.28, SD = .729) and those not utilising them (M = 1.17, SD =.747), t(60) = .611, p =.543, which suggests a positive impact of cloud on accessibility of data. Equally, any discrepancies between emotions attached to scalability, cost reduction, collaboration, and compliance according to whether they had encountered case studies or not were insubstantial (all p > .05).

Table 5: Independent Samples Test

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Power BI helps in making faster decisions	Equal variances assumed	12.199	.002	1.838	20	.081	.667	.363	-.090	1.423
	Equal variances not assumed.			1.512	8.000	.169	.667	.441	-.350	1.684
Dashboards are updated in real time	Equal variances assumed	1.677	.210	-.760	20	.456	-.299	.394	-1.120	.522
	Equal variances not assumed.			-.711	13.257	.489	-.299	.421	-1.206	.608
Forecasting with Power BI has reduced trial delays/errors	Equal variances assumed	1.633	.216	.732	20	.473	.342	.467	-.632	1.316
	Equal variances not assumed.			.670	12.115	.515	.342	.510	-.768	1.452
Training on BI tools was sufficient	Equal variances assumed	.403	.533	.634	20	.533	.265	.418	-.607	1.137
	Equal variances not assumed.			.615	15.467	.547	.265	.431	-.651	1.181
Power BI dashboards are trusted by decision-makers	Equal variances assumed	13.979	.001	-1.478	20	.155	-.590	.399	-1.422	.242
	Equal variances not assumed.			-1.679	17.737	.111	-.590	.351	-1.329	.149

As an illustration, when it comes to Clouds that assisted in lowering the problem of infrastructure costs, t(46) = -1.193, p = .239 demonstrated that scenario-induced exposure had no significant effect on the perceptions of costs. The next test involved comparing the respondents who felt that Power BI was ready to work in the regulated settings to those who did not. In this case, training on BI tools was enough was the only difference that was not significant, such that the training on BI tools was sufficient, t(20) = .634, p = .533. And the only one with a near significance was a belief in Power BI helps make faster decisions with a higher mean among respondents who believed in the regulatory readiness (M = 1.67) than those who did not (M = 1.00), t (20) = 1.838, p = .081, but this was not significant at the.05 level. All in all, the t-tests reveal that there were no fundamental differences between the groups who experienced similar perceptions in cloud benefits as well as BI advantages, and there was no significant result as evidence of group differences. Chi-square analyses were performed to determine correlations between categorical variables. The correlation between R&D groups in cloud solution and the BI case study awareness was insignificant (chi-square =.597, p = 742).

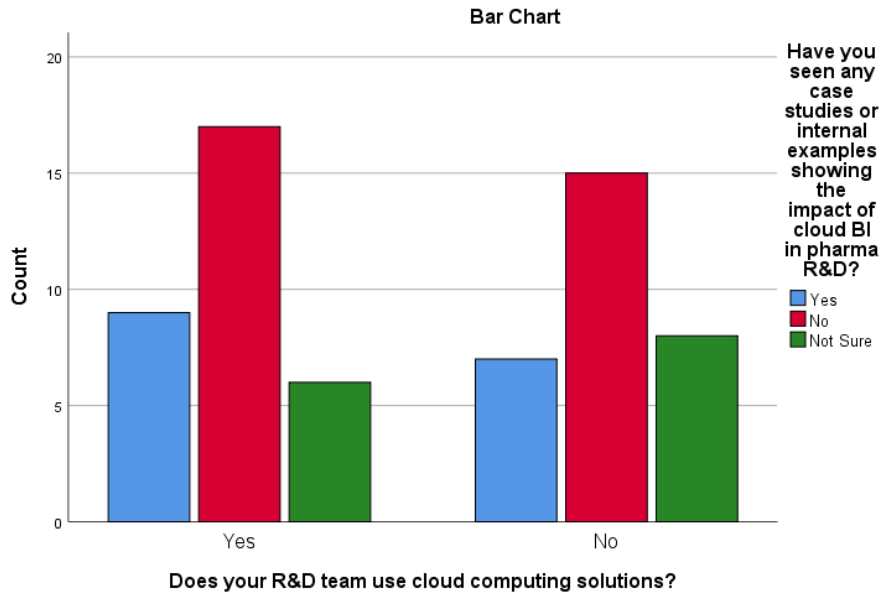

Figure 13 Example related to the use of Cloud BI in R&D

In a similar way, the connection between cloud adoption and a conviction that BI tools are prepared to be used in regulated situations was minor (x2 (3) = 3.266, p = .352). The other tested associations, like the one relating Power BI uptake and being aware of the case (r-value of 585, p = .965) and the integration leverage and the feeling of BI readiness (6 = 3.552, p = .737), were also not significant. These results show that categorical measurements of such as

whether an organisation has adopted cloud or Power BI, are not found to be closely aligned with perceptions of BI readiness or integration potential.

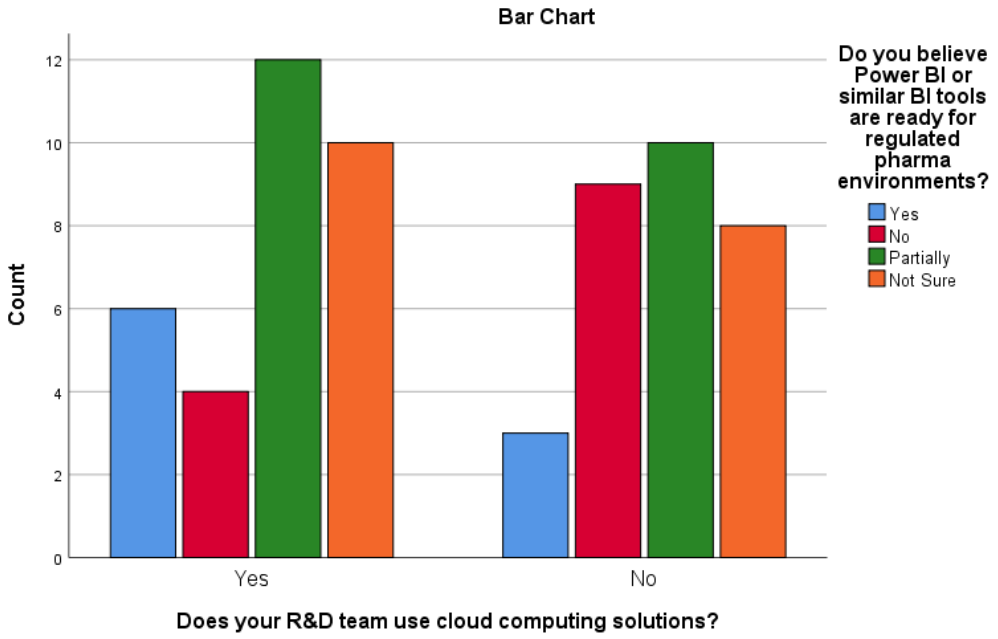

Figure 14: Relation between belief and use of cloud computing

Therefore, the findings point to the fact that the availability of data and sufficient training on BI tools are the most critical factors that determine the adoption and effectiveness of BI, as depicted by the regression results. Scalability is also an advantage to increase collaboration; however, cost savings and compliance difficulties did not represent a key factor. The chi-square analyses together with the t-tests essentially indicate a lack of group effects and the existence of categorical correlations, which points to an overall agreement in how the respondents perceived the given issue. These results confirm that, notwithstanding organisational infrastructure and tools implementation, outcome differentiators of BI success within pharmaceutical R&D remain efficiency in accessing information and any related training of end-users.

4.3 Qualitative Analysis

4.3.1 Theme Development

Table 6: Themes development

S. No.	Objective	Theme	Keywords
1	To explore how cloud computing contributes to improved access to data, system scalability, and cost-effectiveness within pharmaceutical R&D processes.	Cloud computing contribution towards enhancement in pharmaceutical R&D processes	data accessibility, real-time visibility, scalability, pay-as-you-go, cost efficiency, batch record management, digital infrastructure, cloud adoption
2	To assess the role of Power BI dashboards in enhancing data interpretation, workflow transparency, and decision-making efficiency in pharma research environments.	Role of Power BI dashboards	data interpretation, workflow transparency, faster decision-making, real-time updates, anomaly detection, visualisation, time-saving, limited adoption
3	To investigate the synergistic impact of cloud-based platforms and BI tools on improving data management, decision accuracy, and research efficiency.	Impact of Cloud-based platforms and BI tools	integration, interoperability, ERP-MES linkage, predictive compliance, data management, decision accuracy, research efficiency, AI-assisted detection
4	To identify the technical, ethical, and operational barriers that pharmaceutical organisations face when implementing cloud and BI technologies.	Barriers faced by pharmaceutical organisations while implementing cloud and BI technologies	technical skills gap, steep learning curve, compliance (GDPR/HIPAA), data security, cost constraints, cultural resistance, legacy systems, change management
5	To propose an actionable framework for the adoption of integrated cloud and Power BI systems within pharmaceutical R&D teams.	Actionable framework for the adoption of integrated cloud and Power BI systems	phased adoption, modular rollout, training, governance, compliance, interoperability, executive sponsorship, change management, user readiness

4.3.2 Cloud computing contribution towards enhancement in pharmaceutical R&D processes

Based on the interview findings, participants highlighted the significant role of cloud computing in enhancing data accessibility, scalability, and cost-effectiveness within pharmaceutical R&D. One participant noted that "we still use a mix of paper batch records and electronic systems", yet the transition to cloud platforms is gradually enabling greater visibility and efficiency. Another participant explained that "we can look at that information in real time", showing how cloud systems improve immediate access to critical data for decision-making. Cost-effectiveness was also emphasised, with a participant observing that "it all depends on… budget… modules", indicating that modular adoption strategies can reduce financial burdens. These insights reveal that cloud adoption not only strengthens data accessibility and operational scalability but also supports cost-efficient digital transformation, thereby improving the agility and competitiveness of pharmaceutical R&D organisations.

4.3.3 Role of Power BI dashboards

The interview findings indicated that Power BI dashboards have contributed to improved data interpretation, transparency, and efficiency in pharmaceutical research settings. Participants stressed that dashboards help visualise trends more clearly, with one noting that "the dashboard flagged an unusual spike in rejects in real time… we adjusted… immediately", highlighting the role of dashboards in quick problem identification and corrective action. Another participant reported that "it reduced time to nearly half", showing how Power BI facilitates faster decision-making and workflow management. However, adoption remained uneven, with one participant commenting that "Power BI is not something which is being used very frequently… it is at a smaller level", suggesting that its use is still limited in some environments. Overall, the evidence shows that Power BI dashboards can enhance interpretation and efficiency when adopted, but integration and wider accessibility remain areas for further improvement.

4.3.4 Impact of Cloud-based platforms and BI tools

Interview findings revealed that the combined use of cloud platforms and BI tools creates a strong synergy that improves data management, decision accuracy, and research efficiency. Participants highlighted how integration supports faster and more reliable processes. One participant explained that "fully paperless batch records… AI-assisted detection" are becoming feasible when cloud and BI work together, streamlining compliance and record-keeping. Another participant noted that "improve the integration between ERP and MES",

demonstrating how cloud-embedded BI dashboards can unify multiple systems into a single source of truth. And one respondent indicated that "predictive compliance is becoming a reality", a reflection of the impact of BI and cloud on proactive monitoring and forecasting. In combination, these cases demonstrate that cloud computing and Power BI not only increase the accuracy of decision-making but also promote efficiency and innovation throughout pharmaceutical R&D processes.

4.3.5 Barriers faced by pharmaceutical organisations while implementing cloud and BI technologies

The interviews helped identify some of the technical, ethical, and operational obstacles impeding the implementation of cloud and BI technologies in the pharmaceutical organisations. Participants mentioned some technical obstacles, with one noting that "the learning curve was steep for some operators" and another adding that "we don't have the skill sets…not enough data analysts", indicating the challenge of unskilled individuals. Ethical and compliance concerns were also discussed, as one respondent stated that "it has to be GDPR compliant… the security of that data", emphasising the sensitivity of clinical and patient data. Barriers to the operations, like cost and adoption strategies, were also addressed, with one saying "it all depends on… budget… modules". Overall, these findings indicate that despite the efficiency-related advantages that cloud and BI tools present, they can only achieve success when they manage to overcome skills shortages, secure good compliance and deal with financial and organisational restraints.

4.3.6 Actionable framework for adoption of integrated cloud and Power BI systems

The results of interviews with several cloud and BI experts indicated the need to develop an actionable framework to adapt cloud and BI systems to the pharmaceutical industry with a view to integration, compliance, as well as user friendliness. Respondents also emphasised the significance of modular and scalable approaches, with one stating that "it all depends on… budget… modules", which pinpoints the necessity to roll it out in flexible ways depending on resources. The usability was also highlighted by one of the participants, who noted that the system should be "user-friendly… for shop floor adoption", signifying issues within training and design. Cross-digital platform integration was also viewed as an essential component, with one respondent stating to "improve the integration between ERP and MES". These conclusions point to the need to develop a comprehensive framework that would integrate the phased implementation, the training of the staff, and an efficient compliance system. This would make

the cloud and BI tools accessible and well-integrated with long-term efficiency in R&D processes.

4.4 Discussion

4.4.1 Cloud computing contribution towards enhancement in pharmaceutical R&D processes

Based on the findings obtained through the interview data, it was found that the adoption of the cloud is rapidly transforming the pharmaceutical R&D processes by enhancing access to data and operational scalability. Participants of the interview also asserted that while "a mix of paper batch records and electronic systems" is still utilised, this shows that cloud platforms increasingly help in the real-time monitoring and also the faster access to critical information or data. Another participant confirmed that "we can look at that information in real time", demonstrating how cloud systems reduce delays in decision-making. These accounts align with the literature, which emphasises that cloud adoption allows centralisation of data across sites and provides elastic computing capacity for large-scale simulations and analytics (Banimfreg, 2023; Kaippully, 2024). Moreover, literature suggests that cloud-hosted services such as AWS and Azure enable scalable access to global data repositories, supporting more collaborative and efficient research pipelines (Sugandha, 2023; Reinhardt et al., 2020).

However, the quantitative results presented a more sceptical picture. A large proportion of survey respondents strongly disagreed that cloud platforms improve accessibility or cost efficiency, with 88.7% rejecting the claim of enhanced data access. This contrasts with both the literature and the interview findings, which broadly emphasised the enabling role of the cloud. The survey responses may reflect organisational inertia, limited exposure to cloud-native systems, or concerns about compliance. Indeed, the literature identifies data privacy, GDPR, HIPAA, and GxP compliance as persistent inhibitors of adoption (Alharbi, 2022; Sugandha, 2023). These compliance and governance concerns may explain why the survey captured more resistance, while interviews—conducted with participants who had direct exposure to implementation—reported more tangible benefits.

Scalability emerged as a clear benefit across interviews and the literature. The ability to expand storage and compute resources on demand was noted as a major advantage, allowing pharmaceutical firms to manage peak workloads efficiently. The literature confirms that hosted models reduce the total cost of ownership when utilisation is below 70% of on-premises capacity, providing greater financial flexibility (Banimfreg, 2023). Yet, survey responses again

reflected caution, suggesting that concerns about validation, reconfiguration costs, and infrastructure complexity may overshadow perceived cost benefits. Cloud systems can cut documentation time by 78% and boost audit accuracy by 92%, but organisations still weigh these benefits against overhead costs and technical barriers (Mosali, 2025).

4.4.2 Role of Power BI dashboards

The interview findings emphasised that Power BI dashboards can improve interpretation of data, transparency of workflows, and decision-making efficiency in pharmaceutical R&D. One participant explained that "the dashboard flagged an unusual spike in rejects in real time… we adjusted… immediately", illustrating the role of dashboards in surfacing anomalies and supporting immediate corrective action. Another participant observed that dashboard use "reduced time to nearly half", reflecting how BI tools contribute to quicker insights and operational efficiency. However, not all participants reported consistent usage, with one stating that "Power BI is not something which is being used very frequently… it is at a smaller level", highlighting limitations in adoption and accessibility. The literature strongly supports the potential of BI dashboards in data-intensive settings. Power BI enables dynamic reporting and prescriptive analytics, helping researchers accelerate decisions and optimise trial design (Zingde and Shroff, 2020). The platform consolidates large, heterogeneous datasets into visual dashboards that are accessible even to non-technical users, thereby increasing transparency across teams (Osho et al., 2020). forecasting dashboards reduce errors and improve efficiency in clinical trial management, aligning closely with the interview evidence of time savings and transparency (Goncalves et al., 2023).

In contrast, survey results presented a more sceptical perspective. A majority of respondents disagreed that Power BI dashboards enhanced faster decision-making, with 83.9% strongly rejecting the claim. Similarly, nearly half of the participants disagreed that dashboards offered real-time updates or improved trust in data outputs. These results suggest that, in practice, the full potential of Power BI is not being realised across organisations. Barriers may include limited access to premium licenses, a lack of integration with legacy lab systems, or insufficient training for end users. Compliance validation, middleware complexity, and user resistance are widely recognised as the biggest challenges to successful BI adoption within the pharmaceutical context (Beem, 2019; Orlovskyi and Kopp, 2020). A critical comparison of results shows that the literature and interviews centre on the potential of BI dashboards as enabling, but the results collected through the survey indicate more practical weaknesses in terms of implementation. The inconsistency indicates that although Power BI can be proven

very effective in enhancing the transparency of workflow efficiency, its advantages are limited to good training programs, excellent governance, and appropriate infrastructure. BI integrated with AI and machine learning can automate decision-making, but until workflows and quality inputs of data have been validated, dashboards may misinform as opposed to inform.

4.4.3 Impact of Cloud-based platforms and BI tools

The interviews highlighted that the combined use of cloud platforms and BI tools strengthens data management and enhances decision accuracy in pharmaceutical R&D. One participant explained that "fully paperless batch records… AI-assisted detection" illustrates how cloud and BI integration can streamline compliance and reduce manual workloads. Another emphasised the importance of interoperability, suggesting the need to "improve the integration between ERP and MES", reflecting how cloud and BI dashboards together can unify disparate systems into a consolidated view. Similarly, one participant pointed out that "predictive compliance is becoming a reality", suggesting that the combined use of cloud analytics and BI forecasting supports proactive monitoring and informed decision-making. The literature strongly supports these synergistic benefits. Cloud-based ETL pipelines integrated with BI dashboards reduce latency, optimise schema evolution, and improve scalability (Tran, 2024; Seenivasan, 2024). Integration supports real-time visualisation and automated decision-making through machine learning and NLP-driven dashboards (Syed and Nampally, 2021). Empirical studies show that such AI-enabled systems can reduce manual data handling by 60–70%, accelerating efficiency in research workflows (Islam et al., 2024). The Sociotechnical Systems (STS) framework further underlines that adoption must balance technical optimisation with organisational processes, ensuring integration enhances both efficiency and usability (Thomas, 2024).

However, the correlation analysis based on the survey data suggested that accessibility and scalability of cloud systems are linked to improved BI performance; respondents remained doubtful about the overall impact. A majority expressed scepticism that BI dashboards truly enhance efficiency or decision-making, with 83.9% strongly disagreeing with the claim of faster decision-making. Yet regression analysis revealed that training and accessibility were key predictors of BI's perceived value, confirming the literature's emphasis on facilitating conditions in the Technology Acceptance Model (Wandira et al., 2024). This suggests that the synergy between cloud and BI is not solely technical but also contingent on user readiness, training, and governance. A critical comparison shows that while interviews and literature emphasise the transformative synergy of cloud and BI—particularly in areas such as automation, forecasting, and compliance—survey data underscores the implementation gap.

Organisations might have implemented cloud or BI in silos, resulting in an inability to have perfect integration, or they might not have trained their employees on how to use the cloud and the BI in combination. This goes along with why innovation is emphasised in literature and practitioner narratives, although survey respondents are sceptical.

4.4.4 Barriers faced by pharmaceutical organisations while implementing cloud and BI technologies

The findings of the study also showcases number of technical ethical and operational barriers that impacts the implementation of the cloud and BI systems within the pharmaceutical R&D. Interview participants frequently highlighted issues of usability and skills, with one noting that "the learning curve was steep for some operators" and another observing that "we don't have the skill sets… not enough data analysts". These concerns align with the literature, which repeatedly identifies human capital shortages and resistance to change as critical inhibitors of digital transformation (Bahaa-El-Din, 2024; Kaippully, 2024). Cost and deployment strategies were mentioned in terms of an operational perspective: one participant stressed that "it all depends on… budget… modules" and the need to balance innovation with the constrained resources. The second strong theme was ethical and compliance barriers. Respondents emphasised the necessity of strong governance, with one noting that it must be GDPR compliant… the security of that data. These issues are similar to those highlighted in the literature about the complexity of regulations, such as GDPR, HIPAA and PIC/S Annexe 11, which are demanding validation, audit trail, and cross-border data transfer (Singh, 2023; Molkander et al., 2022). Ethical issues cannot be reduced to regulatory controls, but also include patient consent and data privacy, and responsible data sharing. Such compliance and ethical risks tend to curb the adoption, as organisations are concerned about revealing sensitive R&D data to the multi-tenant environment (Sriram et al., 2025).

The findings obtained through the surveys showed that the issues of compliance and trust have a noticeable effect on the perception and adoption. A significant number of the respondents neither agreed nor strongly disagreed that cloud tools or BI tools increased accessibility, efficiency, or collaboration. Such opposition could be due to the doubt that the integrity and security of data can be preserved in decentralised systems. These perceptions are supported by that BI dashboards tend to have issues of validation and audit, and cloud service integration with legacy systems can be problematic in terms of security (Orlovskyi and Kopp, 2020). There are also operational and organisational barriers to change, which include organisational culture and resistance (Beem, 2019). As the literature reveals, pharmaceutical organisations have

always been risk-averse, as they prefer established approaches to more disruptive technologies (Bahaa-El-Din, 2024). This sentiment is mirrored in interviews as interviewees recount the issues they had in user adoption and training. Unless there is explicit change management, such as executive sponsorship, communications, and iterative training, employees might switch back to legacy systems, sabotaging the realisation of the cloud and BI (Mijkander et al., 2025).

4.4.5 Recommendations for the adoption of integrated cloud and Power BI systems

The results of interviews, surveys, and literature reviews indicate that pharmaceutical research and development can adopt cloud and Power BI systems with a methodical, multidimensional approach. The initial recommendation is to have phases of implementation. Participants stressed that adoption can hinge on "budget… modules" and therefore indicated that organisations can adopt in phases in situations of modular rollout. Literature also agrees with it, suggesting pilot projects, which mitigate initial risk and enable lessons learned to be applied to the larger deployments (Shin et al., 2024). Secondly, the findings strongly indicate the importance of training and user readiness. A lack of skilled data analysts and steep learning curves were noted in interviews. Survey regression analysis further confirmed training as a critical predictor of BI effectiveness. This underscores the need for continuous capability-building programmes. Literature echoes this, highlighting upskilling initiatives as essential to ensure compliance and foster user trust (Bahaa-El-Din, 2024; Kaippully, 2024). Pharmaceutical organisations should invest in role-specific training to enhance adoption at both operational and managerial levels.

Third, governance and compliance frameworks must be prioritised. Concerns about GDPR and data security were consistent in both interviews and the literature. Prior studies demonstrate that cloud adoption is only sustainable if robust governance systems—including audit trails, validation protocols, and risk-based frameworks such as Pharma-E and ALCOA+—are embedded from the start (Ullagaddi, 2024; Molkander et al., 2022). Establishing cross-functional governance boards that include IT, quality assurance, and compliance units can ensure data integrity while maintaining agility. Fourthly, the integration of cloud and BI should focus on interoperability and system unification. Interviewees pointed to the need for better integration between ERP, MES, and BI dashboards. Literature supports this by recommending interoperable ecosystems that enable seamless data exchange across platforms (Tran, 2024; Snowflake Inc., 2025). This not only improves efficiency but also reduces silos that otherwise undermine transparency and collaboration.

Finally, leadership and change management are crucial enablers. Another key challenge is resistance to innovation, which the survey data also illustrated by the unfavourable responses. In the literature, the results are consistent, showing that executive sponsors, effective communication, and agile adoption techniques enhance acceptance (Owusu et al., 2020; Sultan et al., 2024). Organisations must appoint change champions who will spearhead adoption and offer continued support so that the cultural aspect aligns with digital transformation objectives.

4.5 Summary

This chapter provided both qualitative and quantitative analysis on use of cloud computing and Power BI dashboards in pharmaceutical R&D. Thematic analysis of the interview identified five core themes: the role of cloud in enabling access to data and scalability, the role of power BI in decision making, the synergistic effect of integrated systems, barriers to adoption and an actionable framework. Quantitative survey data have complemented these findings, with scepticism being expressed more strongly in respect to efficiency and adoption. Through a comparative analysis of the literature available, the discussion has critically analysed the identified insights during the research. Taken together, the findings highlight opportunities, challenges, and practical ways of digital transformation in R&D.

CHAPTER 5: CONCLUSION & RECOMMENDATIONS

5.1 Introduction

This chapter brings together the key outcomes of the study and situates them within the broader academic and practical context. It summarises the main findings in relation to the research objectives, highlighting how cloud computing and Power BI dashboards influence pharmaceutical R&D practices. The chapter then compares these findings with existing literature, outlines practical recommendations for industry adoption, and reflects on the study's limitations and contributions. Finally, it suggests avenues for future research and concludes with a personal reflection on the dissertation process, emphasising its academic and professional significance.

5.2 Summary of Main Findings

This research focuses on how cloud computing and Power BI dashboards would transform the pharmaceutical research and development (R&D). By combining interview-based thematic insights with survey results, the study presents an in-depth perspective of the perceived and actual impacts of these technologies on the industry. The first objective of the study was to explore how cloud computing contributes to improved access to data, scalability, and cost-effectiveness. The survey results showed that there was a high percentage of scepticism, using strong disagree data, with 88.71% of the respondents disagreeing that cloud is beneficial for accessibility, 75.8% disagreeing with the scalability factor, and 77.4% disagreeing about cost reduction. Interviews, however, gave a non-obstructive picture. Although issues with compliance and validation were noted by participants, a variety of concrete advantages also emerged: enhanced cooperation across sites globally, interoperability of R&D produced data, and the ability to respond to challenges more rapidly due to greater availability of real-time information. Such divergence implies that, despite operational realities undermining the perceived value of cloud, its potential has been identified by practitioners through the observed benefits of particular efficiency.

The second aim was objective was to assess the role of Power BI dashboards in enhancing interpretation, workflow transparency, and decision-making. The results of the survey were mostly negative: 83.87% disagreed that Power BI could make decisions faster, 47.6% disagreed that it could speed up the trials, and 79.4% did not feel it could help us in the real-time context. Training inadequacy was flagged by 79.4% of respondents, and trust in dashboards was low, with 76.2% expressing doubt. In contrast, interview participants emphasised that when deployed effectively, Power BI dashboards enhanced forecasting, improved trial monitoring,

and facilitated transparency across teams. However, they also stressed that these benefits required strong data governance and adequate user training, reinforcing survey findings about gaps in capability and trust. The third objective was to investigate the synergetic impact of cloud-BI integration. The correlation analysis indicated that cloud accessibility and performance conversions in decision-making through Power BI are positively correlated with each other, indicating the ability of one technology to foster the efficacy of the other. This was affirmed by interviewees who said that the interconnected systems made it possible to achieve a flow of data, anomaly detection, and accelerated hypothesis iteration. They claimed that integration and not isolated adoption are the keys to making R&D workflows as efficient and accurate as possible.

The fourth objective was to determine technical, ethical and operational barriers. Both data sources identified numerous obstacles. The survey-based responses highlighted compliance and validation as the key challenges, and the interviews added contextual nuance, citing the difficulties with integration of legacy systems, regulatory frameworks which were highly demanding and employee resistance. Ethical considerations relating to the issue of data sovereignty and patient privacy were also highlighted and were in line with the wider industry discussion. Most notably, both data sets showed organisational resistance, where employees were fearful of being made redundant and were not ready to give up legacy tools. Therefore, it is evident that organisational readiness must be equally prepared as the technical one. The last aim was to recommend an adoption framework that can be implemented. Both literature and empirical evidence pointed to the fact that executive sponsorship, strong governance, and iterative approaches to adoption are important. The interviewees singled out the usefulness of pilot testing, ongoing training and communication strategy. The survey data supported this, as correlations showed that adequate training and trust significantly improved perceptions of decision-making and forecasting value.

In conclusion, the findings illustrate a notable gap between the potential of cloud computing and Power BI dashboards and their current perceived effectiveness. While surveys reflected widespread scepticism, interviews demonstrated that with proper governance, training, and integration, these technologies can significantly enhance pharmaceutical R&D efficiency. Successful adoption, therefore, depends on bridging perception gaps through structured frameworks, organisational readiness, and cultural change.

5.3 Comparison with Literature

The findings of this study both reinforce and challenge existing literature on the adoption of cloud computing and Power BI dashboards in pharmaceutical R&D.On cloud computing, prior research consistently emphasises its benefits in enhancing accessibility, scalability, and cost-effectiveness (Banimfreg, 2023; Straits Research, 2024). Literature highlights cloud ecosystems as critical enablers of collaborative and real-time analytics, with small firms particularly benefiting from pay-as-you-go models (Sachdeva et al., 2024). However, this study's survey findings revealed strong scepticism, with over 75% of respondents disagreeing that cloud improved scalability or reduced costs. Interviews partially resolved this inconsistency, with practitioners describing practical advantages such as international cooperation or interoperability, but also highlighted the regulatory and professional validation as barriers. This discrepancy indicates that although literature might over-emphasise the universal benefits of cloud, adoption performance is sensitive to compliance contexts and organisational preparedness.

In the case of Power BI dashboards, the literature discusses them as data visualisation, forecasting, and decision support tools that are transformative (Osho et al., 2020; Daruvuri et al., 2024). Literature suggests that they can help to minimise trial delays and enhance transparency when AI-driven analytics is leveraged (Zingde & Shroff, 2020). By contrast, survey findings were overwhelmingly negative: 83.87% strongly disagreed that Power BI enabled faster decisions, while 79.4% doubted training adequacy. Yet, interviews echoed literature in highlighting that when properly deployed, dashboards improved trial monitoring and workflow transparency. This contrast reflects a critical implementation gap where theoretical potential is undermined by inadequate training and resistance within R&D environments. On integration, the literature aligns closely with this study. Both confirm that synergy between cloud and BI tools enhances efficiency, collaboration, and innovation (Syed & Nampally, 2021; Wandira et al., 2024). Finally, barriers identified in this research—legacy system integration, compliance, governance, and cultural resistance—mirror those discussed in prior work (Bahaa-El-Din, 2024; Molkander et al., 2022), affirming that adoption is shaped as much by human and regulatory factors as by technological readiness.

5.4 Recommendation

Based on the findings of this study, the following recommendations are proposed for pharmaceutical organisations aiming to leverage cloud computing and Power BI dashboards effectively:

S. No.	Recommendation Area	Recommendations
1	Enhance Training and Capacity Building	• Implement structured training programmes tailored to R&D professionals. • Provide continuous learning modules to improve confidence and trust in dashboards.
2	Strengthen Data Governance and Compliance	• Establish robust governance frameworks aligned with GxP, HIPAA, and GDPR. • Introduce clear validation procedures and audit trails for cloud-BI integration.
3	Adopt a Phased Implementation Strategy	• Begin with pilot projects to test scalability and compliance. • Scale adoption gradually while monitoring performance and ROI.
4	Promote Cross-Functional Collaboration	• Foster collaboration between IT, data scientists, and R&D teams. • Reduce siloed systems by encouraging joint ownership of digital tools.
5	Secure Executive Sponsorship	• Ensure leadership commitment to resource allocation and change management. • Communicate the strategic importance of cloud-BI adoption across all levels.
6	Leverage Integration for Synergy	• Prioritise integrated cloud-BI ecosystems instead of isolated deployments. • Align integration with AI-enabled analytics to maximise forecasting and efficiency.

These recommendations highlight that successful adoption requires a balance of technical readiness, regulatory compliance, and cultural transformation.

5.5 Limitations and Contributions

This study faced several limitations that should be acknowledged. First, the sample size of survey respondents was relatively small and confined to professionals accessible via online networks, which may limit the generalisability of results across the wider pharmaceutical industry. Second, the study adopted a cross-sectional design, capturing perceptions at a single point in time. Consequently, it might not capture all the dynamics of digital adoption in pharmaceutical research and development. Third, interviews were particularly insightful, but

the sample size was small and therefore some voices, most notably those of larger pharmaceutical companies and regulators, might have remained unrepresented. Lastly, this study has targeted cloud computing and Power BI dashboards, and therefore will not represent the totality of the effect of other types of digital tools like AI-driven systems or sophisticated analytics tools.

In spite of the identified shortcomings, the study makes certain contributions to the practical setting and to the theory. Theoretically, it complements the existing literature with a contribution on the investigation of the synergetic effect of the integration of cloud and BI in pharmaceutical R&D, since the area is underrepresented. Practically, it can be used by organisations to identify barriers, enablers, and adoption frameworks. These contributions serve as a roadmap to the effective digital transformation of regulated environments, especially by small and mid-sized firms.

5.6 Future Research

Future studies need to further generalise this study by adding more and varied samples in various geographical locations to reflect geographical differences in the pharmaceutical R&D practices. A cross-country comparison of both developed and emerging markets may be of interest as it can offer insights on how regulatory frameworks, infrastructure, and resources might determine the adoption of cloud-BI. Longitudinal research would also be useful in the analysis of the evolution of perceptions and outcomes as organisations increase their digital maturity. Further research may also broaden the scope of enquiring not only to cloud computing and Power BI dashboards but also to other new digital solutions, as artificial intelligence, blockchain and advanced analytics, which have begun to influence the way in which pharmaceuticals are developed. The addition of the views of regulators, clients, and other stakeholders may also help deepen the knowledge of the adoption issues and ethical opportunities. This type of research would not be limited to theoretical knowledge but would also reinforce the practical platforms used in guiding digital change within the pharmaceutical industry.

5.7 Final Reflection

Writing this dissertation has been a very rewarding and demanding process. I have tried to critically review how cloud computing and Power BI dashboards can change the paradigm of pharmaceutical R&D, but it turned out that academic studies had only been a small part of it. It involved dedication, analytical reasoning, and responsiveness, especially in my analysis of

different views of surveys and interviews. Analysis of quantitative and qualitative data made me better comprehend mixed-method research and improve my analytical capacity. I also became more adept at realising the complexities in the adoption of digital technologies, where there is often a gap between the technical possibility and the organisational reality. This journey, personally and professionally, has improved my organisational skills, helped me be better at prioritising, and being more resilient under stress. The dissertation has been an overall learning experience that has not only increased my academic knowledge but also my practical competencies.

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APPENDICES

Appendix 1: Ethics Application & Declaration Form

Innopharma education

GRIFFITH COLLEGE

Ethics Application & Declaration Form

DISSERTATION TITLE: Exploring the Impact of Cloud Computing and Power BI Dashboards to Improve Pharma R&D Practices

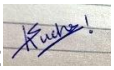
RESEARCHER'S NAME: Komal Shriram Kuche

PROGRAMME OF STUDY: Digital Transformation in Life Sciences

SUPERVISOR'S NAME: Brendan McLaughlin

DECLARATION:
The information in this application form is accurate to the best of my knowledge. I undertake to abide by the principles outlined by Innopharma/Griffith College ethics policy in my research dissertation. I confirm that I have completed a full ethics assessment for my research dissertation as per the college guidelines. I will not begin my primary research until such approval from my supervisor and/or ethics Committee has been obtained.
I pledge to carry out my research according to the Innopharma/Griffith College academic integrity standards. Any results presented in my dissertation will be from my own, original research, I will reference and/or acknowledge any material or sources used in its preparation and I will not plagiarise the work of anyone else.

For Student:

STUDENT SIGNATURE: 

DATE: 01/07/2025

The research contained within this research dissertation proposal has been approved.

For Supervisor:

Ethics Committee Approval Required: Yes [ ] No [X]

SUPERVISOR SIGNATURE: Brendan McLaughlin

DATE: 03/07/2025

For Ethics Committee (if required): [ ] [ ]

Ethics Committee Approval Given:	Yes	No
ETHICS COMMITTEE MEMBER SIGNATURE:		
DATE:		

NOTE: Supervisors are responsible for ensuring their students fill in this form correctly and that all ethical areas have been considered.

SECTION 1: DESCRIPTION OF RESEARCH STUDY

1.1 Purpose and objectives of research [*300 words maximum/ use literature review findings to guide]*

1.2 Research methodology: [*300 words maximum/ detail how you will acquire your primary data (focus groups/interviews/online surveys etc). Proposed questions for questionnaires and/or interviews **must be included** in the appendix]*.

SECTION 2: POSSIBLE ETHICAL ISSUES

Answer 'yes' or 'no' to the following questions.

SUBJECT MATTER

Does the research proposal involve:	
Research into specific company activities that would be deemed sensitive or confidential	No
Research into politically and/or racially/ethnically and/or commercially sensitive areas	No
Sensitive, personal, professional or corporate issues	No

RESEARCH PROCEDURES

Does the research proposal involve:	
Research that might damage the reputation of companies or participants	No
Research that may negatively affect the reputation of Griffith College/Innopharma	No
Use of personal records without consent	No
Use of company data without consent	No
The offer of any inducements to participate	No
Audio or visual recording without consent	No
Using a language other than English	No

PARTICIPANTS

Does the research proposal involve:	
People who are not competent and/or fluent in English	No
Does your research group include any of the following vulnerable groups	No

(Adults with psychological impairments; Adults with learning difficulties; Adults under the protection/control /influence of others (e.g. in care/prison); Relatives of ill people (e.g. parents of sick children); Hospital or GP participants recruited in a medical facility; persons under the age of 18)

If you have answered NO to ALL questions, please go straight to Section 4.

If you have answered YES to ANY question in SECTION 2, you must fill in SECTION 3.

SECTION 3: STEPS TAKEN TO AVOID ETHICAL ISSUES

[Only fill in this section if you answered YES to ANY of the questions in Section 3. For example, if you answered yes to

including participants who are not fluent in English, you might put forward a plan that offers your survey in two languages to take this into account. Another example could be a study where the researcher wants to include information about the care received by children with a long-term condition but it would not be ethical to approach the children directly but it might be acceptable to instead ask parents questions about their child's care. If these plans are acceptable to your supervisor, you may not need to apply for ethical approval from the Ethics Committee].

3.1. If your ethics relates to ***Subject Matter***, outline your action plan to work around any sensitive issues.
3.2. If your ethics relates to ***Research Procedures***, outline your action plan to deal with possible ethical issues in your research procedures.
3.3. If your ethics relates to ***Participants***, outline how you will protect vulnerable persons or those that do not have English as their first language.

SECTION 4: ABOUT YOUR PARTICIPANTS

4.1. Outline your participant profile and why you have chosen them for this study *[Do not provide names except where it is deemed impossible to conceal identity].*

4.2 How do you plan to gain access to/contact/approach your participant(s).

SECTION 5: INFORMATION, CONSENT AND CONFIDENTIALITY

5.1 **Participant Information Letter (PIL) for participants**

[You must submit an information letter for participants with this application, as part of your appendices document. For online surveys, it is sufficient to include a paragraph summarising and explaining the purpose of the research at the beginning of the survey. In all other research e.g. interviews, phonecalls, a PIL should be provided to each participant before they are asked for their consent to take part. A template PIL is available in Moodle].

Please confirm below that your information letter covers:

Description of the research topic and method	Yes
Details of what participation will involve	Yes
Rights to anonymity	Yes
Confidentiality	Yes
Rights to withdraw from the research	Yes
The contact details of the researcher and supervisor (if necessary)	Yes

5.2 **Informed Consent Form (ICF) for participants**

[Informed consent is required for most research. For online surveys, it is sufficient to get the participant to tick two boxes at the beginning of the survey – one to state they understand the research and one to give consent. In all other research e.g. interviews, phonecalls, a signed consent form is required. If the data is gathered online e.g. zoom, a signed consent form can be scanned and sent to the researcher. A template ICF is available in Moodle. The signed ICFs, along with the surveys, audio files or interview notes etc. must be stored in the primary data folder on moodle and can be accessed by Innopharma staff for the purposes of verifying the authenticity of the research carried out and the data collected].

Please indicate below if your research requires a signed consent form by selecting the relevant option only:

No: my research study involves an online survey only and/or does not require signed consent

---

SECTION 6: STORAGE OF DATA

[Please ensure that you are abiding by GDPR and the national Data protection laws https://www.hrb.ie/funding/gdpr-guidance-for-researchers/gdpr-and-health-research/).

*The student is responsible for storage of data and this will be handed over to the college in an electronic format as part of the thesis submission i.e. primary data and completed ICFs where applicable will be added to the primary data folder on moodle. The rationale is to keep data **as long as it is still useful** and there is an intention to use it further **for research** so if this is not the case then this can be stipulated here and a shorter retention period given.]*

6.1. How will you store the research data and for how long? How will you manage data protection issues?

SECTION 7: NON-DISCLOSURE AGREEMENT & STUDENT CONSENT

7.1 **Non-Disclosure Agreement (NDA)**
Will the final dissertation contain any information pertaining to any source what would warrant the use of a Non-Disclosure Agreement (NDA) e.g. industry-based research?

No

7.2 **Student consent**
If a Non-Disclosure Agreement (NDA) is not required, does the Student consent to allow their completed dissertation to be held/published by Innopharma/Griffith College?

Yes

SECTION 8: RECORDING AND RETENTION OF DISSERTATION VIVA

8.1 **Viva Recording**
The Dissertation viva will be recorded. This recording may be used to facilitate assessment by Innopharma staff, a third reader if necessary and/or if requested by the external examiner for the Programme. The recording will be held in line with current GDPR guidelines and will not be made publicly available.

SECTION 9: DOCUMENT CHECKLIST

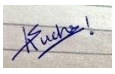
NOTE: Applicants must attach the following documents in electronic format to the appendix.

Which documents are added to the appendix? Please tick N/A if not applicable:

9.1 Participant Information Letter (PIL) for participant	Yes
9.2 Informed Consent Form (ICF) for participant	Yes
9.3 Questions/survey for interviewees/focus groups etc *(can be in draft form)*	Yes
9.4 Any other documents e.g. Non-Disclosure Agreement	N/A

I confirm that this application is complete and all required documents are included in the appendix.

For Student:

STUDENT SIGNATURE: 

DATE: 02/07/2025

Appendix 2: Participant Information Letter

Participant Information Letter

Title of Study: Exploring the Impact of Cloud Computing and Power BI Dashboards to Improve Pharma R&D Practices
Researcher: Komal Shriram Kuche
Course- M.Sc. in Digital Transformation in Life Sciences, Griffith College (Innopharma).
Supervisor: Brendan McLaughlin

I would like to invite you to take part in a research study. Before you decide you need to understand why the research is being done and what it would involve for you. Please take time to read the following information carefully. Ask questions if anything you read is not clear or if you would like more information. Take time to decide whether or not to take part.

WHO I AM AND WHAT THIS STUDY IS ABOUT

I am a Master's student at Griffith College, conducting this research as part of my dissertation for the programme *Digital Transformation in Life Sciences*. This study aims to explore how cloud computing and Power BI dashboards impact pharmaceutical research and development (R&D) practices. Specifically, the research examines their role in enhancing data accessibility, decision-making, cost efficiency, and collaboration, as well as the barriers organisations face in adopting these technologies.

WHAT WOULD TAKING PART INVOLVE?

If you agree to take part, you may be asked to complete:

- **A short online survey** (10–15 minutes) with mostly closed-ended questions about your experience or views on cloud and BI technologies.
- **An optional semi-structured interview** (30–45 minutes, via Zoom or phone), where you can share deeper insights about your professional experience.

With your permission, interviews will be audio-recorded to ensure accuracy when transcribing responses. These recordings will be anonymised, stored securely, and deleted once transcripts have been prepared.

WHY HAVE YOU BEEN INVITED TO TAKE PART?

You have been invited because you are a professional working in or connected with pharmaceutical R&D or related digital/IT functions. Your insights are valuable for

understanding real-world experiences of adopting cloud and Power BI tools in regulated environments.

DO YOU HAVE TO TAKE PART?

Participation is entirely voluntary. You may:

- Decline to take part without any consequences.
- Skip any questions you are not comfortable answering.
- Withdraw from the study at any time, without giving a reason.

If you wish to withdraw, please contact me at **komalkuche1326@gmail.com**

WHAT ARE THE POSSIBLE RISKS AND BENEFITS OF TAKING PART?

Risks:

- There are minimal risks. Questions are professional in nature and not of a personal or sensitive kind.
- A small risk of loss of confidentiality exists, but strict data protection measures will be in place.

Benefits:

- You will contribute to academic research that may guide better use of digital tools in pharmaceutical R&D.
- Your input may also highlight organisational challenges and help shape best practices for future adoption.

WILL TAKING PART BE CONFIDENTIAL?

Yes. All data will be kept strictly confidential. Your responses will be anonymised in transcripts and reports — no names, organisations, or identifying details will be published. Confidentiality may only be broken if there is reason to believe there is a risk of serious harm or disclosure of criminal activity.

Consent forms and raw audio files will not be shared with anyone outside the research process.

HOW WILL INFORMATION YOU PROVIDE BE STORED AND PROTECTED?

- Signed consent forms and original audio recordings will be securely stored in a password-protected folder on my laptop, accessible only to me and my supervisor.
- Once my degree has been conferred, these will be deleted.
- Anonymised transcripts and survey data will be retained for up to two years for academic verification.
- All data handling complies with GDPR and Griffith College ethical guidelines.

WHAT WILL HAPPEN TO THE RESULTS OF THE STUDY?

The results will be written up as part of my Master's dissertation. A copy will be submitted to Griffith College and may be stored in the college library or repository. Findings may also be shared in academic conferences or publications, but your identity will always remain anonymous.

Who Should You Contact for Further Information?

- **Researcher:** Komal Shriram Kuche – komalkuche1326@gmail.com
- **Supervisor:** Brendan McLaughlin – brendan.mclaughlin@griffith.ie

[THANK YOU]

Appendix 3: Survey questions

Exploring the Impact of Cloud Computing and Power BI in Pharma R&D

Consent and Eligibility

1. Tick all that apply:
    - I have read the participant information
    - I understand the purpose of this research
    - I agree to take part in this research voluntarily
    - I know I can withdraw anytime
2. Do you currently work or have you previously worked in a pharmaceutical R&D role/team?
    - Yes
    - No (End form if selected)

Participant Profile

3. What is your current job title/role? (Optional)
    - R&D Scientist / Research Associate
    - Clinical Data Manager / Biostatistician
    - IT / Cloud Infrastructure Specialist

- Regulatory Affairs / Compliance Officer
- Business Intelligence / Data Analytics Professional
- Other: _____

4. How long have you worked in the pharmaceutical industry?
    - <1 year
    - 1–5 years
    - 5–10 years
    - 10+ years
5. What type of pharmaceutical organization do you work in?
    - Large Pharma
    - Mid-sized Pharma
    - Biotech Startup
    - CRO/Outsourced R&D
    - Other: _____

Cloud Computing in Your R&D

6. Does your R&D team use cloud computing solutions?
    - Yes
    - No
7. Which cloud provider(s) does your team use? (Tick all that apply)
    - Microsoft Azure
    - AWS
    - Google Cloud
    - Private Cloud
    - Don’t know

Power BI and BI Tool Usage

8. Please rate each statement (1 = Strongly Disagree, 5 = Strongly Agree):
    - Power BI helps in making faster decisions
    - Dashboards are updated in real time
    - Forecasting with Power BI reduced delays/errors
    - Training on BI tools was sufficient
    - BI dashboards are trusted by decision-makers
9. Is Power BI used in your R&D operations?
    - Yes, widely adopted
    - Partially used
    - No, not used
10. If yes, which functions are most commonly used?

- Visualising lab results
- Forecasting and trend analysis
- Monitoring clinical trials
- Regulatory reporting
- Other: _____

Integrated Use of Cloud + BI

11. Please rate (1 = Strongly Disagree, 5 = Strongly Agree):

- Cloud improves data accessibility
- Cloud enhances scalability for research workloads
- Cloud helped reduce infrastructure costs
- Cloud improved collaboration across teams
- Cloud created compliance/validation challenges

12. What has improved the most due to using both tools together?

- Decision-making speed
- Collaboration between departments

- Forecast accuracy
- Workflow transparency
- Cost efficiency
- Other: _____

13. How would you rate your organization's success in integrating cloud + BI tools?

- Very successful
- Moderately successful
- Limited success
- Unsuccessful

14. What were the main challenges during implementation?

- Resistance from staff
- Integration with legacy systems
- Cost concerns
- Regulatory/validation issues
- Lack of skilled personnel
- Inadequate training

Future Potential and Support Needs

15. Do you believe your organization has fully leveraged cloud-BI integration?

- Yes
- No
- Partially

16. What support/resources would help adoption?

- Better training
- Leadership support
- Dedicated cloud-BI strategy
- Improved governance tools

- Other: _____

17. Would you be open to a follow-up interview?

- Yes
- No

Research Gaps & Barriers

18. Have you seen case studies/internal examples of cloud BI impact in pharma R&D?

- Yes
- No
- Not sure

19. Does your organization lack a standardized framework for cloud BI tools?

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

20. What are the biggest uncertainties in adopting cloud + BI in pharma R&D?

- Security & data privacy
- Lack of benchmarked success models
- Ethical & compliance uncertainties
- Absence of cross-functional governance
- Low empirical evidence
- Other: _____

21. Do you believe BI tools (like Power BI) are ready for regulated pharma environments?

- Yes
- No

- Maybe
- Partially
- Not sure

22. How confident are you in the long-term ROI from cloud + Power BI?

- Very confident
- Somewhat confident
- Not confident
- Too early to assess

Final Thoughts

23. Do you have any additional comments, suggestions, or insights related to adoption of cloud computing or Power BI in pharma R&D?

- [Open text response]

Appendix 4: Interview questions

Production Operator, Managing Director

- Can you briefly describe your role and the main activities you handle in production and packaging (e.g., tablet inspection, material handling, equipment operation)?
- What types of data do you work with most often — for example, batch records, MES/ERP transactions, inspection logs, or cleaning checklists?
- How do you usually track and share production or inspection results with your team or supervisors?
- You mentioned using ERP/MES systems — how do these digital systems support your daily production or packaging work?
- Have you had exposure to cloud-based systems or dashboards (such as production monitoring, OEE, or quality dashboards)? If yes, in what way?
- How are dashboards or digital reports used in your work — for example, to monitor packaging efficiency, inspection results, or compliance checks?
- How easy is it to access the production or inspection data you need during your shift?
- Have you ever experienced delays in getting updated data (e.g., quality approval, machine reports) and how does that affect your work?

- Since you work under GMP and compliance standards, how are compliance and traceability ensured when using ERP/MES or digital systems?
- Have you been part of any system upgrades or new technology rollouts (e.g., MES updates, new digital inspection tools)?
- What kind of training or support was provided when these systems were introduced?
- Were there any concerns among operators when adopting new digital systems — for example, data accuracy, extra workload, or compliance issues?
- Have dashboards or digital tools helped improve efficiency in inspection, packaging, or reporting tasks?
- Can you recall a situation where quick access to data helped resolve a deviation or avoid a production delay?
- What dashboard features would be most useful for you on the shop floor (e.g., live defect tracking, KPI dashboards, machine performance trends)?
- Do you feel your organisation is fully making use of ERP, MES, and dashboards to support shop-floor operations?
- If you could improve one aspect of the current digital setup in packaging/inspection, what would it be?
- Looking forward, how do you see digital tools (cloud systems, dashboards, AI alerts) changing your role in production or packaging in the next few years?
- Is there anything else you'd like to add about your experience with digital systems, compliance, or dashboards in your role at Catalyx?

Validation Engineer

- Can you briefly describe your role as a Validation Engineer and the types of validation activities you typically handle (e.g., equipment, process, cleaning, or computer system validation)?
- What types of data do you work with most often during validation (protocols, reports, batch data, audit logs, etc.)?
- How do you usually track, document, and share validation results with QA, regulatory, or R&D teams?
- Have you been involved in computer system validation (CSV) for cloud-based platforms or dashboards such as Power BI?

- Can you share an example where cloud computing or BI tools supported validation activities — for instance, trend analysis, deviation tracking, or audit readiness?
- Since digital tools were adopted, have you noticed any changes in how you collaborate with QA, engineering, or R&D during validation projects?
- What factors encouraged your organisation to consider integrating BI tools like Power BI with validation and compliance processes?
- Were there any regulatory or GMP-related challenges you faced when validating cloud or BI systems (e.g., 21 CFR Part 11, GAMP 5)?
- Does your team follow a specific framework or process for ensuring compliance and data integrity when using cloud-based systems?
- From your experience, what helped make validation and adoption of these digital tools smoother?
- Have dashboards or cloud-based tools helped improve decision-making speed, accuracy of validation data, or efficiency in reporting to auditors/regulators?
- Can you recall a situation where dashboard insights supported a compliance-related decision or flagged an issue early?
- How are dashboards typically used in your validation work — for example, monitoring equipment performance, reviewing CAPA effectiveness, or visualising validation trends?
- Do you feel your organisation is fully leveraging cloud and BI tools for validation and compliance activities?
- If you could improve one aspect of the current digital setup for validation, what would it be?
- Looking ahead, how do you see cloud and dashboards evolving in validation — for example, predictive compliance checks, AI-driven risk assessments, or fully paperless validation systems?
- Is there anything else you'd like to add about your experience with validation, compliance, or the role of digital tools in supporting these activities?

Clinical Research Coordinator

- Can you briefly describe your role and main responsibilities as a Clinical Research Coordinator?

- What types of data did you work with most often (e.g., patient data, trial progress, lab results)?
- How did you typically track and share study progress with your team and sponsors?
- What software or systems did you use for data entry, reporting, or compliance during trials?
- Did you have any exposure to cloud-based systems (e.g., web portals for trial data, remote monitoring platforms)?
- How were dashboards or reporting tools used (if at all) in your role?
- How easy was it to access the data you needed to perform your job?
- Did you face any delays or challenges in getting updated information during a study?
- How was information typically shared across your site and with external teams (sponsors, CROs, regulators)?
- Have you been involved in the implementation of a new digital system in a study?
- What training or support was provided when new tools were introduced?
- What were the main concerns or barriers (e.g., technical, regulatory, user resistance)?
- Can you recall a situation where quick access to accurate data influenced a clinical or operational decision?
- If you had a real-time dashboard showing patient recruitment, adverse events, and trial milestones, how would it have changed your workflow?
- What features would you find most useful in a dashboard for clinical trial coordination?
- How were compliance requirements like GCP, GDPR, or patient privacy handled in your data systems?
- Did you face challenges in ensuring that electronic systems met regulatory standards?
- In your opinion, what's the biggest improvement digital tools could bring to the day-to-day work of a Clinical Research Coordinator?
- How do you see cloud platforms and visual dashboards fitting into clinical research in the next 3–5 years?
- Is there anything you wish your previous digital systems could have done better?
- Anything else you'd like to add about technology in clinical trials?

Production Operator

- Can you briefly describe your role and main responsibilities?
- What types of data do you work with most often?
- How do you track and share production progress?
- What systems do you use for recording and reporting data?
- Any exposure to cloud-based systems?
- How are dashboards used in your work?
- How easy is it to access production data you need?
- Any delays in getting updated information?
- Have you been part of a system upgrade or new technology rollout?
- What training or support was provided?
- What were the main concerns?
- Can you recall a time when quick access to data helped operations?
- If you had a real-time dashboard with KPIs, quality alerts, and production trends, how would it change your workflow?
- What dashboard features would be most useful?
- How is compliance ensured in your systems?
- Any challenges with compliance in digital systems?
- What's the biggest improvement digital tools could bring to your role?
- How do you see cloud and dashboards evolving in production?
- Anything you wish your systems could do better?

Appendix 5: SPSS output

Frequency Table

Do you currently work or have you previously worked in a pharmaceutical research and development (R&D) role or team?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	62	98.4	98.4	98.4
	No	1	1.6	1.6	100.0
	Total	63	100.0	100.0	

What is your current job title or role?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	R&D Scientist / Research Associate	8	12.7	12.9	12.9
	Clinical Data Manager / Biostatistician	12	19.0	19.4	32.3
	IT / Cloud Infrastructure Specialist	24	38.1	38.7	71.0

	Regulatory Affairs or Compliance Officer	14	22.2	22.6		93.5
	Business Intelligence / Data Analytics Professional	4	6.3	6.5		100.0
	Total	62	98.4	100.0		
Missing	System	1	1.6			
Total		63	100.0			

How long have you worked in the pharmaceutical industry?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<1 year	8	12.7	12.9	12.9
	1–5 years	24	38.1	38.7	51.6
	5–10 years	23	36.5	37.1	88.7
	10+ years	7	11.1	11.3	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

What type of pharmaceutical organization do you work in?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Large Pharma	5	7.9	8.1	.1
	Mid-sized Pharma	27	42.9	43.5	5.6
	Biotech Startup	25	39.7	40.3	9.9
	CRO/Outsourced R&D	5	7.9	8.1	10.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

Does your R&D team use cloud computing solutions?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	32	50.8	51.6	51.6
	No	30	47.6	48.4	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

Which cloud provider(s) does your team use?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Microsoft Azure	6	9.5	9.7	9.7
	AWS	17	27.0	27.4	37.1
	Google Cloud	25	39.7	40.3	77.4
	Private Cloud	12	19.0	19.4	96.8
	Don't know	2	3.2	3.2	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

Cloud improves data accessibility

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	55	87.3	88.7	88.7
	Disagree	3	4.8	4.8	93.5
	Neutral	2	3.2	3.2	96.8
	Agree	1	1.6	1.6	98.4
	Strongly agree	1	1.6	1.6	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

Cloud enhances scalability for research workloads

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	22	34.9	35.5	35.5
	Disagree	25	39.7	40.3	75.8
	Neutral	11	17.5	17.7	93.5
	Agree	4	6.3	6.5	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

Cloud helped reduce infrastructure costs

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	26	41.3	41.9	41.9
	Disagree	22	34.9	35.5	77.4
	Neutral	12	19.0	19.4	96.8
	Agree	1	1.6	1.6	98.4
	Strongly agree	1	1.6	1.6	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

Cloud has improved collaboration across teams

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	22	34.9	35.5	35.5
	Disagree	26	41.3	41.9	77.4
	Neutral	12	19.0	19.4	96.8
	Agree	2	3.2	3.2	100.0
	Total	62	98.4	100.0	

Missing	System	1	1.6		
Total		63	100.0		

Cloud has created compliance or validation challenges

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	27	42.9	43.5	43.5
	Disagree	24	38.1	38.7	82.3
	Neutral	7	11.1	11.3	93.5
	Agree	2	3.2	3.2	96.8
	Strongly agree	2	3.2	3.2	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

Is Power BI used in your R&D operations?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes, widely adopted	21	33.3	33.9	33.9
	Partially used	30	47.6	48.4	82.3
	No, not used	11	17.5	17.7	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

If yes, which functions are most commonly used?

		Frequency	Percent	Valid Percent	Cumulative Perc
Valid	Visualizing lab results	9	14.3	14.5	14.5
	Forecasting and trend analysis	22	34.9	35.5	50.0
	Monitoring clinical trials	26	41.3	41.9	91.9
	Regulatory reporting	5	7.9	8.1	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

Power BI helps in making faster decisions

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	52	82.5	83.9	83.9
	Disagree	7	11.1	11.3	95.2
	Neutral	2	3.2	3.2	98.4
	Strongly agree	1	1.6	1.6	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

Dashboards are updated in real time

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	28	44.4	45.2	45.2
	Disagree	24	38.1	38.7	83.9
	Neutral	9	14.3	14.5	98.4
	Agree	1	1.6	1.6	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

Forecasting with Power BI has reduced trial delays/errors

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	30	47.6	48.4	48.4
	Disagree	17	27.0	27.4	75.8
	Neutral	14	22.2	22.6	98.4
	Strongly agree	1	1.6	1.6	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

Training on BI tools was sufficient

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	24	38.1	38.7	38.7
	Disagree	26	41.3	41.9	80.6
	Neutral	9	14.3	14.5	95.2
	Agree	3	4.8	4.8	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

Power BI dashboards are trusted by decision-makers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	35	55.6	56.5	56.5
	Disagree	13	20.6	21.0	77.4
	Neutral	13	20.6	21.0	98.4
	Agree	1	1.6	1.6	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

What has improved the most due to using both tools together?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Decision-making speed	3	4.8	4.8	4.8
	Collaboration between departments	25	39.7	40.3	45.2
	Forecast accuracy	21	33.3	33.9	79.0
	Workflow transparency	10	15.9	16.1	95.2
	Cost efficiency	3	4.8	4.8	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

How would you rate your organisation's success in integrating cloud and BI tools?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very successful	17	27.0	27.4	27.4
	Moderately successful	29	46.0	46.8	74.2
	Limited success	12	19.0	19.4	93.5
	Unsuccessful	4	6.3	6.5	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

What were the main challenges during implementation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Resistance from staff	6	9.5	9.7	9.7
	Integration with legacy systems	23	36.5	37.1	46.8
	Cost concerns	21	33.3	33.9	80.6
	Regulatory/validation issues	7	11.1	11.3	91.9
	Lack of skilled personnel	4	6.3	6.5	98.4
	Inadequate training	1	1.6	1.6	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

Do you believe your organization has fully leveraged the potential of cloud-BI integration?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	18	28.6	29.0	29.0
	No	32	50.8	51.6	80.6
	Partially	12	19.0	19.4	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

What support/resources would help adoption?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Better training	7	11.1	11.3	11.3
	Leadership support	24	38.1	38.7	50.0
	Dedicated cloud-BI strategy	21	33.3	33.9	83.9
	Improved governance/compliance tools	10	15.9	16.1	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

Would you be open to a follow-up interview for deeper insights?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	56	88.9	90.3	90.3
	No	6	9.5	9.7	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

Have you seen any case studies or internal examples showing the impact of cloud BI in pharma R&D?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	16	25.4	25.8	25.8
	No	32	50.8	51.6	77.4
	Not Sure	14	22.2	22.6	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

Does your organization lack a standardized framework for cloud BI tools?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	23	36.5	37.1	37.1
	Agree	29	46.0	46.8	83.9
	Neutral	8	12.7	12.9	96.8
	Disagree	1	1.6	1.6	98.4
	Strongly Disagree	1	1.6	1.6	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

What are the biggest uncertainties in adopting cloud + BI in pharma R&D?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Security and data privacy	6	9.5	9.7	9.7

	Lack of benchmarked success models	13	20.6	21.0	30.6
	Ethical and compliance uncertainties	14	22.2	22.6	53.2
	Absence of cross-functional governance	21	33.3	33.9	87.1
	Low empirical evidence	8	12.7	12.9	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

Do you believe Power BI or similar BI tools are ready for regulated pharma environments?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	9	14.3	14.5	14.5
	No	13	20.6	21.0	35.5
	Partially	22	34.9	35.5	71.0
	Not Sure	18	28.6	29.0	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

How confident are you in the long-term ROI from cloud + Power BI?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very confident	6	9.5	9.7	9.7
	Somewhat confident	33	52.4	53.2	62.9
	Not confident	19	30.2	30.6	93.5
	Too early to assess	4	6.3	6.5	100.0
	Total	62	98.4	100.0	
Missing	System	1	1.6		
Total		63	100.0		

Bar Chart

Oneway

Descriptives

			N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum	Between-Component Variance
Do you currently work or have you previously worked in a pharmaceutical research and development (R&D) role or team?	Resistance from staff		6	1.00	.000	.000	1.00	1.00	1	1	
	Integration with legacy systems		23	1.00	.000	.000	1.00	1.00	1	1	
	Cost concerns		21	1.00	.000	.000	1.00	1.00	1	1	
	Regulatory/validation issues		7	1.00	.000	.000	1.00	1.00	1	1	
	Lack of skilled personnel		4	1.00	.000	.000	1.00	1.00	1	1	
	Inadequate training		1	1.00	.	.	.	.	1	1	
	Total		62	1.00	.000	.000	1.00	1.00	1	1	
What is your current job title or role?	Resistance from staff		6	2.50	1.049	.428	1.40	3.60	1	4	
	Integration with legacy systems		23	3.00	1.168	.243	2.50	3.50	1	5	
	Cost concerns		21	2.95	1.024	.223	2.49	3.42	1	5	
	Regulatory/validation issues		7	2.86	1.069	.404	1.87	3.85	1	4	
	Lack of skilled personnel		4	2.75	1.708	.854	.03	5.47	1	5	
	Inadequate training		1	3.00	.	.	.	.	3	3	
	Total		62	2.90	1.097	.139	2.62	3.18	1	5	
	Model	Fixed Effects			1.134	.144	2.61	3.19			
		Random Effects				.144[a]	2.53[a]	3.27[a]			-.113
How long have you worked in the pharmaceutical industry?	Resistance from staff		6	2.67	.516	.211	2.12	3.21	2	3	
	Integration with legacy systems		23	2.57	.945	.197	2.16	2.97	1	4	
	Cost concerns		21	2.43	.811	.177	2.06	2.80	1	4	
	Regulatory/validation issues		7	2.29	1.113	.421	1.26	3.31	1	4	
	Lack of skilled personnel		4	2.00	.816	.408	.70	3.30	1	3	
	Inadequate training		1	3.00	.	.	.	.	3	3	
	Total		62	2.47	.863	.110	2.25	2.69	1	4	
	Model	Fixed Effects			.882	.112	2.24	2.69			
		Random Effects				.112[a]	2.18[a]	2.76[a]			-.045
What type of pharmaceutical organization do you work in?	Resistance from staff		6	2.33	.516	.211	1.79	2.88	2	3	
	Integration with legacy systems		23	2.61	.722	.151	2.30	2.92	1	4	
	Cost concerns		21	2.43	.870	.190	2.03	2.82	1	4	
	Regulatory/validation issues		7	2.29	.756	.286	1.59	2.98	1	3	
	Lack of skilled personnel		4	2.75	.957	.479	1.23	4.27	2	4	
	Inadequate training		1	2.00	.	.	.	.	2	2	
	Total		62	2.48	.763	.097	2.29	2.68	1	4	
	Model	Fixed Effects			.781	.099	2.29	2.68			
		Random Effects				.099[a]	2.23[a]	2.74[a]			-.038
Does your R&D team use cloud computing solutions?	Resistance from staff		6	1.50	.548	.224	.93	2.07	1	2	
	Integration with legacy systems		23	1.43	.507	.106	1.22	1.65	1	2	
	Cost concerns		21	1.38	.498	.109	1.15	1.61	1	2	
	Regulatory/validation issues		7	1.71	.488	.184	1.26	2.17	1	2	
	Lack of skilled personnel		4	1.75	.500	.250	.95	2.55	1	2	
	Inadequate training		1	2.00	.	.	.	.	2	2	
	Total		62	1.48	.504	.064	1.36	1.61	1	2	
	Model	Fixed Effects			.505	.064	1.36	1.61			

		Random Effects				.064[a]	1.32[a]	1.65[a]			-.002
Which cloud provider(s) does your team use?	Resistance from staff		6	3.00	.632	.258	2.34	3.66	2	4	
	Integration with legacy systems		23	2.48	.947	.198	2.07	2.89	1	4	
	Cost concerns		21	2.86	1.014	.221	2.40	3.32	1	5	
	Regulatory/validation issues		7	2.86	.900	.340	2.03	3.69	2	4	
	Lack of skilled personnel		4	3.25	.957	.479	1.73	4.77	2	4	
	Inadequate training		1	5.00	.	.	.	.	5	5	
	Total		62	2.79	.977	.124	2.54	3.04	1	5	
	Model	Fixed Effects			.944	.120	2.55	3.03			
		Random Effects				.197	2.28	3.30			.087
Cloud improves data accessibility	Resistance from staff		6	1.33	.816	.333	.48	2.19	1	3	
	Integration with legacy systems		23	1.13	.626	.130	.86	1.40	1	4	
	Cost concerns		21	1.19	.512	.112	.96	1.42	1	3	
	Regulatory/validation issues		7	1.57	1.512	.571	.17	2.97	1	5	
	Lack of skilled personnel		4	1.25	.500	.250	.45	2.05	1	2	
	Inadequate training		1	1.00	.	.	.	.	1	1	
	Total		62	1.23	.734	.093	1.04	1.41	1	5	
	Model	Fixed Effects			.752	.095	1.03	1.42			
		Random Effects				.095[a]	.98[a]	1.47[a]			-.036
Cloud enhances scalability for research workloads	Resistance from staff		6	1.83	1.329	.543	.44	3.23	1	4	
	Integration with legacy systems		23	2.00	.953	.199	1.59	2.41	1	4	
	Cost concerns		21	1.95	.669	.146	1.65	2.26	1	3	
	Regulatory/validation issues		7	2.00	1.291	.488	.81	3.19	1	4	
	Lack of skilled personnel		4	1.75	.500	.250	.95	2.55	1	2	
	Inadequate training		1	2.00	.	.	.	.	2	2	
	Total		62	1.95	.895	.114	1.72	2.18	1	4	
	Model	Fixed Effects			.931	.118	1.71	2.19			
		Random Effects				.118[a]	1.65[a]	2.26[a]			-.090
Cloud helped reduce infrastructure costs	Resistance from staff		6	2.00	.632	.258	1.34	2.66	1	3	
	Integration with legacy systems		23	1.65	.832	.173	1.29	2.01	1	4	
	Cost concerns		21	2.00	.837	.183	1.62	2.38	1	3	
	Regulatory/validation issues		7	1.71	1.496	.565	.33	3.10	1	5	
	Lack of skilled personnel		4	2.25	.957	.479	.73	3.77	1	3	
	Inadequate training		1	2.00	.	.	.	.	2	2	
	Total		62	1.85	.903	.115	1.63	2.08	1	5	
	Model	Fixed Effects			.920	.117	1.62	2.09			
		Random Effects				.117[a]	1.55[a]	2.16[a]			-.043
Cloud has improved collaboration across teams	Resistance from staff		6	2.50	1.049	.428	1.40	3.60	1	4	
	Integration with legacy systems		23	2.00	.905	.189	1.61	2.39	1	4	
	Cost concerns		21	1.62	.590	.129	1.35	1.89	1	3	
	Regulatory/validation issues		7	1.86	.900	.340	1.03	2.69	1	3	
	Lack of skilled personnel		4	2.00	.816	.408	.70	3.30	1	3	
	Inadequate training		1	2.00	.	.	.	.	2	2	
	Total		62	1.90	.824	.105	1.69	2.11	1	4	
	Model	Fixed Effects			.816	.104	1.70	2.11			
		Random Effects				.125	1.58	2.22			.017
Cloud has created compliance or validation challenges	Resistance from staff		6	1.00	.000	.000	1.00	1.00	1	1	
	Integration with legacy systems		23	1.87	1.014	.211	1.43	2.31	1	4	
	Cost concerns		21	1.95	.921	.201	1.53	2.37	1	5	
	Regulatory/validation issues		7	2.29	1.380	.522	1.01	3.56	1	5	
	Lack of skilled personnel		4	1.50	.577	.289	.58	2.42	1	2	
	Inadequate training		1	2.00	.	.	.	.	2	2	
	Total		62	1.84	.978	.124	1.59	2.09	1	5	
	Model	Fixed Effects			.964	.122	1.59	2.08			
		Random Effects				.161	1.42	2.25			.039
Is Power BI used in your R&D operations?	Resistance from staff		6	2.00	.632	.258	1.34	2.66	1	3	
	Integration with legacy systems		23	1.78	.795	.166	1.44	2.13	1	3	
	Cost concerns		21	1.67	.658	.144	1.37	1.97	1	3	
	Regulatory/validation issues		7	2.29	.488	.184	1.83	2.74	2	3	
	Lack of skilled personnel		4	2.00	.816	.408	.70	3.30	1	3	
	Inadequate training		1	2.00	.	.	.	.	2	2	
	Total		62	1.84	.706	.090	1.66	2.02	1	3	
	Model	Fixed Effects			.707	.090	1.66	2.02			
		Random Effects				.090[a]	1.61[a]	2.07[a]			-.003
If yes, which functions are most commonly used?	Resistance from staff		6	2.67	1.033	.422	1.58	3.75	1	4	
	Integration with legacy systems		23	2.39	.891	.186	2.01	2.78	1	4	
	Cost concerns		21	2.33	.913	.199	1.92	2.75	1	4	
	Regulatory/validation issues		7	2.57	.535	.202	2.08	3.07	2	3	
	Lack of skilled personnel		4	2.75	.500	.250	1.95	3.55	2	3	
	Inadequate training		1	2.00	.	.	.	.	2	2	
	Total		62	2.44	.842	.107	2.22	2.65	1	4	
	Model	Fixed Effects			.865	.110	2.22	2.66			
		Random Effects				.110[a]	2.15[a]	2.72[a]			-.055

Power BI helps in making faster decisions	Resistance from staff		6	1.17	.408	.167	.74	1.60	1	2	
	Integration with legacy systems		23	1.35	.935	.195	.94	1.75	1	5	
	Cost concerns		21	1.19	.512	.112	.96	1.42	1	3	
	Regulatory/validation issues		7	1.14	.378	.143	.79	1.49	1	2	
	Lack of skilled personnel		4	1.25	.500	.250	.45	2.05	1	2	
	Inadequate training		1	1.00	.	.	.	.	1	1	
	Total		62	1.24	.670	.085	1.07	1.41	1	5	
	Model	Fixed Effects			.693	.088	1.07	1.42			
		Random Effects				.088[a]	1.02[a]	1.47[a]			-.043
Dashboards are updated in real time	Resistance from staff		6	1.67	.816	.333	.81	2.52	1	3	
	Integration with legacy systems		23	1.78	.850	.177	1.41	2.15	1	4	
	Cost concerns		21	1.52	.750	.164	1.18	1.87	1	3	
	Regulatory/validation issues		7	2.00	.816	.309	1.24	2.76	1	3	
	Lack of skilled personnel		4	2.00	.000	.000	2.00	2.00	2	2	
	Inadequate training		1	2.00	.	.	.	.	2	2	
	Total		62	1.73	.772	.098	1.53	1.92	1	4	
	Model	Fixed Effects			.785	.100	1.53	1.93			
		Random Effects				.100[a]	1.47[a]	1.98[a]			-.027
Forecasting with Power BI has reduced trial delays/errors	Resistance from staff		6	1.83	.983	.401	.80	2.87	1	3	
	Integration with legacy systems		23	1.96	1.107	.231	1.48	2.44	1	5	
	Cost concerns		21	1.52	.680	.148	1.21	1.83	1	3	
	Regulatory/validation issues		7	2.00	.816	.309	1.24	2.76	1	3	
	Lack of skilled personnel		4	1.75	.957	.479	.23	3.27	1	3	
	Inadequate training		1	2.00	.	.	.	.	2	2	
	Total		62	1.79	.908	.115	1.56	2.02	1	5	
	Model	Fixed Effects			.924	.117	1.56	2.03			
		Random Effects				.117[a]	1.49[a]	2.09[a]			-.040
Training on BI tools was sufficient	Resistance from staff		6	2.00	.632	.258	1.34	2.66	1	3	
	Integration with legacy systems		23	2.00	1.000	.209	1.57	2.43	1	4	
	Cost concerns		21	1.57	.598	.130	1.30	1.84	1	3	
	Regulatory/validation issues		7	1.86	1.215	.459	.73	2.98	1	4	
	Lack of skilled personnel		4	2.25	.500	.250	1.45	3.05	2	3	
	Inadequate training		1	2.00	.	.	.	.	2	2	
	Total		62	1.85	.846	.107	1.64	2.07	1	4	
	Model	Fixed Effects			.853	.108	1.64	2.07			
		Random Effects				.108[a]	1.58[a]	2.13[a]			-.016
Power BI dashboards are trusted by decision-makers	Resistance from staff		6	1.50	.837	.342	.62	2.38	1	3	
	Integration with legacy systems		23	1.61	.891	.186	1.22	1.99	1	3	
	Cost concerns		21	1.62	.805	.176	1.25	1.99	1	4	
	Regulatory/validation issues		7	2.29	.951	.360	1.41	3.17	1	3	
	Lack of skilled personnel		4	1.50	1.000	.500	-.09	3.09	1	3	
	Inadequate training		1	2.00	.	.	.	.	2	2	
	Total		62	1.68	.864	.110	1.46	1.90	1	4	
	Model	Fixed Effects			.870	.110	1.46	1.90			
		Random Effects				.110[a]	1.39[a]	1.96[a]			-.013
What has improved the most due to using both tools together?	Resistance from staff		6	3.50	1.049	.428	2.40	4.60	2	5	
	Integration with legacy systems		23	2.61	1.033	.215	2.16	3.06	1	5	
	Cost concerns		21	2.81	.873	.190	2.41	3.21	2	5	
	Regulatory/validation issues		7	2.43	.976	.369	1.53	3.33	1	4	
	Lack of skilled personnel		4	2.75	.500	.250	1.95	3.55	2	3	
	Inadequate training		1	3.00	.	.	.	.	3	3	
	Total		62	2.76	.953	.121	2.52	3.00	1	5	
	Model	Fixed Effects			.951	.121	2.52	3.00			
		Random Effects				.125	2.44	3.08			.004
How would you rate your organisation's success in integrating cloud and BI tools?	Resistance from staff		6	2.33	1.211	.494	1.06	3.60	1	4	
	Integration with legacy systems		23	1.87	.757	.158	1.54	2.20	1	4	
	Cost concerns		21	1.95	.740	.161	1.62	2.29	1	3	
	Regulatory/validation issues		7	2.71	1.113	.421	1.69	3.74	1	4	
	Lack of skilled personnel		4	2.00	.816	.408	.70	3.30	1	3	
	Inadequate training		1	2.00	.	.	.	.	2	2	
	Total		62	2.05	.858	.109	1.83	2.27	1	4	
	Model	Fixed Effects			.849	.108	1.83	2.26			
		Random Effects				.132	1.71	2.39			.021
Do you believe your organization has fully leveraged the potential of cloud-BI integration?	Resistance from staff		6	1.67	.516	.211	1.12	2.21	1	2	
	Integration with legacy systems		23	1.96	.878	.183	1.58	2.34	1	3	
	Cost concerns		21	1.95	.498	.109	1.73	2.18	1	3	
	Regulatory/validation issues		7	2.14	.690	.261	1.50	2.78	1	3	
	Lack of skilled personnel		4	1.50	.577	.289	.58	2.42	1	2	
	Inadequate training		1	1.00	.	.	.	.	1	1	
	Total		62	1.90	.694	.088	1.73	2.08	1	3	
	Model	Fixed Effects			.696	.088	1.73	2.08			
		Random Effects				.088[a]	1.68[a]	2.13[a]			-.002
	Resistance from staff		6	2.33	.516	.211	1.79	2.88	2	3	

What support/resources would help adoption?	Integration with legacy systems		23	2.35	.935	.195	1.94	2.75	1	4	
	Cost concerns		21	2.71	.902	.197	2.30	3.13	1	4	
	Regulatory/validation issues		7	2.57	.787	.297	1.84	3.30	2	4	
	Lack of skilled personnel		4	3.50	.577	.289	2.58	4.42	3	4	
	Inadequate training		1	1.00	.	.	.	.	1	1	
	Total		62	2.55	.899	.114	2.32	2.78	1	4	
	Model	Fixed Effects			.861	.109	2.33	2.77			
		Random Effects				.194	2.05	3.05			.092
Would you be open to a follow-up interview for deeper insights?	Resistance from staff		6	1.00	.000	.000	1.00	1.00	1	1	
	Integration with legacy systems		23	1.09	.288	.060	.96	1.21	1	2	
	Cost concerns		21	1.10	.301	.066	.96	1.23	1	2	
	Regulatory/validation issues		7	1.14	.378	.143	.79	1.49	1	2	
	Lack of skilled personnel		4	1.25	.500	.250	.45	2.05	1	2	
	Inadequate training		1	1.00	.	.	.	.	1	1	
	Total		62	1.10	.298	.038	1.02	1.17	1	2	
	Model	Fixed Effects			.306	.039	1.02	1.17			
		Random Effects				.039[a]	1.00[a]	1.20[a]			-.007
Have you seen any case studies or internal examples showing the impact of cloud BI in pharma R&D?	Resistance from staff		6	1.67	.516	.211	1.12	2.21	1	2	
	Integration with legacy systems		23	2.00	.739	.154	1.68	2.32	1	3	
	Cost concerns		21	1.95	.740	.161	1.62	2.29	1	3	
	Regulatory/validation issues		7	2.14	.690	.261	1.50	2.78	1	3	
	Lack of skilled personnel		4	2.25	.500	.250	1.45	3.05	2	3	
	Inadequate training		1	1.00	.	.	.	.	1	1	
	Total		62	1.97	.701	.089	1.79	2.15	1	3	
	Model	Fixed Effects			.706	.090	1.79	2.15			
		Random Effects				.090[a]	1.74[a]	2.20[a]			-.010
Does your organization lack a standardized framework for cloud BI tools?	Resistance from staff		6	1.50	.837	.342	.62	2.38	1	3	
	Integration with legacy systems		23	1.78	.671	.140	1.49	2.07	1	3	
	Cost concerns		21	1.90	.944	.206	1.48	2.33	1	5	
	Regulatory/validation issues		7	2.43	.976	.369	1.53	3.33	1	4	
	Lack of skilled personnel		4	1.25	.500	.250	.45	2.05	1	2	
	Inadequate training		1	2.00	.	.	.	.	2	2	
	Total		62	1.84	.834	.106	1.63	2.05	1	5	
	Model	Fixed Effects			.820	.104	1.63	2.05			
		Random Effects				.139	1.48	2.19			.030
What are the biggest uncertainties in adopting cloud + BI in pharma R&D?	Resistance from staff		6	3.50	1.049	.428	2.40	4.60	2	5	
	Integration with legacy systems		23	2.96	1.364	.285	2.37	3.55	1	5	
	Cost concerns		21	3.29	1.007	.220	2.83	3.74	2	5	
	Regulatory/validation issues		7	3.71	1.254	.474	2.55	4.87	2	5	
	Lack of skilled personnel		4	2.50	1.291	.645	.45	4.55	1	4	
	Inadequate training		1	4.00	.	.	.	.	4	4	
	Total		62	3.19	1.199	.152	2.89	3.50	1	5	
	Model	Fixed Effects			1.204	.153	2.89	3.50			
		Random Effects				.153[a]	2.80[a]	3.59[a]			-.017
Do you believe Power BI or similar BI tools are ready for regulated pharma environments?	Resistance from staff		6	2.33	1.211	.494	1.06	3.60	1	4	
	Integration with legacy systems		23	2.61	1.076	.224	2.14	3.07	1	4	
	Cost concerns		21	2.86	1.014	.221	2.40	3.32	1	4	
	Regulatory/validation issues		7	3.43	.787	.297	2.70	4.16	2	4	
	Lack of skilled personnel		4	3.00	.816	.408	1.70	4.30	2	4	
	Inadequate training		1	3.00	.	.	.	.	3	3	
	Total		62	2.79	1.026	.130	2.53	3.05	1	4	
	Model	Fixed Effects			1.027	.130	2.53	3.05			
		Random Effects				.130[a]	2.45[a]	3.13[a]			-.002
How confident are you in the long-term ROI from cloud + Power BI?	Resistance from staff		6	2.17	.983	.401	1.13	3.20	1	3	
	Integration with legacy systems		23	2.26	.689	.144	1.96	2.56	1	4	
	Cost concerns		21	2.38	.865	.189	1.99	2.77	1	4	
	Regulatory/validation issues		7	2.43	.535	.202	1.93	2.92	2	3	
	Lack of skilled personnel		4	2.75	.500	.250	1.95	3.55	2	3	
	Inadequate training		1	2.00	.	.	.	.	2	2	
	Total		62	2.34	.745	.095	2.15	2.53	1	4	
	Model	Fixed Effects			.764	.097	2.14	2.53			
		Random Effects				.097[a]	2.09[a]	2.59[a]			-.038

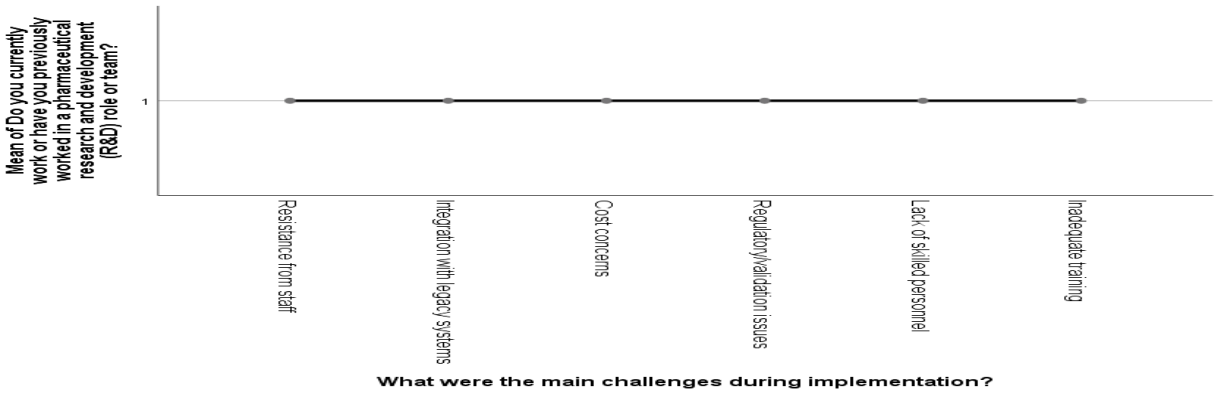
a. Warning: Between-component variance is negative. It was replaced by 0.0 in computing this random effects measure.

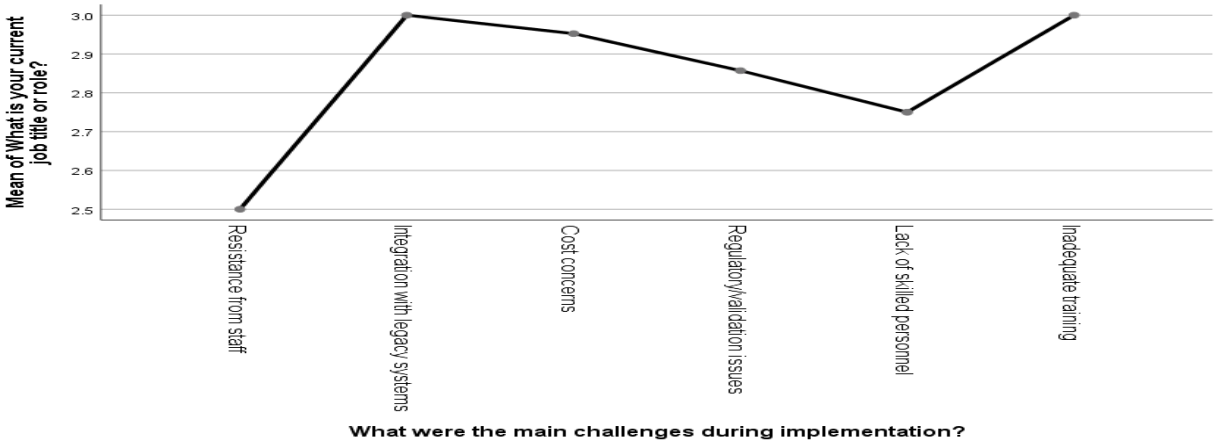
ANOVA

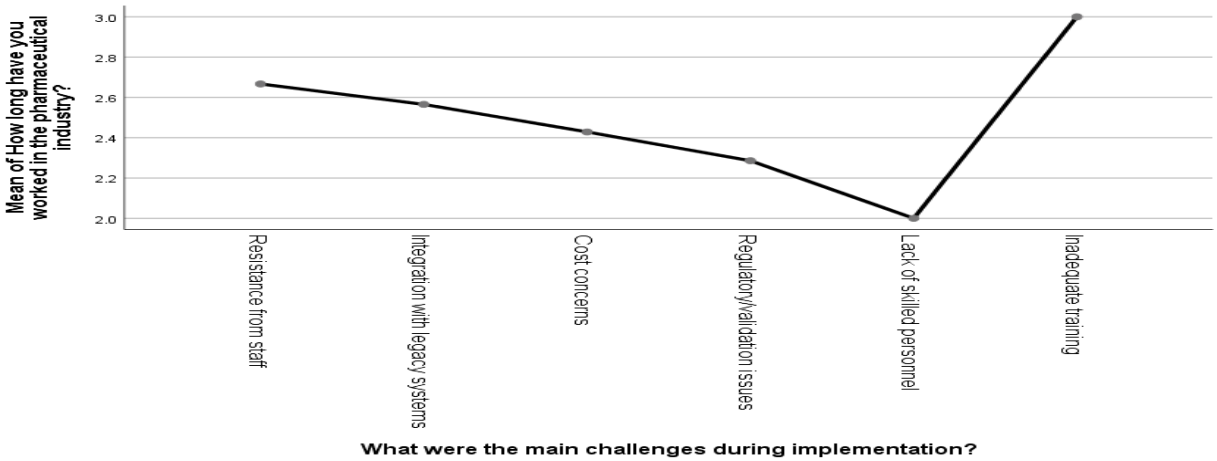
		Sum of Squares	df	Mean Square	F	Sig.
Do you currently work or have you previously worked in a pharmaceutical research and development (R&D) role or team?	Between Groups	.000	5	.000	.	.
	Within Groups	.000	56	.000		
	Total	.000	61			
What is your current job title or role?	Between Groups	1.360	5	.272	.211	.956
	Within Groups	72.060	56	1.287		
	Total	73.419	61			
How long have you worked in the pharmaceutical industry?	Between Groups	1.879	5	.376	.483	.787
	Within Groups	43.557	56	.778		
	Total	45.435	61			

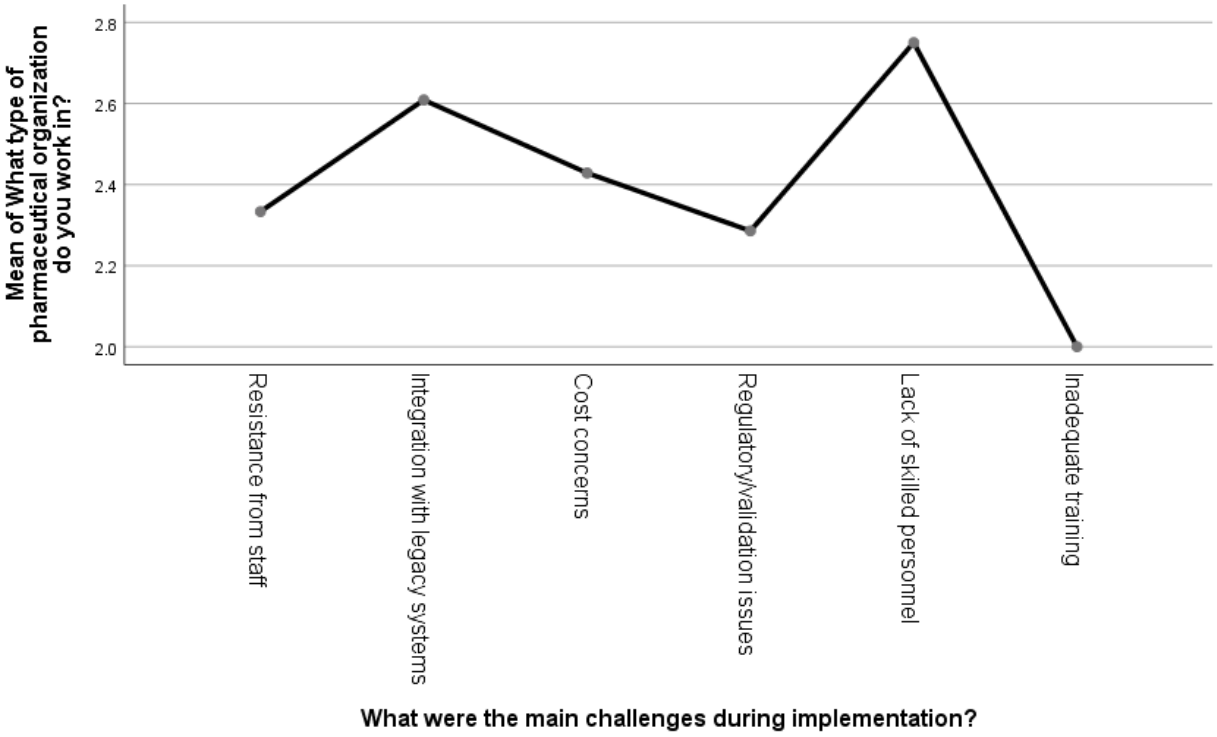
What type of pharmaceutical organization do you work in?	Between Groups	1.351	5	.270	.443	.816
	Within Groups	34.133	56	.610		
	Total	35.484	61			
Does your R&D team use cloud computing solutions?	Between Groups	1.201	5	.240	.942	.461
	Within Groups	14.283	56	.255		
	Total	15.484	61			
Which cloud provider(s) does your team use?	Between Groups	8.356	5	1.671	1.875	.113
	Within Groups	49.918	56	.891		
	Total	58.274	61			
Cloud improves data accessibility	Between Groups	1.194	5	.239	.423	.831
	Within Groups	31.644	56	.565		
	Total	32.839	61			
Cloud enhances scalability for research workloads	Between Groups	.319	5	.064	.074	.996
	Within Groups	48.536	56	.867		
	Total	48.855	61			
Cloud helped reduce infrastructure costs	Between Groups	2.298	5	.460	.543	.743
	Within Groups	47.396	56	.846		
	Total	49.694	61			
Cloud has improved collaboration across teams	Between Groups	4.110	5	.822	1.234	.306
	Within Groups	37.310	56	.666		
	Total	41.419	61			
Cloud has created compliance or validation challenges	Between Groups	6.397	5	1.279	1.378	.246
	Within Groups	51.990	56	.928		
	Total	58.387	61			
Is Power BI used in your R&D operations?	Between Groups	2.379	5	.476	.951	.455
	Within Groups	28.008	56	.500		
	Total	30.387	61			
If yes, which functions are most commonly used?	Between Groups	1.299	5	.260	.347	.882
	Within Groups	41.943	56	.749		
	Total	43.242	61			
Power BI helps in making faster decisions	Between Groups	.475	5	.095	.198	.962
	Within Groups	26.896	56	.480		
	Total	27.371	61			
Dashboards are updated in real time	Between Groups	1.854	5	.371	.602	.698
	Within Groups	34.484	56	.616		
	Total	36.339	61			
Forecasting with Power BI has reduced trial delays/errors	Between Groups	2.496	5	.499	.585	.711
	Within Groups	47.778	56	.853		
	Total	50.274	61			
Training on BI tools was sufficient	Between Groups	2.944	5	.589	.809	.548
	Within Groups	40.750	56	.728		
	Total	43.694	61			
Power BI dashboards are trusted by decision-makers	Between Groups	3.189	5	.638	.843	.525
	Within Groups	42.359	56	.756		
	Total	45.548	61			
What has improved the most due to using both tools together?	Between Groups	4.690	5	.938	1.037	.405
	Within Groups	50.681	56	.905		
	Total	55.371	61			
How would you rate your organisation's success in integrating cloud and BI tools?	Between Groups	4.532	5	.906	1.259	.295
	Within Groups	40.323	56	.720		
	Total	44.855	61			
Do you believe your organization has fully leveraged the potential of cloud-BI integration?	Between Groups	2.320	5	.464	.959	.451
	Within Groups	27.099	56	.484		
	Total	29.419	61			
What support/resources would help adoption?	Between Groups	7.804	5	1.561	2.104	.078
	Within Groups	41.551	56	.742		
	Total	49.355	61			
Would you be open to a follow-up interview for deeper insights?	Between Groups	.177	5	.035	.377	.862
	Within Groups	5.243	56	.094		
	Total	5.419	61			
Have you seen any case studies or internal examples showing the impact of cloud BI in pharma R&D?	Between Groups	2.043	5	.409	.820	.541
	Within Groups	27.893	56	.498		
	Total	29.935	61			
Does your organization lack a standardized framework for cloud BI tools?	Between Groups	4.700	5	.940	1.397	.240
	Within Groups	37.687	56	.673		
	Total	42.387	61			
What are the biggest uncertainties in adopting cloud + BI in pharma R&D?	Between Groups	6.507	5	1.301	.898	.489
	Within Groups	81.171	56	1.449		
	Total	87.677	61			
Do you believe Power BI or similar BI tools are ready for regulated pharma environments?	Between Groups	5.177	5	1.035	.981	.437
	Within Groups	59.097	56	1.055		
	Total	64.274	61			
How confident are you in the long-term ROI from cloud + Power BI?	Between Groups	1.202	5	.240	.412	.838
	Within Groups	32.685	56	.584		
	Total	33.887	61			

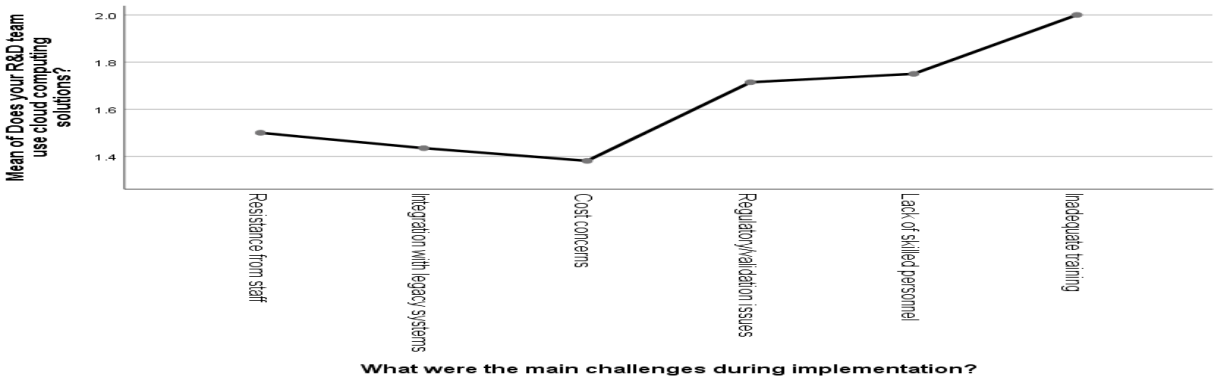
Means Plots

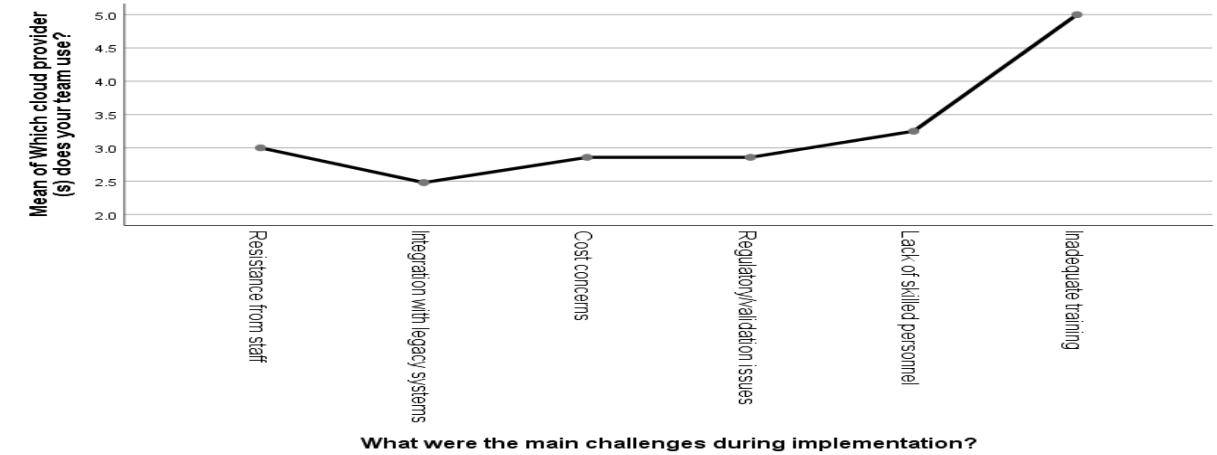

Mean of Do you currently work or have you previously worked in a pharmaceutical research and development (R&D) role or team?
1
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

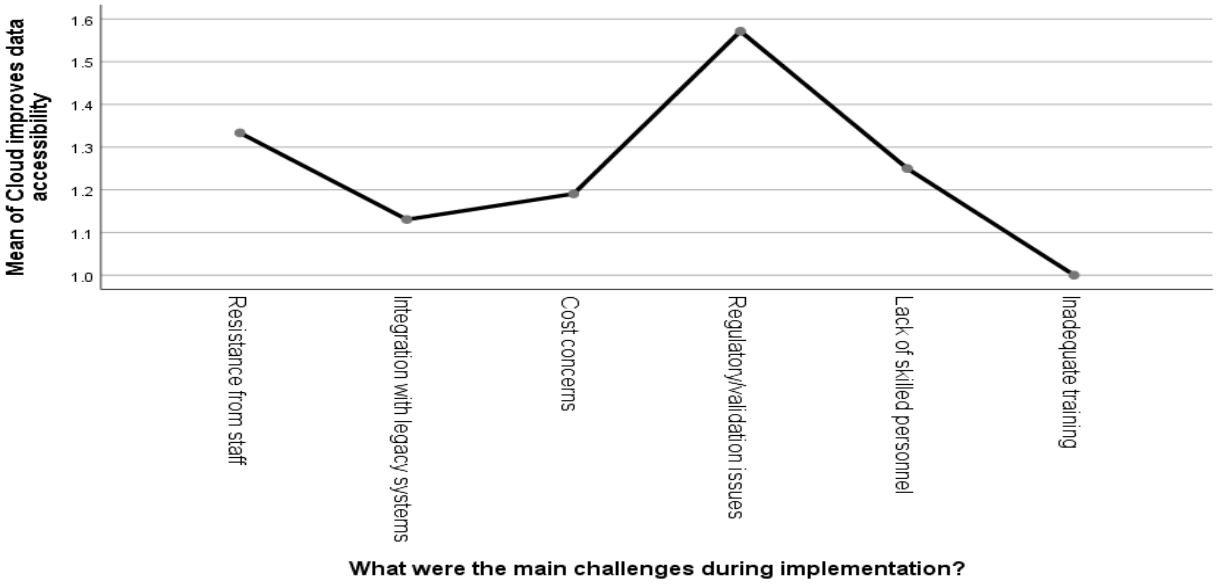

Mean of What is your current job title or role?
3.0
2.9
2.8
2.7
2.6
2.5
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

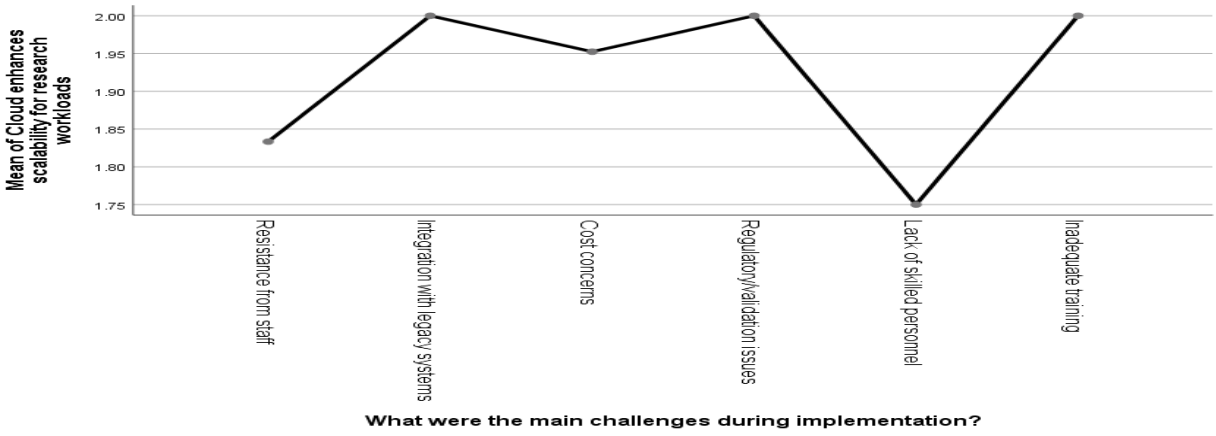

Mean of How long have you worked in the pharmaceutical industry?
3.0
2.8
2.6
2.4
2.2
2.0
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

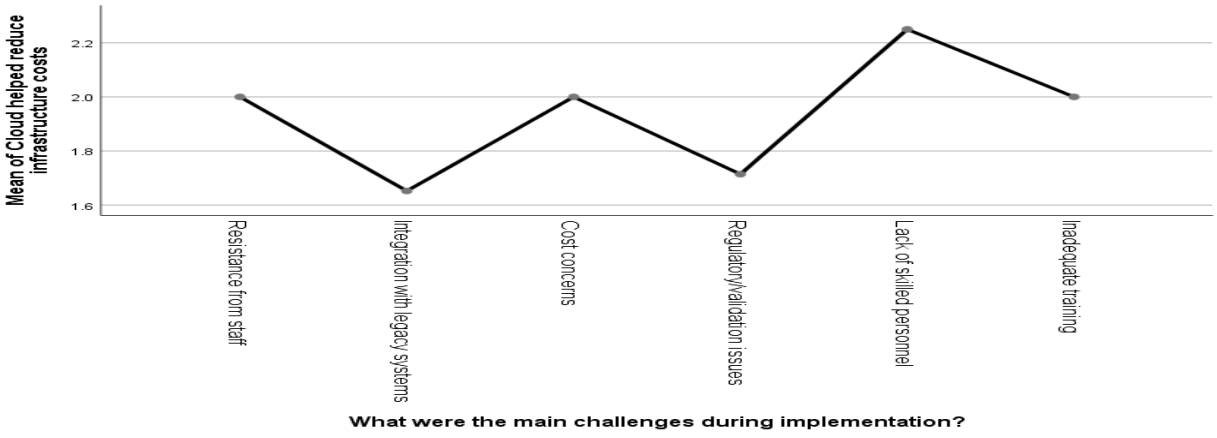

Mean of What type of pharmaceutical organization do you work in?
2.8
2.6
2.4
2.2
2.0
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

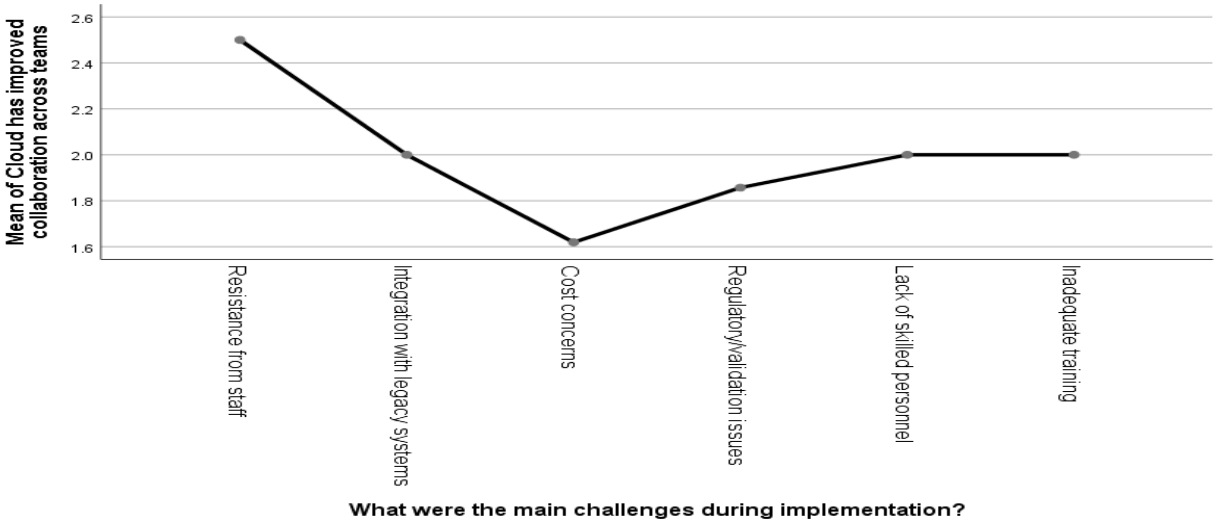

Mean of Does your R&D team use cloud computing solutions?
2.0
1.8
1.6
1.4
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

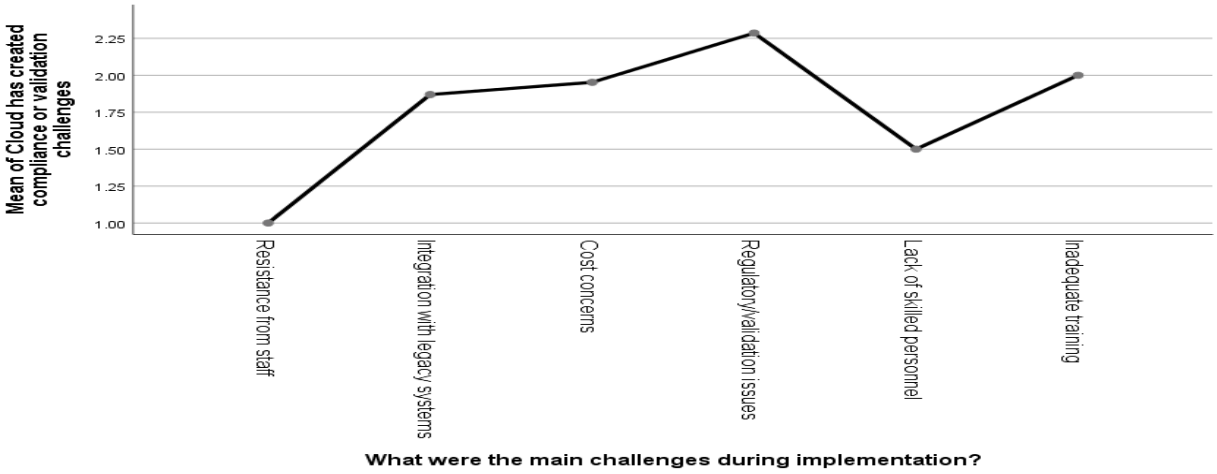

Mean of Which cloud provider (s) does your team use?
5.0
4.5
4.0
3.5
3.0
2.5
2.0
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

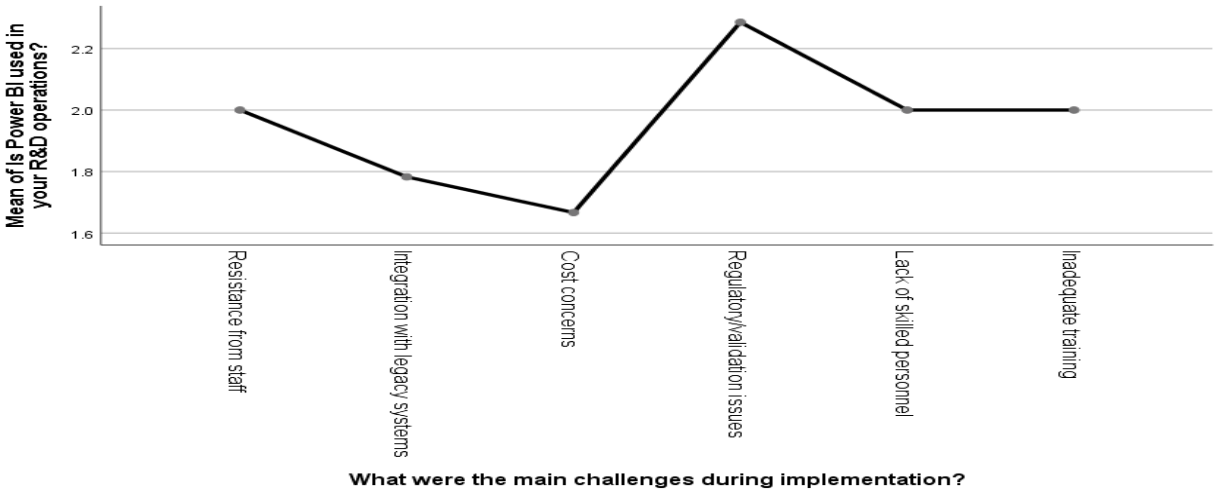

Mean of Cloud improves data accessibility
1.6
1.5
1.4
1.3
1.2
1.1
1.0
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

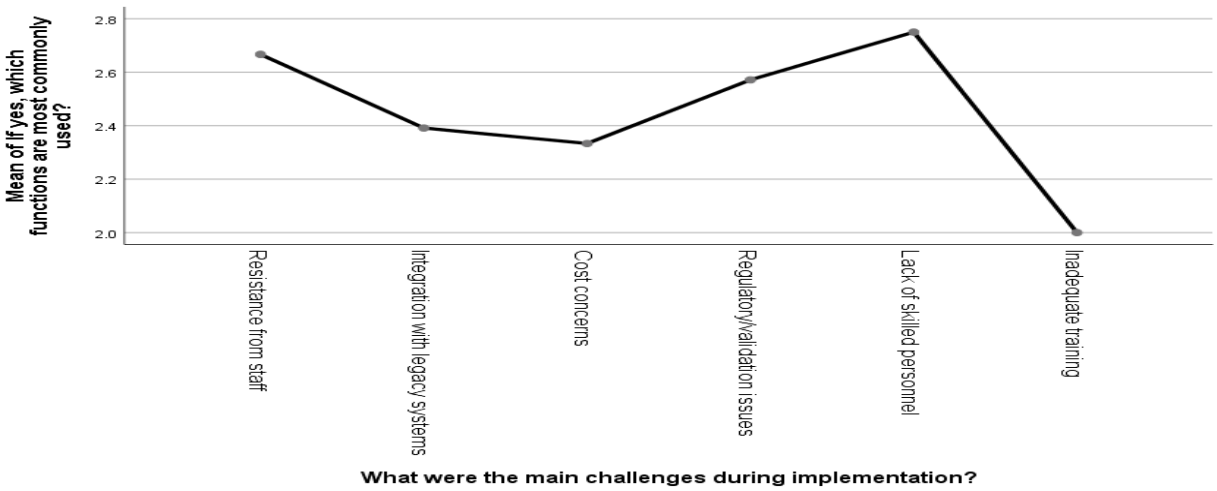

Mean of Cloud enhances scalability for research workloads
2.00
1.95
1.90
1.85
1.80
1.75
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

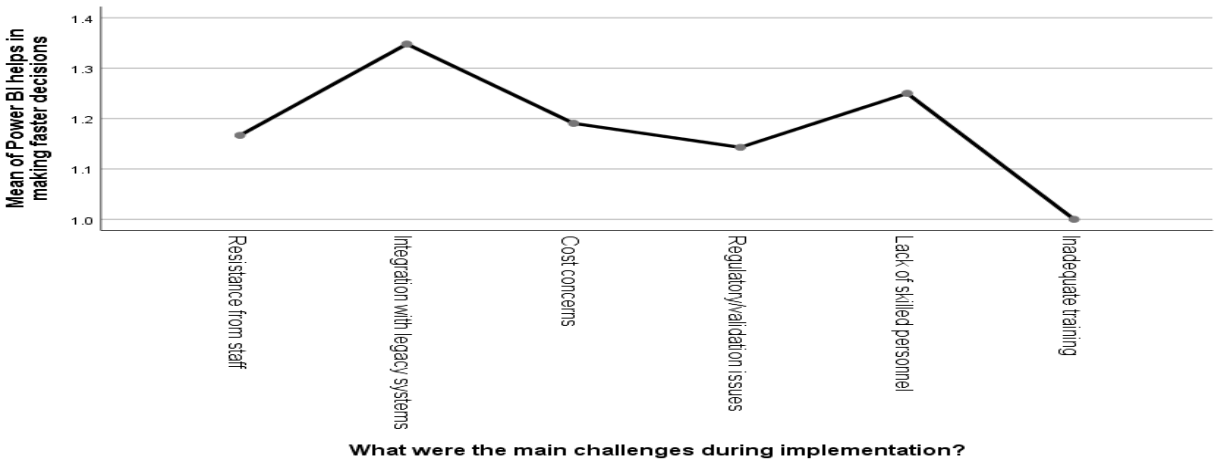

Mean of Cloud helped reduce infrastructure costs
2.2
2.0
1.8
1.6
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

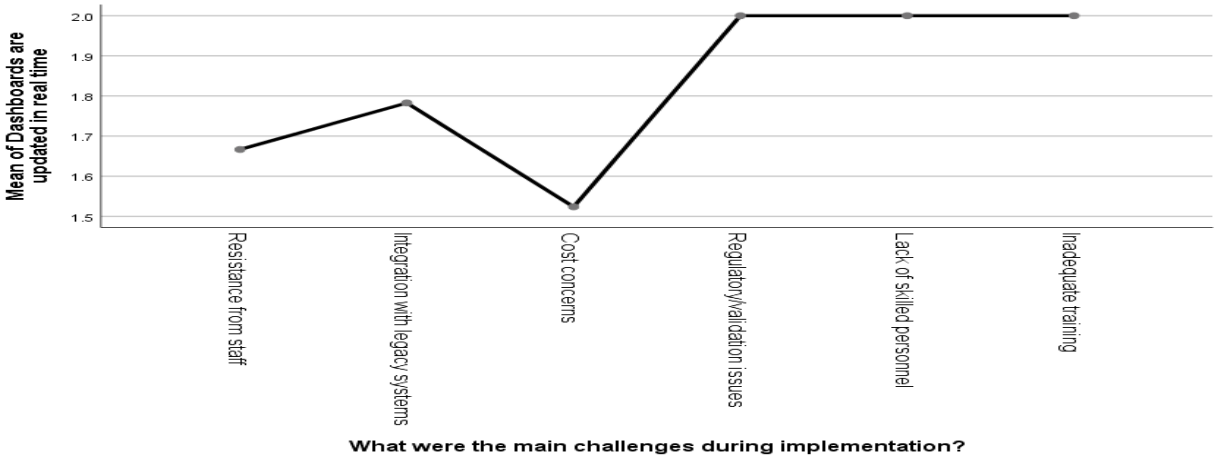

Mean of Cloud has improved collaboration across teams
2.6
2.4
2.2
2.0
1.8
1.6
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

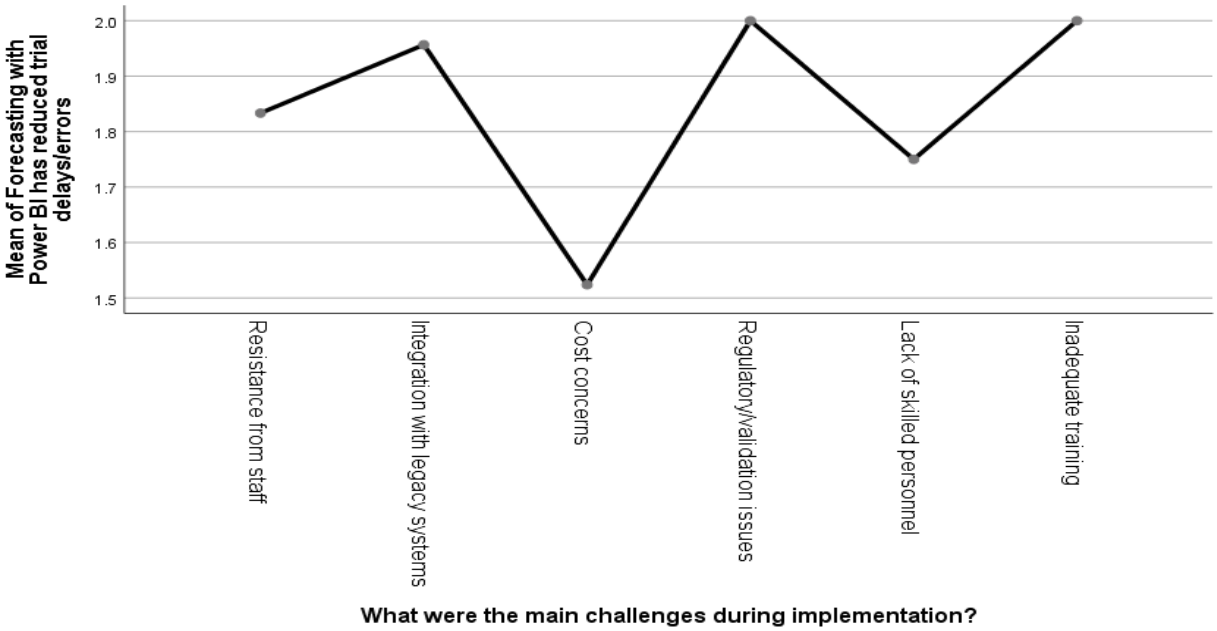

Mean of Cloud has created compliance or validation challenges
2.25
2.00
1.75
1.50
1.25
1.00
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

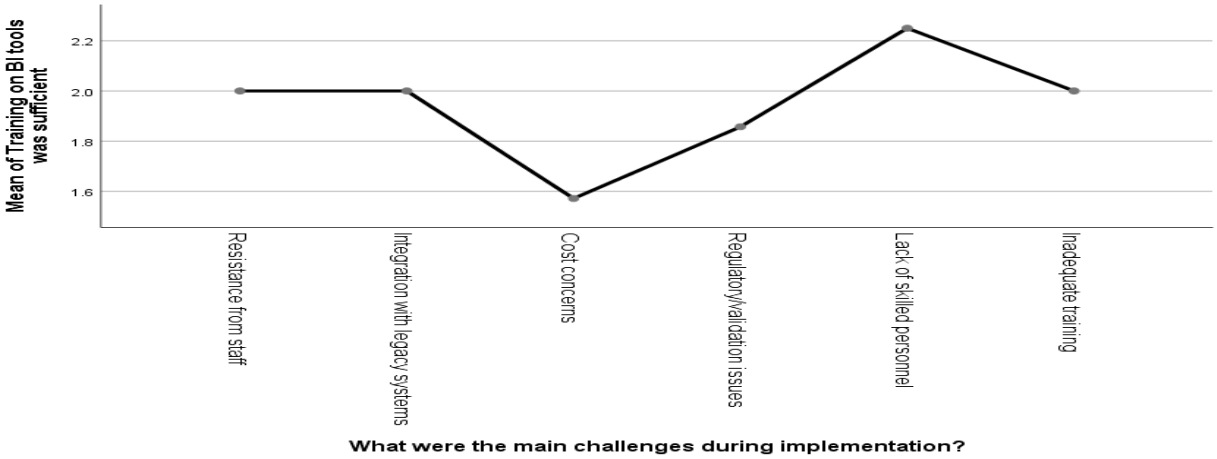

Mean of Is Power BI used in your R&D operations?
2.2
2.0
1.8
1.6
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

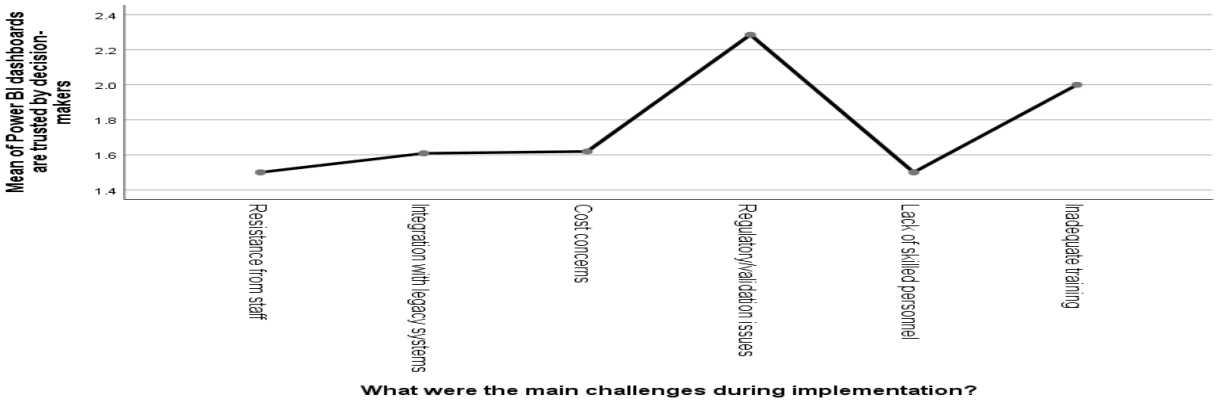

Mean of If yes, which functions are most commonly used?
2.8
2.6
2.4
2.2
2.0
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

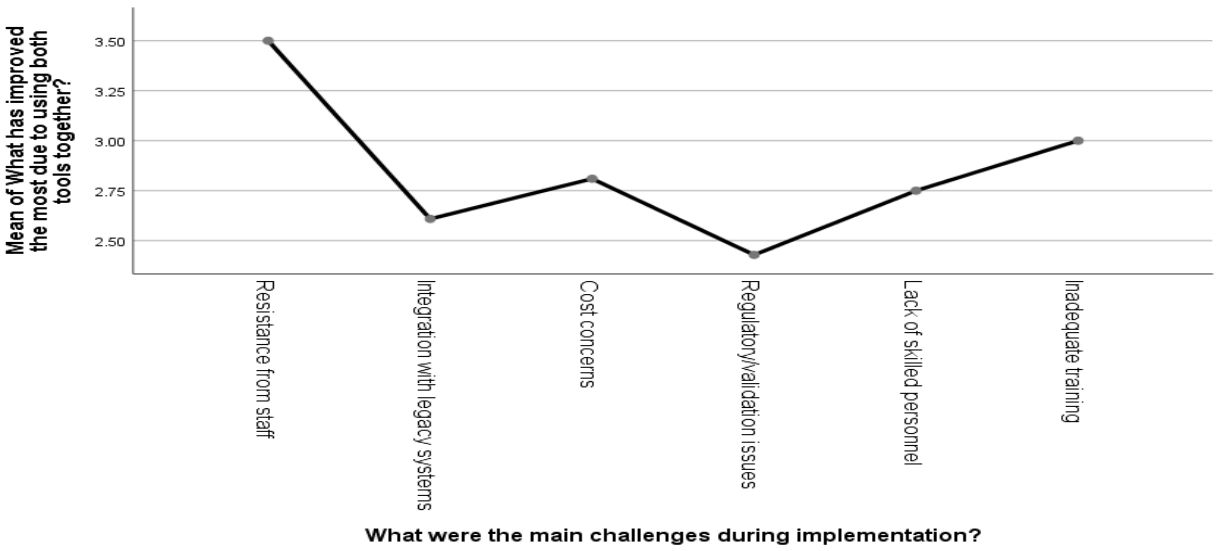

Mean of Power BI helps in making faster decisions
1.4
1.3
1.2
1.1
1.0
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

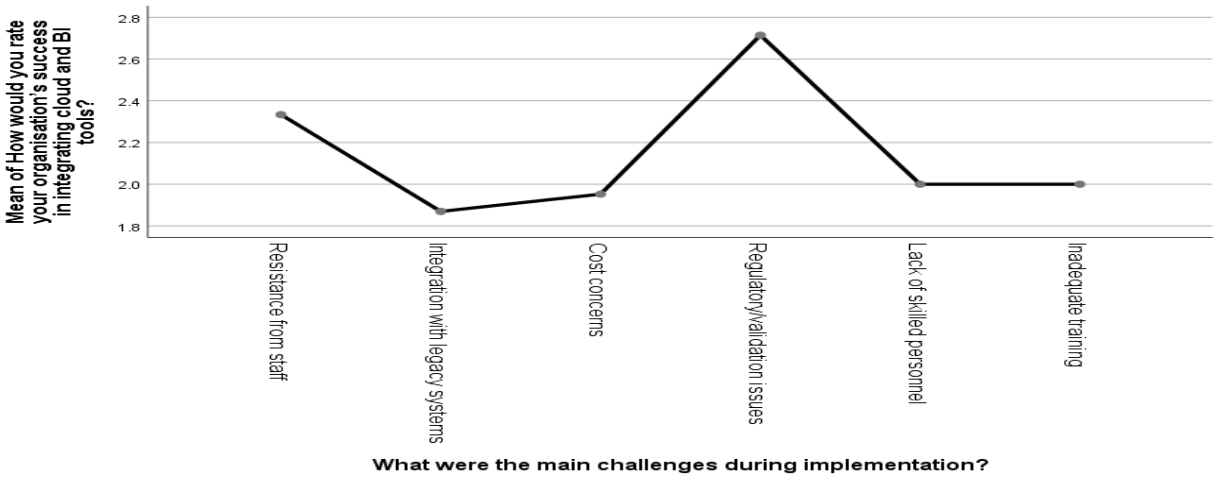

Mean of Dashboards are updated in real time
2.0
1.9
1.8
1.7
1.6
1.5
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

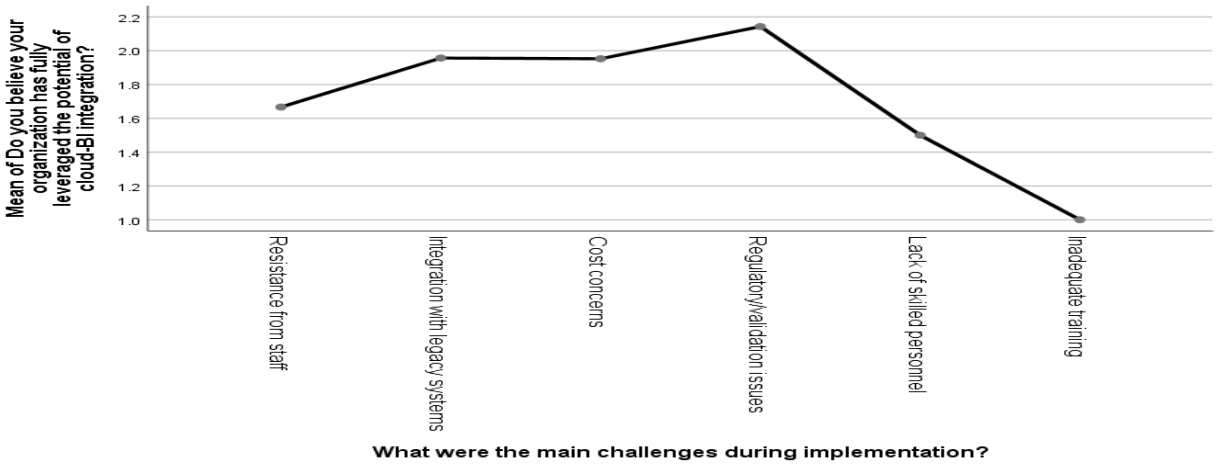

Mean of Forecasting with Power BI has reduced trial delays/errors
2.0
1.9
1.8
1.7
1.6
1.5
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

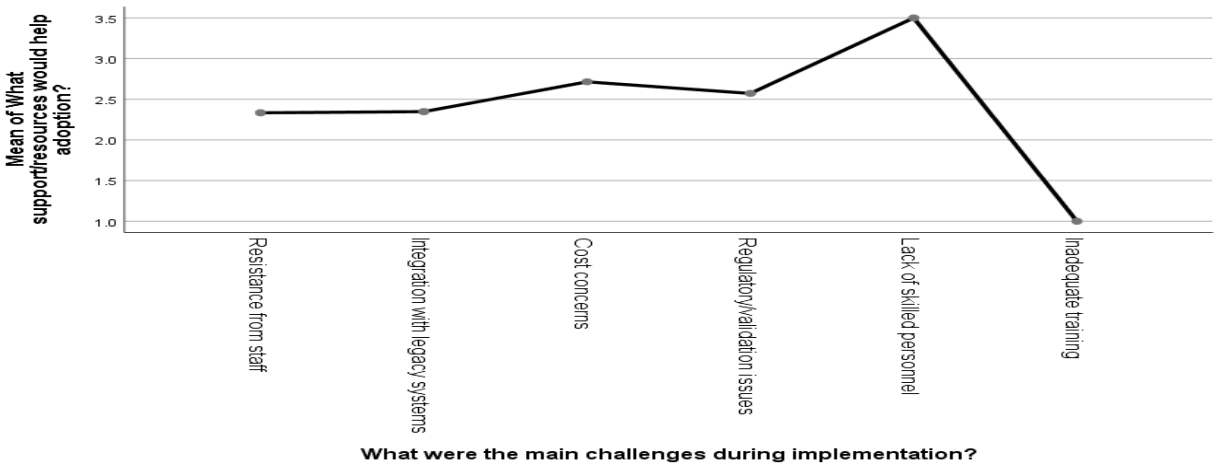

Mean of Training on BI tools was sufficient
2.2
2.0
1.8
1.6
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

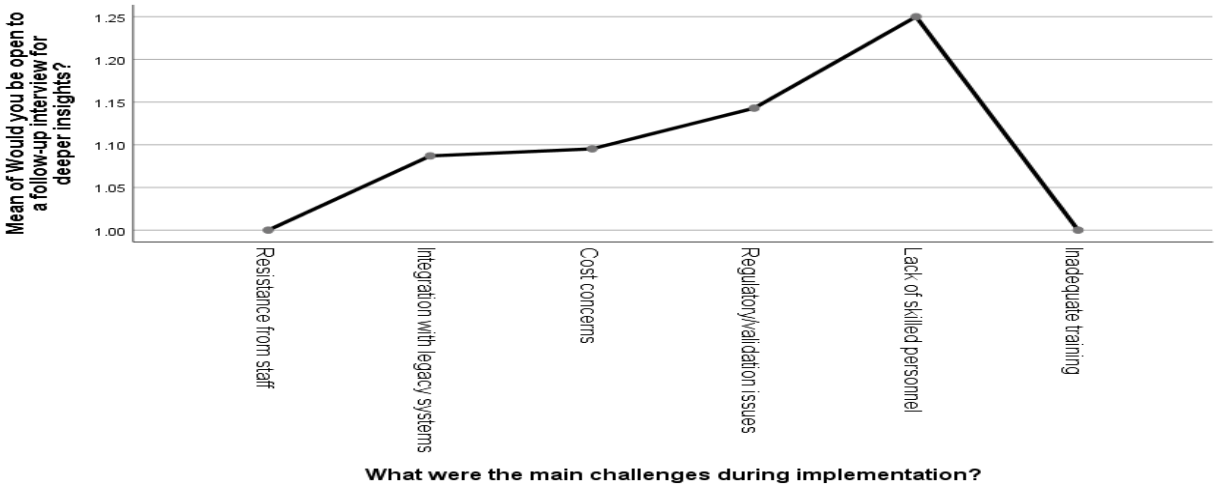

Mean of Power BI dashboards are trusted by decision-makers
2.4
2.2
2.0
1.8
1.6
1.4
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

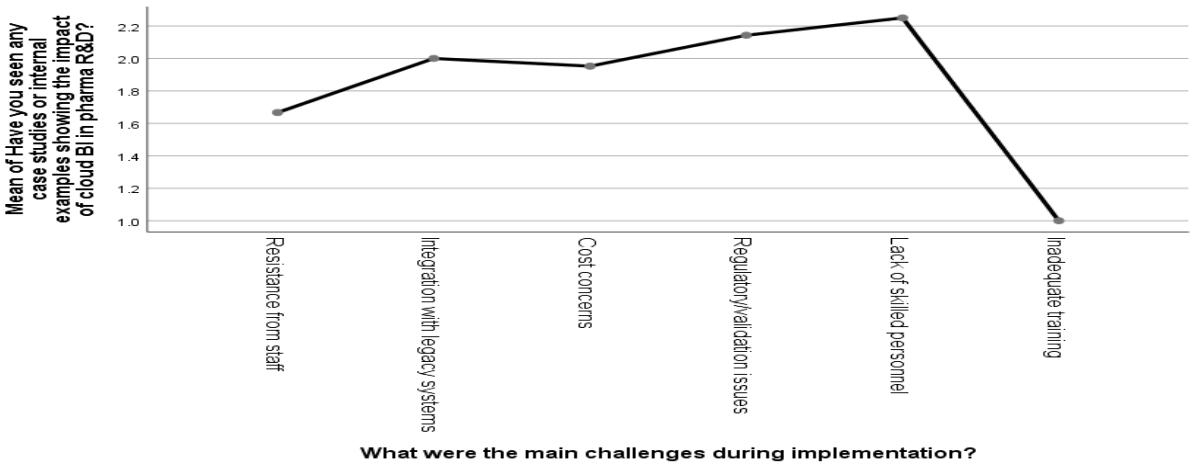

Mean of What has improved the most due to using both tools together?
3.50
3.25
3.00
2.75
2.50
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

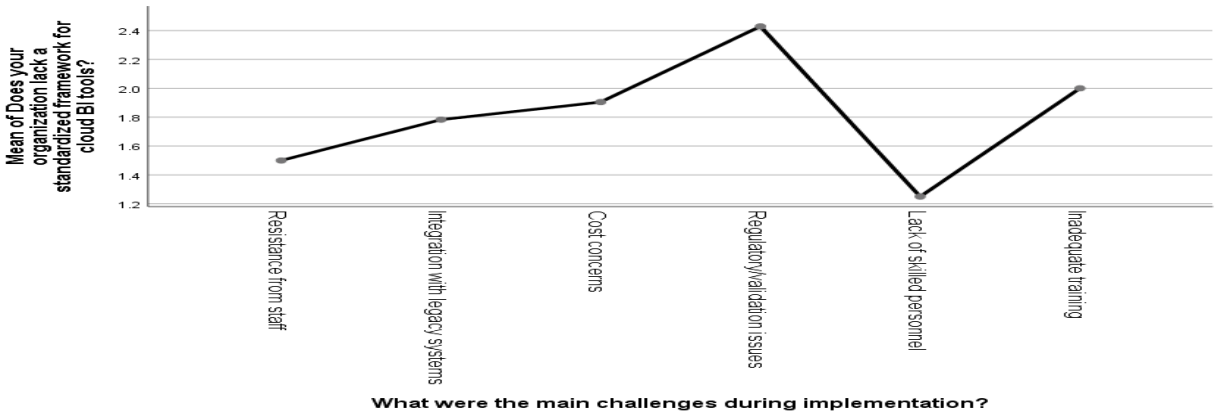

Mean of How would you rate your organisation's success in integrating cloud and BI tools?
2.8
2.6
2.4
2.2
2.0
1.8
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

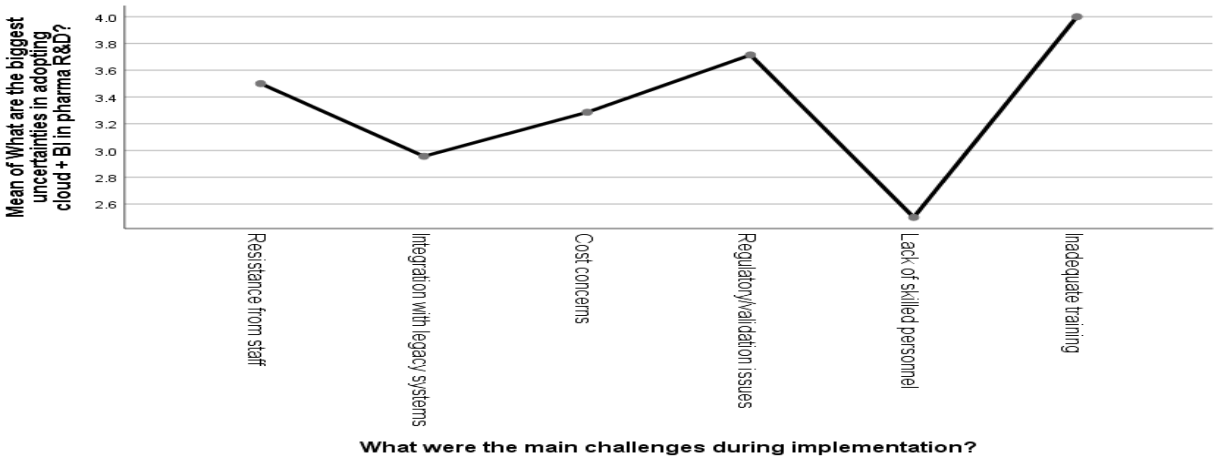

Mean of Do you believe your organization has fully leveraged the potential of cloud-BI integration?
2.2
2.0
1.8
1.6
1.4
1.2
1.0
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

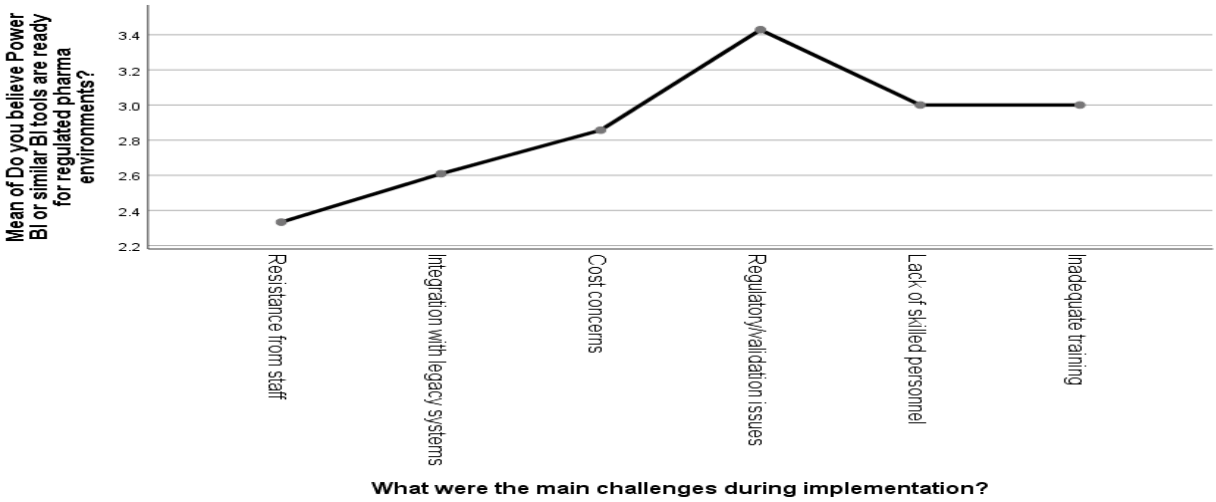

Mean of What support/resources would help adoption?
3.5
3.0
2.5
2.0
1.5
1.0
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

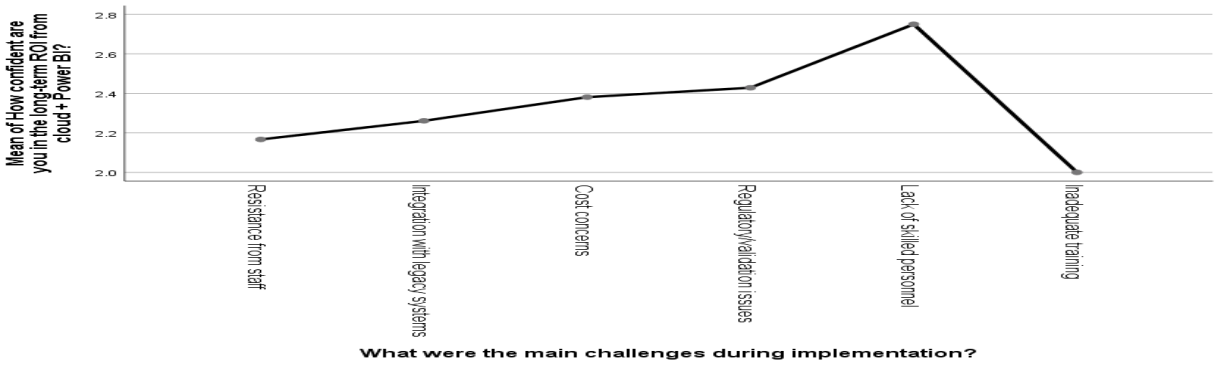

Mean of Would you be open to a follow-up interview for deeper insights?
1.25
1.20
1.15
1.10
1.05
1.00
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?


Mean of Have you seen any case studies or internal examples showing the impact of cloud BI in pharma R&D?
2.2
2.0
1.8
1.6
1.4
1.2
1.0
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?


Mean of Does your organization lack a standardized framework for cloud BI tools?
2.4
2.2
2.0
1.8
1.6
1.4
1.2
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?


Mean of What are the biggest uncertainties in adopting cloud + BI in pharma R&D?
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?


Mean of Do you believe Power BI or similar BI tools are ready for regulated pharma environments?
3.4
3.2
3.0
2.8
2.6
2.4
2.2
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?


Mean of How confident are you in the long-term ROI from cloud + Power BI?
2.8
2.6
2.4
2.2
2.0
Resistance from staff
Integration with legacy systems
Cost concerns
Regulatory/validation issues
Lack of skilled personnel
Inadequate training
What were the main challenges during implementation?

Correlations

Correlations

		Cloud improves data accessibility	Cloud enhances scalability for research workloads	Cloud helped reduce infrastructure costs	Cloud has improved collaboration across teams	Cloud has created compliance or validation challenges	Power BI helps in making faster decisions	Dashboards are updated in real time	Forecasting with Power BI has reduced trial delays/errors	Training on BI tools was sufficient	Power BI dashboards are trusted by decision-makers	Does your organization lack a standardized framework for cloud BI tools?
Cloud improves data accessibility	Pearson Correlation	1	.391**	.545**	.471**	.508**	.587**	.111	.220	.054	.065	.275*
	Sig. (2-tailed)		.002	.000	.000	.000	.000	.390	.086	.679	.615	.031
	N	62	62	62	62	62	62	62	62	62	62	62
Cloud enhances scalability for research workloads	Pearson Correlation	.391**	1	.458**	.416**	.440**	.293*	.265*	.290*	.185	.191	.033
	Sig. (2-tailed)	.002		.000	.001	.000	.021	.037	.022	.149	.136	.797
	N	62	62	62	62	62	62	62	62	62	62	62
Cloud helped reduce infrastructure costs	Pearson Correlation	.545**	.458**	1	.267*	.326**	.357**	.107	.282*	.187	.128	.164
	Sig. (2-tailed)	.000	.000		.036	.010	.004	.409	.026	.147	.321	.201
	N	62	62	62	62	62	62	62	62	62	62	62
Cloud has improved collaboration across teams	Pearson Correlation	.471**	.416**	.267*	1	.306*	.340**	.164	.301*	.191	.048	.049
	Sig. (2-tailed)	.000	.001	.036		.016	.007	.203	.017	.137	.714	.708
	N	62	62	62	62	62	62	62	62	62	62	62
Cloud has created compliance or validation challenges	Pearson Correlation	.508**	.440**	.326**	.306*	1	.236	.223	.220	.229	.325**	.128
	Sig. (2-tailed)	.000	.000	.010	.016		.065	.082	.086	.074	.010	.320
	N	62	62	62	62	62	62	62	62	62	62	62
Power BI helps in making faster decisions	Pearson Correlation	.587**	.293*	.357**	.340**	.236	1	.289*	.381**	.323*	.165	.071
	Sig. (2-tailed)	.000	.021	.004	.007	.065		.023	.002	.010	.199	.583
	N	62	62	62	62	62	62	62	62	62	62	62
Dashboards are updated in real time	Pearson Correlation	.111	.265*	.107	.164	.223	.289*	1	.291*	.490**	.480**	.134
	Sig. (2-tailed)	.390	.037	.409	.203	.082	.023		.022	.000	.000	.299
	N	62	62	62	62	62	62	62	62	62	62	62
Forecasting with Power BI has reduced trial delays/errors	Pearson Correlation	.220	.290*	.282*	.301*	.220	.381**	.291*	1	.386**	.289*	.150
	Sig. (2-tailed)	.086	.022	.026	.017	.086	.002	.022		.002	.023	.246
	N	62	62	62	62	62	62	62	62	62	62	62
Training on BI tools was sufficient	Pearson Correlation	.054	.185	.187	.191	.229	.323*	.490**	.386**	1	.137	-.103
	Sig. (2-tailed)	.679	.149	.147	.137	.074	.010	.000	.002		.290	.424
	N	62	62	62	62	62	62	62	62	62	62	62
Power BI dashboards are trusted by decision-makers	Pearson Correlation	.065	.191	.128	.048	.325**	.165	.480**	.289*	.137	1	.109
	Sig. (2-tailed)	.615	.136	.321	.714	.010	.199	.000	.023	.290		.401
	N	62	62	62	62	62	62	62	62	62	62	62
Does your organization lack a standardized framework for cloud BI tools?	Pearson Correlation	.275*	.033	.164	.049	.128	.071	.134	.150	-.103	.109	1
	Sig. (2-tailed)	.031	.797	.201	.708	.320	.583	.299	.246	.424	.401	
	N	62	62	62	62	62	62	62	62	62	62	62

Regression

Descriptive Statistics

	Mean	Std. Deviation	N
Power BI helps in making faster decisions	1.24	.670	62
Cloud improves data accessibility	1.23	.734	62
Cloud has improved collaboration across teams	1.90	.824	62
Dashboards are updated in real time	1.73	.772	62
Training on BI tools was sufficient	1.85	.846	62

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method

1	Training on BI tools was sufficient, Cloud improves data accessibility, Dashboards are updated in real time, Cloud has improved collaboration across teams[b]	.	Enter

a. Dependent Variable: Power BI helps in making faster decisions
b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.663[a]	.440	.400	.519	.440	11.178	4	57	.000

a. Predictors: (Constant), Training on BI tools was sufficient, Cloud improves data accessibility, Dashboards are updated in real time, Cloud has improved collaboration across teams
b. Dependent Variable: Power BI helps in making faster decisions

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12.032	4	3.008	11.178	.000[b]
	Residual	15.339	57	.269		
	Total	27.371	61			

a. Dependent Variable: Power BI helps in making faster decisions
b. Predictors: (Constant), Training on BI tools was sufficient, Cloud improves data accessibility, Dashboards are updated in real time, Cloud has improved collaboration across teams

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions				
				(Constant)	Cloud improves data accessibility	Cloud has improved collaboration across teams	Dashboards are updated in real time	Training on BI tools was sufficient
1	1	4.498	1.000	.00	.01	.01	.01	.01
	2	.249	4.252	.00	.43	.03	.08	.11
	3	.104	6.589	.05	.47	.56	.24	.00
	4	.084	7.339	.04	.08	.03	.50	.86
	5	.066	8.261	.90	.00	.37	.17	.02

a. Dependent Variable: Power BI helps in making faster decisions

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	.89	3.29	1.24	.444	62
Residual	-1.035	1.708	.000	.501	62
Std. Predicted Value	-.799	4.616	.000	1.000	62
Std. Residual	-1.994	3.293	.000	.967	62

a. Dependent Variable: Power BI helps in making faster decisions

Charts

Regression

Descriptive Statistics

	Mean	Std. Deviation	N
Cloud has improved collaboration across teams	1.90	.824	62
Cloud improves data accessibility	1.23	.734	62
Cloud enhances scalability for research workloads	1.95	.895	62
Cloud helped reduce infrastructure costs	1.85	.903	62
Cloud has created compliance or validation challenges	1.84	.978	62

Correlations

		Cloud has improved collaboration across teams	Cloud improves data accessibility	Cloud enhances scalability for research workloads	Cloud helped reduce infrastructure costs	Cloud has created compliance or validation challenges
Pearson Correlation	Cloud has improved collaboration across teams	1.000	.471	.416	.267	.306
	Cloud improves data accessibility	.471	1.000	.391	.545	.508

	Cloud enhances scalability for research workloads	.416	.391	1.000	.458	.440
	Cloud helped reduce infrastructure costs	.267	.545	.458	1.000	.326
	Cloud has created compliance or validation challenges	.306	.508	.440	.326	1.000
Sig. (1-tailed)	Cloud has improved collaboration across teams	.	.000	.000	.018	.008
	Cloud improves data accessibility	.000	.	.001	.000	.000
	Cloud enhances scalability for research workloads	.000	.001	.	.000	.000
	Cloud helped reduce infrastructure costs	.018	.000	.000	.	.005
	Cloud has created compliance or validation challenges	.008	.000	.000	.005	.
N	Cloud has improved collaboration across teams	62	62	62	62	62
	Cloud improves data accessibility	62	62	62	62	62
	Cloud enhances scalability for research workloads	62	62	62	62	62
	Cloud helped reduce infrastructure costs	62	62	62	62	62
	Cloud has created compliance or validation challenges	62	62	62	62	62

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Cloud has created compliance or validation challenges, Cloud helped reduce infrastructure costs, Cloud enhances scalability for research workloads, Cloud improves data accessibility[b]	.	Enter

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.538[a]	.290	.240	.718	.290	5.816	4	57	.001

a. Predictors: (Constant), Cloud has created compliance or validation challenges, Cloud helped reduce infrastructure costs, Cloud enhances scalability for research workloads, Cloud improves data accessibility
b. Dependent Variable: Cloud has improved collaboration across teams

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12.006	4	3.001	5.816	.001[b]
	Residual	29.414	57	.516		
	Total	41.419	61			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	.964	.258		3.733	.000					
	Cloud improves data accessibility	.452	.165	.403	2.745	.008	.471	.342	.306	.579	1.728
	Cloud enhances scalability for research workloads	.276	.123	.300	2.238	.029	.416	.284	.250	.693	1.442
	Cloud helped reduce infrastructure costs	-.081	.128	-.089	-.634	.529	.267	-.084	-.071	.631	1.584
	Cloud has created compliance or validation challenges	-.002	.115	-.002	-.016	.987	.306	-.002	-.002	.672	1.488

a. Dependent Variable: Cloud has improved collaboration across teams

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions				
				(Constant)	Cloud improves data accessibility	Cloud enhances scalability for research workloads	Cloud helped reduce infrastructure costs	Cloud has created compliance or validation challenges
1	1	4.541	1.000	.01	.01	.01	.01	.01
	2	.155	5.421	.19	.56	.13	.00	.02
	3	.139	5.711	.00	.03	.00	.31	.64
	4	.089	7.123	.67	.01	.68	.00	.00
	5	.076	7.747	.13	.40	.19	.68	.33

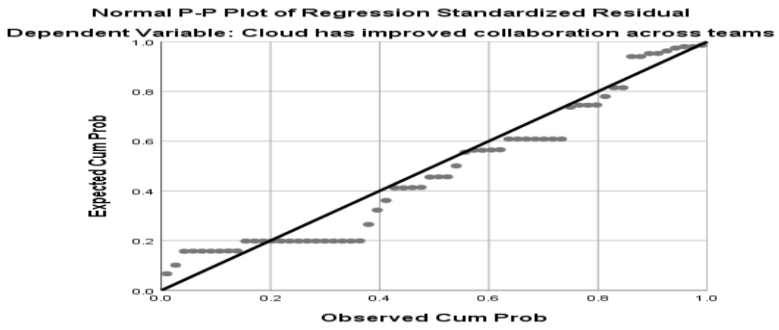
a. Dependent Variable: Cloud has improved collaboration across teams

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	1.45	3.92	1.90	.444	62
Residual	-1.079	1.567	.000	.694	62
Std. Predicted Value	-1.029	4.535	.000	1.000	62
Std. Residual	-1.501	2.182	.000	.967	62

a. Dependent Variable: Cloud has improved collaboration across teams

Charts



T-Test

Group Statistics

	Does your R&D team use cloud computing solutions?	N	Mean	Std. Deviation	Std. Error Mean
Cloud improves data accessibility	Yes	32	1.28	.729	.129
	No	30	1.17	.747	.136

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Cloud improves data accessibility	Equal variances assumed	1.103	.298	.611	60	.543	.115	.187	-.260	.489
	Equal variances not assumed			.611	59.521	.544	.115	.188	-.261	.490

T-Test

Group Statistics

	Have you seen any case studies or internal examples showing the impact of cloud BI in pharma R&D?	N	Mean	Std. Deviation	Std. Error Mean
Cloud enhances scalability for research workloads	Yes	16	1.94	.998	.249
	No	32	1.88	.871	.154
Cloud helped reduce infrastructure costs	Yes	16	1.63	.885	.221
	No	32	1.97	.967	.171
Cloud has improved collaboration across teams	Yes	16	2.06	.998	.249
	No	32	1.75	.803	.142
Cloud has created compliance or validation challenges	Yes	16	2.06	1.181	.295
	No	32	1.72	.958	.169

T-Test

Group Statistics

	Do you believe Power BI or similar BI tools are ready for regulated pharma environments?	N	Mean	Std. Deviation	Std. Error Mean
Power BI helps in making faster decisions	Yes	9	1.67	1.323	.441
	No	13	1.00	.000	.000
Dashboards are updated in real time	Yes	9	1.78	1.093	.364
	No	13	2.08	.760	.211
Forecasting with Power BI has reduced trial delays/errors	Yes	9	2.11	1.364	.455
	No	13	1.77	.832	.231
Training on BI tools was sufficient	Yes	9	2.11	1.054	.351
	No	13	1.85	.899	.249
Power BI dashboards are trusted by decision-makers	Yes	9	1.33	.500	.167
	No	13	1.92	1.115	.309

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Power BI helps in making faster decisions	Equal variances assumed	12.199	.002	1.838	20	.081	.667	.363	-.090	1.423
	Equal variances not assumed			1.512	8.000	.169	.667	.441	-.350	1.684
Dashboards are updated in real time	Equal variances assumed	1.677	.210	-.760	20	.456	-.299	.394	-1.120	.522
	Equal variances not assumed			-.711	13.257	.489	-.299	.421	-1.206	.608
Forecasting with Power BI has reduced trial delays/errors	Equal variances assumed	1.633	.216	.732	20	.473	.342	.467	-.632	1.316
	Equal variances not assumed			.670	12.115	.515	.342	.510	-.768	1.452
Training on BI tools was sufficient	Equal variances assumed	.403	.533	.634	20	.533	.265	.418	-.607	1.137
	Equal variances not assumed			.615	15.467	.547	.265	.431	-.651	1.181

Power BI dashboards are trusted by decision-makers	Equal variances assumed	13.979	.001	-1.478	20	.155	-.590	.399	-1.422	.242
	Equal variances not assumed			-1.679	17.737	.111	-.590	.351	-1.329	.149

Crosstabs

Case Processing Summary

	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Does your R&D team use cloud computing solutions? * Have you seen any case studies or internal examples showing the impact of cloud BI in pharma R&D?	62	98.4%	1	1.6%	63	100.0%
Does your R&D team use cloud computing solutions? * Do you believe Power BI or similar BI tools are ready for regulated pharma environments?	62	98.4%	1	1.6%	63	100.0%
Is Power BI used in your R&D operations? * Have you seen any case studies or internal examples showing the impact of cloud BI in pharma R&D?	62	98.4%	1	1.6%	63	100.0%
Is Power BI used in your R&D operations? * Do you believe Power BI or similar BI tools are ready for regulated pharma environments?	62	98.4%	1	1.6%	63	100.0%
Do you believe your organization has fully leveraged the potential of cloud-BI integration? * Have you seen any case studies or internal examples showing the impact of cloud BI in pharma R&D?	62	98.4%	1	1.6%	63	100.0%
Do you believe your organization has fully leveraged the potential of cloud-BI integration? * Do you believe Power BI or similar BI tools are ready for regulated pharma environments?	62	98.4%	1	1.6%	63	100.0%

Does your R&D team use cloud computing solutions? * Have you seen any case studies or internal examples showing the impact of cloud BI in pharma R&D?

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.597[a]	2	.742
Likelihood Ratio	.598	2	.742
Linear-by-Linear Association	.510	1	.475
N of Valid Cases	62		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.77.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.098	.742
	Cramer's V	.098	.742
N of Valid Cases		62	

Does your R&D team use cloud computing solutions? * Do you believe Power BI or similar BI tools are ready for regulated pharma environments?

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.266[a]	3	.352
Likelihood Ratio	3.333	3	.343
Linear-by-Linear Association	.031	1	.861
N of Valid Cases	62		

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is 4.35.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.230	.352
	Cramer's V	.230	.352
N of Valid Cases		62	

Is Power BI used in your R&D operations? * Have you seen any case studies or internal examples showing the impact of cloud BI in pharma R&D?

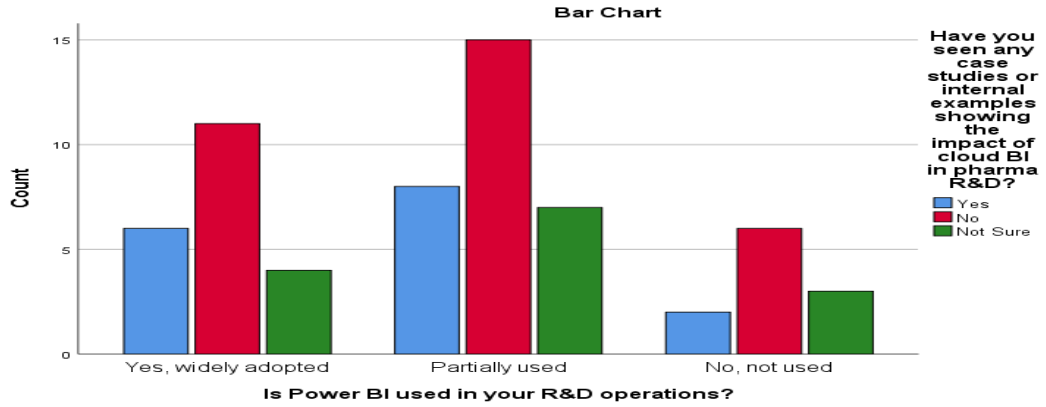
Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.585[a]	4	.965
Likelihood Ratio	.611	4	.962
Linear-by-Linear Association	.481	1	.488
N of Valid Cases	62		

a. 3 cells (33.3%) have expected count less than 5. The minimum expected count is 2.48.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.097	.965
	Cramer's V	.069	.965
N of Valid Cases		62	



Is Power BI used in your R&D operations? * Do you believe Power BI or similar BI tools are ready for regulated pharma environments?

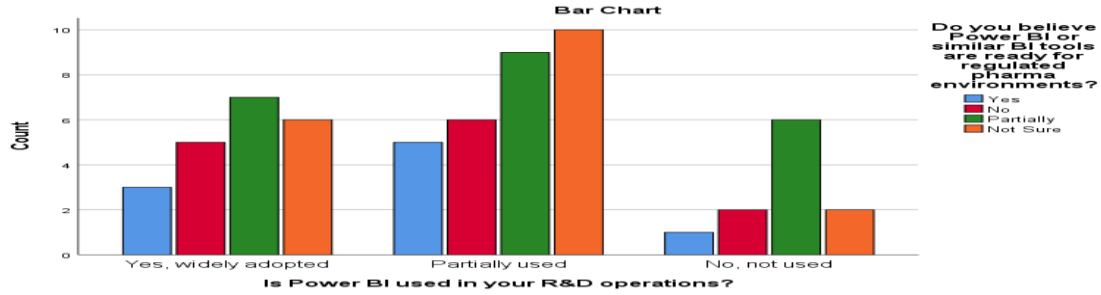
Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.501[a]	6	.868
Likelihood Ratio	2.445	6	.875
Linear-by-Linear Association	.025	1	.873
N of Valid Cases	62		

a. 7 cells (58.3%) have expected count less than 5. The minimum expected count is 1.60.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.201	.868
	Cramer's V	.142	.868
N of Valid Cases		62	



Do you believe your organization has fully leveraged the potential of cloud-BI integration? * Have you seen any case studies or internal examples showing the impact of cloud BI in pharma R&D?

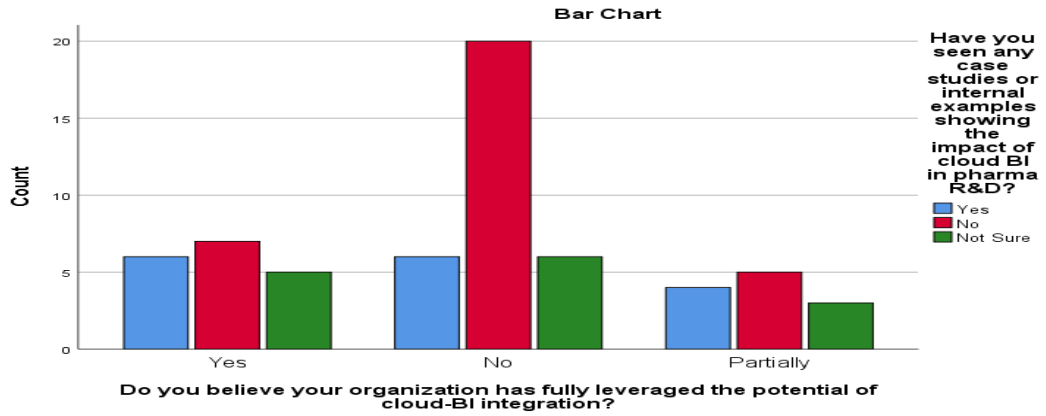
Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.260[a]	4	.515
Likelihood Ratio	3.289	4	.511
Linear-by-Linear Association	.003	1	.959
N of Valid Cases	62		

a. 4 cells (44.4%) have expected count less than 5. The minimum expected count is 2.71.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.229	.515
	Cramer's V	.162	.515
N of Valid Cases		62	



Do you believe your organization has fully leveraged the potential of cloud-BI integration? * Do you believe Power BI or similar BI tools are ready for regulated pharma environments?

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.552[a]	6	.737
Likelihood Ratio	3.632	6	.726
Linear-by-Linear Association	.098	1	.754
N of Valid Cases	62		

a. 7 cells (58.3%) have expected count less than 5. The minimum expected count is 1.74.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.239	.737
	Cramer's V	.169	.737
N of Valid Cases		62