Significance of Manager of Manager toolset in IT Service Management chain: Analysing a resilient IT-OT integration and its impact on IT Visibility within the Mining and Consumer sector

By

Nikhil Sharma

(SID – 59311)

DISSERTATION

Presented to the Swiss School of Business and Management Geneva

Towards Fulfilment

Of the Requirements For

GLOBAL DOCTOR OF BUSINESS ADMINISTRATION

SWISS SCHOOL OF BUSINESS AND MANAGEMENT GENEVA

13th October 2024

Significance of Manager of Manager toolset in IT Service Management chain: Analysing a resilient IT-OT integration and its impact on IT Visibility within the Mining and Consumer sector

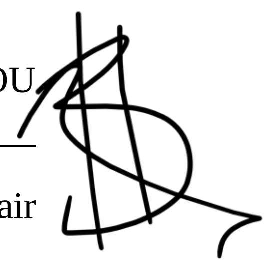
by

Nikhil Sharma

(SID: 59311)

APPROVED BY

VASILIKI GROUGIOU



____

Dissertation chair

RECEIVED/APPROVED BY:

Dedication

This work is dedicated to my kids (Jayaditya and Virhaan) and my wife (Ramnish) whose unconditional love, support, and encouragement have been my constant source of strength throughout this journey. To my parents and brother, for their endless sacrifices and unwavering belief in me, this achievement is as much yours as it is mine. To my friends colleagues and business partners, thank you for your patience, understanding, and for always being there when I needed you the most.

Finally, I dedicate this work to everyone who believes in the power of knowledge and the pursuit of dreams. Thank you all for being a part of my journey, and for helping me to achieve this significant milestone. I couldn't have done it without you, and I am forever grateful for your love and support.

Acknowledgements

I would like to express my deepest gratitude to all those who have contributed to the completion of this work. First and foremost, I would like to thank **Prof. Dr. Minja Bolesnikov, Ph.D.**, whose invaluable guidance, support, and encouragement were crucial in shaping this project. Your insights and expertise were instrumental in helping me navigate the challenges and bring this research to fruition.

I am also grateful to the faculty members and staff of **Department of Business Administration, Swiss School of Business Management Geneva** for providing a supportive environment and resources that facilitated my work. I would also like to acknowledge the my professional network - respondents who contributed their time and insights, which were essential for this study. Without your willingness to engage, this research would not have been possible.

Special thanks go to my colleagues and peers for their constructive feedback and for fostering an atmosphere of collaboration and intellectual exchange.

Finally, I would like to express my heartfelt appreciation to my family and friends for their unwavering support and understanding throughout this journey. Your encouragement and patience have been a source of strength for me.

Thank you all for making this endeavor a success.

ABSTRACT

Significance of Manager of Manager toolset in IT Service Management chain: Analysing a resilient IT-OT integration and its impact on IT Visibility within the Mining sector

Nikhil Sharma (SID: 59311)

Swiss School of Business Management Geneva

Oct 2024

Dissertation Chair: Prof. Dr. Minja Bolesnikov, Ph.D.

The IT Service Management chain underlined the significance of Manager of Manager toolset provides IT-OT flexibility, especially in the mining industry, which experienced highly convergence impacts due to combination of IT-OT technology. This work aims to explore the effectiveness of different IT Service Management tools and platform approaches used during and after the IT-OT integration to increase mining resilience. To this end, the study extends a wide-ranging literature review to identify how several elements, including digital technology applications, risk management, and mining chain flexibility, have been used to manage disruption and sustain business operations. The study also examines the relationship between resilience and operational performance which encompasses smart causal analysis solution that analyses historical data using specialized correlation and clustering techniques to detect patterns and pinpoint common sources of performance problems. By doing so, the research outlines factors that enhance mining chain resiliency and provides guidance to provides a systematic approach to diagnosing and resolving IT issues, ensuring that technology supports business goals effectively around the

globe. The outcomes proved to be quite helpful in understanding these strategies and indicated the increasing need for a strategic approach to IT Service management in mining chain to maintain high performance over time, given the current global context.

Furthermore, the research aims to analysing the impact of mining chain resilience on operational performance, focusing on identifying the most critical issues first, enabling the engineers to focus on resolving the most impactful problems, such as ERP connectors and open-source file systems, leading to a significant reduction in incidents and improved service uptime. This research provides guidelines that mining firms can use to strengthen their IT Service Management tool chain and prepare for potential enhancing user experience and improving platform stability by evaluating the effectiveness of the above listed strategies. It also gives an understanding of the main characteristics of mining chain for strength and the essential drivers that foster such strength. The research offers important insights into the suitability of these strategies and underscores the importance of addressing impact of IT-OT convergence risks before they materialize and of maintaining superior performance in a world that increasingly poses consolidation.

Keywords: Mining Chain Resilience, IT-OT, Mining Sector, Mining Chain Strategies, Operational Performance, Smart Causal Analysis, Digital Technology Integration, Risk Management, Service Management.

TABLE OF CONTENTS

LIST OF TABLES

TABLE OF FIGURES.

LIST OF FIGURES

CHAPTER I: INTRODUCTION

1.1 Introduction

The IT-OT integration is considered one of the most severe disruptions in the mining technology transformation in history. It has been identified that even before the integration there was a lot of pressure on mining IT chain regarding external effects, globalization, and increasing complexity in the mining technology networks. Most companies faced tremendous challenges at every stage in the IT-OT tool set convergence process (Razaque (2021). For the purpose of making a resilient IT-OT integration, certain elements need to be taken into account related to coordination and financial support, contingency plans, and the use of information technology. It is observed that for organization, managing IT chain process understanding is becoming the most important for overcoming the mountain task of IT-OT integration (Mckinnon (2022).

Furthermore, resiliency in the mining chain helps organizations in recovering from negative influences through unknown disruptions and adapting to uncertain events. By being ready and able to do crucial tasks in the event of a disruption, critical functions can be used to gauge mining IT-OT integration chain resilience. Managing the IT-OT integration, mitigating risk, leanness, and other practices are considered important aspects for the purpose of achieving success in the organization (Paredes, Ignacio. (2020). The main aim of information technology managers in mining is to establish integrated, effective, and efficient technology integration chains for maintaining a competitive edge in the market. On the other side, modern commercial mining chains enable the process of production and cater to the cost-effective delivery of commodities in the proper quantities, at the proper time, and at the proper location. In the present global economy, competition among businesses forced them to carry out operations in an uncertain and high-risk environment (Sharon et al (2022).

Mining technology convergence chain resiliency is essential because of some aspects related to global crises, cyberattacks, credit crunch, and natural disasters. If these risks cannot be managed properly then they might create a significant loss in profitability, productivity, revenue, and competitive advantage (Alqudhaibi (2022). The mining technology convergence chain process is affected by the varied natural and man made challenges which are unprecedented and also considered an extraordinary situation which clearly indicates the need for development in mining technology integration chain resilience. The complex situation of integration has affected the mining sites as well as the global economy on a larger scale. It has been evaluated that the availability of IT tools in the mining chain has increased and also caters to balancing the demands Aldmour, Rakan. (2021). The present research provides an understanding related to the mining service management tool chain resilience importance during and post mining IT chain process along with the impact of applied mining strategies on achieving resiliency in the energy and utilities sector. Resilient IT-OT integration is critical for improving operational efficiency, enhancing safety measures, and enabling better decision-making capabilities within the mining sector. While integration can pose challenges, with the right cybersecurity measures, communication protocols, and data analytics tools, organizations can achieve IT visibility and reap the benefits of a connected IT-OT system.

This chapter provides context for the research, explaining why this issue is significant and highlighting the motivations behind the study. The objectives and questions of this study are also specified.

1.2 Research Problem

Companies nowadays must collaborate around problem of IT/OT (Information Technology/Operational Technology) convergence primarily revolving around the integration and management of IT and OT systems to enhance operational efficiency, security, and decision-making capabilities. Organizations are becoming more cognizant of their operational and economic vulnerability as a result of the complexity of meeting customer requirements. Every organizational activity carries the risk of unexpected disturbances that can lead to revenue losses and, in the worst case, firm closures. By developing strategies that allow the mining chain to quickly recover to its original functional state following a disruption, building resilience in the IT chain can help reduce and overcome vulnerability to risks.

The importance of mining chain resilience needs to be assessed in the Technology sector. Prior studies focused primarily on siloed IT tool chain resilience and lacked data regarding the converged IT Service Management environment. Studies chosen to complete the literature on the impact of IT Service Management strategies on the mining industry cannot provide accurate knowledge. Studies place more emphasis on other industries, including Consumer and Industrial sector, when it comes to building winery and beer IT Service management resilience as opposed to the mining industry.

1.3 Purpose of the research

There is a need to determine the significance of mining service management tool chain resilience during and post IT chain process within the mining sector. The previous research emphasized more on mining chain resilience at the time of the tail dam gating and lacked information related to the end-to-end chain integration within the overall mining process. So, instead of providing information about mining tool chain resiliency more emphasis was provided on the operational technology tool chain process. Proper knowledge cannot be gathered from studies identified for completing the literature regarding resilient mining tool IT-OT convergence chain strategies' influence on the mining sector. Studies put more focus on other sectors such as IT chain with respect to developing resiliency in the mining process instead of the energy and utilities sector. Thus, there is a need to evaluate end to end IT-OT convergence tool chain and there by introducing various end to end tools to bring mining process chain resiliency relevance and the impact of applied operational technology tool chain strategies on achieving resilience in the context of the mining segment.

Based on these factors, the research examines the moderating function of IT Service Management smart causal chain benchmarking in Consumer enterprises and evaluates the impact of IT Service Management chain resilience on operational performance.

The hypothesised connections among the variables, the hypotheses made to evaluate these links, and the interrelationships among the variables Methodology details are provided in the study's third chapter. The study strategy, sample size, and data analysis choices are all examples of these. Data analysis, findings from testing the framework and hypotheses, and discussions of these findings are the focus of Chapter 4. The research questions are also addressed. The concluding chapter, "Chapter Five: Conclusions and Implications for Future Research on Mining Chain Resilience and Operational Performance: The Moderating Role of Mining Chain Benchmarking," summarises the whole work, draws conclusions from the research results, and offers implications of the study and pertinent suggestions for future research in this area.

Next, we define the boundaries of this master's thesis. We educate readers on the worldwide IT-OT convergence disruption brought on by siloed tools and platforms and its effects on the Technology industry. We discuss the scope and constraints of this research and identify the issue based on these obstacles.

In IT Service management platforms have a significant impact on organizations by enhancing the efficiency, reliability, and quality of IT services, implementing service management platforms can lead to substantial cost savings. For instance, a 40% reduction in the cost of delivering Service Management Office (SMO) services over three years was achieved through role and responsibility optimization and standardization of services to a managed services model. Service management platforms help in reducing the number of incidents and improving incident resolution times. For example, a 10% reduction in incident tickets and a 27% reduction in overdue Requests for Change (RFCs) were observed. Service management platforms facilitate seamless integration of IT services across multiple functional groups, acquired organizations, partners, and vendors. This integration leads to improved service delivery and performance evaluation. The setup of a centralized service management toolset to integrate and manage a global model with multiple suppliers resulted in a 23% month-on-month reduction in aging calls. In summary, service management platforms significantly enhance the efficiency, reliability, and quality of IT services by reducing costs, improving incident and problem management, facilitating service integration, standardizing processes, enhancing monitoring and reporting, engaging stakeholders, and managing risks. These benefits collectively lead to improved customer satisfaction and optimized service delivery

Consequently, there are several arguments in favor of looking into the IT Service Management Smart Causal analysis data across sectors, especially in light of the tremendous technology disruption caused by the IT-OT Convergence.

1.4 Significance of the study

When it comes to connecting the dots Multi-sourcing engagements involve working with multiple suppliers for different services such as DevOps, Infrastructure, and Digital Workplace. While this approach provides several benefits, it also poses challenges such as driving accountability across all service providers, managing and comparing performance, maintaining a unified Configuration Management Database (CMDB), driving standardization of processes, tools, and technologies, aligning contracts and incentives to business objectives, cost escalation due to duplication of specialized skills and technology resources, lack of standardization leading to productivity loss and deteriorating quality. To overcome these challenges, an effective Service Excellence function needs to be in place that works in collaboration with Tower Heads to drive consistency and best practices between suppliers. This function should ensure effective alignment between suppliers and the Global Service Desk, drive standardized and unified processes with quality assurance across all suppliers, ensure adherence to common standards and processes, build a standardized performance dashboard aligned to business metrics, and drive common operational efficiency and automation initiatives. The key benefits of this model include consistent supplier performance management, improved service availability and incident resolution times, improved customer satisfaction, consolidated service reporting, a single point of ownership, visibility, and control of services, effective introduction of new and changed services, consistency of management, governance, and controls, optimized overall costs of providing services to the business, and improved understanding and overall reduction in service-related risks to the business. By leveraging a strong supplier ecosystem and effectively managing multiple suppliers, organizations can reap the benefits of multi-sourcing engagements while minimizing the associated risks and challenges across chains are important. Most academics are increasingly interested in studying sustainable for holistic approach to IT Service management, recommending that the Infrastructure Operations team should own the Cross-Functional Services, including the Service Desk, which manages incident and service request management. The Service Integration and Management to manage the multiple vendor ecosystem should be retained by the Client. (A. Shaji George, 2024) suggest that retaining the Service Management services with the Infrastructure Operations team would help in having 'One Client' Service Desk for all service teams, including Infrastructure, Applications, DevSecOps, and Enterprise Security. For Cross-Functional Services, analysts recommend a Business Application or Client Product Line "Outcome" based 'Squads & Tribes' delivery model as a future transformation strategy. To implement the Service Management Governance approach across multi-tower and multi-supplier environments, Plavšić, J. et al (2022) proposes working with the client to establish governance, processes, and tools aligned with client requirements. The phased approach involves understanding and analyzing the client's current service management processes, aligning and integrating IT Service Management processes with the client's processes, enhancing the maturity of ITSM modules in the ServiceNow instance, coordinating operational Service Management processes across service areas and parties involved, and facilitating effective on-boarding of IT service delivery team with both qualitative and quantitative reasons. The research highlights the importance of IT-Ot platform consolidation resilience and its bearing on the operational success of businesses. This will aid both practitioners and academics in figuring out how to minimise the worldwide impact of converged disruptions. Absorbent capacity is shown to have an interactive influence on the aforementioned relationship. This will reveal potential new capabilities that businesses may develop to strengthen their resistance to disruptions and provide them with an advantage in the market. New IT Service Management resilience techniques that have been implemented or uncovered are also analysed. Growing businesses may gain an edge over rivals if their hybrid chains are managed efficiently and resiliently in the face of upheaval. As a result of this research, policymakers and IT Service management managers will be better equipped to implement and adopt converged chain resilience practises that will enhance business performance while ensuring economic and social sustainability, ultimately contributing to development. Finally, the study contributes to existing information and serves as a reference for researchers engaged in related endeavours.

The research aimed to understand the impact of IT Service Management Incident tickets, service request tickets and change tickets across Infrastructure and Data Centre domain, with an emphasis on the moderating role of IT-OT Service management chain benchmarking in this connection. IT-OT Service management chain resilience was operationalized in this research with the use of a variety of variables, including teamwork, sturdiness, knowledge, public-private partnerships, technological prowess, adaptability, and risk management. Resources, output, responsiveness to customers, and cost performance (including inventory cost, operating cost, and lead time) were used to define Operational Performance. In addition, "delivery performance, flexibility, cost, and quality)" were used as indicators of IT-OT Service management benchmarking.

- Nonetheless, this research focuses on the Consumer and Industrial sector.
- The overarching goal of this research is to analyse the moderating effect of IT-OT Service management chain benchmarking on resilience and operational performance at Consumer and Industrial enterprises. The following are the precise aims of the research:
- The goal of this study is to analyse the impact of IT-OT Service management chain resilience on the productivity of enterprises.

Objective: Determine the impact of IT-OT Service Management benchmarking on business results. To assess the moderating effect of IT chain benchmarking on the relationship between mining, commercial and industrial sector resilience and operational performance.

What Are We Looking For?

- The following questions were addressed in order to achieve the study's goals:
- How does the robustness of businesses' IT-OT Service Management chains affect their productivity?
- How does benchmarking the mining, commercial and industrial sector affect the efficiency of operations?

- When considering the connection between IT-OT Service Management chains resilience and operational effectiveness, what role does IT-OT Service Management chains benchmarking play?

1.5 Research purpose and Questions

This study will analyse and evaluate the Smart Causal Analysis related to the IT Service Management across Infrastructure, Data Centre and other technology stacks disruption with Incidents, Service requests across sector. In this research, we examine three elements of convergence in the Consumer and Mining sector via the lens of a qualitative multiple case study based on interviews with specialists in the IT Service Management chain from the Consumer and Mining industry. The objectives of the study are as follows:

- R01 To examine the impact and aggregation on Smart Causal Analysis across IT Service Management in the Consumer and Mining sector
- R02 To analyze the impact of strategies related to mining tool chain applied for achieving resilience in the end-to-end process and tool chain within the mining sector
- R03 To analyse the impact of strategic importance of an IT Service Management (ITSM) toolset chain and its ability to enhance the efficiency, reliability, and effectiveness of IT services within an organization
- R04 To scrutinize the impact of strategies analyzing patterns in the data, the solution identifies common sources of performance issues, referred to as "hotspots" linked with the IT Service Management ticket volumes across the Consumer and Mining sector

Many studies have been conducted on the topics of IT Service Management resilience, IT Service Management chain agility, and IT Service Management chain integration. point out that there is a dearth of research on the effects of digital technologies on IT chain resilience and its capacities and consequences.

This study aims to fill this knowledge gap by exploring the potential and repercussions of Smart Causal Analysis quantitative effects of studying IT Service Management Tickets and data chain resilience, agility, and integration as capabilities and operational performance as a result of impact of chain resilience are all investigated in the same context. The results should shed light on how digital technology might act as a moderator in the context of IT Service Management resilience, as well as its relevance, capabilities, and repercussions. Therefore, the following research issues will be addressed in this study:

- RQ1 What is the significance of ITOT convergence Smart Causal Analysis in the consumer and mining sector?
- RQ2 What is the importance of IT Service Management chain resiliency and IT transformation process impacts in the consumer and mining sector?
- RQ3 What way Digital transformation has been implemented in the consumer and mining firms?
- RQ4 What is the impact of consumer and mining end to end process chain strategies applied for achieving resilience within the technology sector?
- RQ5 What are the challenges associated with IT-OT integration in the convergence sector?
- RQ6 How can resilient IT-OT integration be achieved to enhance IT visibility within the Consumer and mining sector?
- RQ7 What are the benefits of resilient IT-OT integration through Smart Causal analysis for the It Service management leaders within the consumer and mining sector?

CHAPTER II: REVIEW OF LITERATURE

2.1 IT Service Management and Resilience Studies

The chosen methodology, data collection, and results processing techniques align with the research objectives of investigating the challenges associated with IT-OT integration in the mining sector, identifying best practices for achieving resilient integration, and highlighting the benefits of resilient IT-OT integration, including enhanced IT visibility, improved operational efficiency, better-informed decision-making, and enhanced safety measures.

The study conducted by Plavšić, J. et al (2022) emphasizes providing insight into mining chain analytics and performance mediated by digital twins integration strategies. For successful integration in the field and to meet user expectations, the roles, capabilities, and potential applications of this evolving technology need to be demystified. It has been evaluated that digital twin is regarded with a new term known as black swan which has a greater influence on mining firms' technology chain process. The main motive behind conducting the study is to do an investigation related to data analytics linked with the mining technology chain which enables effective involvement of adaptability, alignment strategies, and agility which resulted in improving performance influenced by mining IT chain process disruption. It has been analyzed from the study that data analytics in the mining chain contribute significantly towards adaptability and agility. Moreover, the connection between analytics in the mining chain data and performance is affected by the applied 3A strategies of the IT chain.

Valacchi et al (2023) innovation increases in periods of high commodity prices while decreasing during commodity price recessions. Our results suggest that innovation increases mostly with long price cycle variations, while mostly unaffected by medium and short cycles. METS-related innovation seem the driving force of this mechanism. In contrast, countries specializing in mining industries are found to be slower in reacting to price changes. In constructing a model, the main aim maximizes its usefulness that closely connected with the relationship among three key characteristics of every systems model: complexity, credibility, and uncertainly (Klir, Yuan 1995). Modeling the uncertainty is very valuable so that it cause to reduce complexity and increase credibility of the resulting model. Mehrjerdi and Shafiee (2021) conducted a study based on multiple sourcing to achieve a resilient and sustainable IT chain. Fouladgar, Mohammad (2011), it has been identified that resilience and sustainability interaction is not addressed properly in the IT chain. Adapting resilience aspects into the mining IT chain process helps in the simultaneous optimization of resources and cost. In the present market scenario, mining tool chain and IT chain networks are also confronted with changes in climate, the development of social legislation, and disruption risks which helps in finding ways for dealing with uncertainties and changes in the business environment. Multiple sourcing as a strategy helps in developing resiliency in the IT technology process chain. It has been identified from the study that integrating technology resilience and IT chain processes can be improved through sustainability aspects.

The study conducted by Strazzabosco et al. (2022) within the remit of mining analyse historical changes in renewable energy technology has highlighted that 70% of the existi ng operational systems have only been installed since 2019. The characteristics of the mines high ly affect the decision to deploy renewable energy systems. 70% of the renewable energy systems analysed in this study were or are planned to be deployed on-site at off-grid mines powered by diesel and/or gas.

According to Alavanja, Bojan. (2016). Application of SCADA Data Monitoring Methodology and Reliability Analysis of Operational Data. Most of modern wind turbines are equipped with the Supervisory Control And Data Acquisition (SCADA) system which is recording 10minute average values of parameters that depict operatio n of the turbine. That being said, SCADA data contains a vast amount of information that can be used for analysis of mining components health. Therefore, this project will present an application of previously published methodology for SCADA data condition monitoring on real data. The g oal of this project is to investigate on the possibilities of the SCADA monitoring methodology an d what can be the added value of the application for wind farm operators, owners and other stake holders. In preparation of the mining tool chain in gaining opportunities for developing essential goods in the future. In IT chain technology has created robustness and further testing was done for achieving resiliency in the mining IT chain along with concerning products related to energy and utilities. It also leads to creating shortages of products and further aims the development of practices through which mining firms can deal with the issue of disruption in the IT chain process. Taking into consideration a backup capacity strategy helps in responding to the demand and needs of customers in the market during. This supports maintaining inventory in the organization and along with this also constitute developing aspects for future terms. The backup capacity of mining processes is also an important driver for developing resilience in the mining sector. It has been determined that having backup suppliers also support meeting the demand of customers in the market.

Batov and Saida (2023) states digital technologies are fundamentally changing transport networks and their importance for the economic development of the territory. With a variety of existing works on the problems of transformation and digitalization of economic sectors, the implementation of these processes at the level of subjects of the real sector of the economy and the transport industry remains insufficiently developed. It provide an understanding of the mediating role played by information sharing in the process of the mining IT chain. In contemporary business agile process chain aim at the development of practices and further support in fulfilling the demand and needs of customers in the market. With the help of an agile tools risk can be detected and it also helps in achieving market opportunities by assembling knowledge, and assets and building relationships with customers to develop aspects in the long run. This also facilitates building perspective and along with this caters to information sharing related to the mining IT chain. Sharing of information in the process chain affected the agile approach achievement. It has been evaluated that sharing updated and right information support organizations in achieving capabilities and gaining competitive advantage for achieving sustainability.

The study conducted by Anthony (2022) provides insight into IT chain risk can be seen as a subset of operational risk, and arguably it may be the most challenging type of risk to mitigate. To provide effective IT chain resiliency, risk managers must account for risks from a wide variety of internal and external sources that can include rare but drastic black swan events. However, there are a variety of Smart Technology tools to improve resiliency for organizations of all sizes, and the costs of these technologies continues to decline. Applied to IT chain, a heat map rates the risk for its suppliers and/or for critical purchased commodities and components. The ability to grade the individual raw materials and purchased components that go into products is essential to good IT chain resiliency. IT chain resiliency in the mining sector at the time of emerging situations. According to Carrasco et al (2022), this study emphasizes most companies manage Digital Transformation to restart the operation control systems, incorporating remote control principles of Mining 4.0. Providing insights into the influence on the IT chain. Maintenance is considered an important strategy that helps in carrying out the IT chain process in an effective way. It is necessary to focus on adopting resilience in the mining process chain through regular maintenance. It has been evaluated that maintenance also supports strengthening the level of inventory of raw materials and further added mining capacity for enhancing the capability of mining products. Maintenance is an important driver that helps in resilience development in the IT chain. Proper maintenance in the process of the IT chain also helps in developing a resilient IT chain. It has been determined that the maintenance of the IT chain plays a vital role in the mining sector in delivering better services to customers.

Lazarenko (2021) provided a descriptive overview of the global industry trends with regard to digital technologies in the mining sector, as well as develop a conceptual digital transformation framework that is intended to improve business' digitization processes for the mining companies by identifying the core managerial areas on which attention should be focused in order to ensure effective implementation of the digital transformation strategy. These main action fields, along with optional additional dimensions could be further elaborated depending on the organizational context and industry environment and should be taken into consideration when planning and organizing activities directed at delivering effective digital transformations. Further, global IT chains in the present scenario are complex, and creating global networks is considered vulnerable for dealing with these situations. Developing a resilient IT-OT chain enables coping with the reaction of cost-effectiveness and gaining the attention of managers within the organization.

2.2 Resilient IT/OT Convergence

Given those that are skeptical or even resist the notion of digitalization in mining often get it wrong. They assume that digitalization means doing things differently, creating upheaval and disruption. However, true digital transformation, while certainly disruptive, is mainly about doing things better — much better. Digitalization is the catalyst that helps mining operations become "smarter" by leveraging digital tools and processes that make operations instrumented, interconnected and intelligent. For example, correcting issues with mineral processing has always been more reactive than proactive. With dynamic information early on through interconnected digital systems and software, quick course corrections can be made before problems surface. Advanced digital process and control systems enable continuous monitoring and virtual simulations, among other cutting-edge capabilities. The move to the cloud has already transformed every major industry, and mining is no different. Leveraging the cloud allows for real-time enterprise-level views of operations in a mine using an integrated IT cloud-enabled platform. Workers can be better connected real-time via cloud-enabled devices, allowing for a level of collaboration that can boost safety and productivity in any mining operation. Plus, security and infrastructure services can be moved to the cloud, cutting costs while increasing capabilities.

However, resilience is defined differently. According to these authors, one study by Tariq et al. (2020) examined the implementation of a smart mining system that integrated IT and OT systems to improve operational efficiency and safety measures. The study identified challenges associated with communication protocols, cybersecurity, and organizational culture, but also highlighted the benefits of improved operational efficiency, enhanced safety measures, and better-informed decision-making.

Another case study by Calvo-Flores et al. (2021) examined the implementation of a digital twin system in a mining company. The digital twin system integrated IT and OT systems to create a virtual replica of the mining operation, enabling real-time monitoring and analysis of data. The study identified challenges associated with data quality, system integration, and data privacy, but also highlighted the benefits of improved operational efficiency and enhanced decision-making.

2.3 Mining and Consumer Chain Focus

Companies are increasingly adopting cooperative organizational structures in order to adequately account for the rising complexity and unpredictability in today's corporate environment and to enhance efficiency and effectiveness (Achrol and Louis, 1988; Stank, Davis, and Fugate, 2005). While digital transformation focuses on making mines smarter, new technologies and tools on the hardware, transportation, and equipment side bring unprecedented brains and brawn to all major operations. Best of all, these new technologies can connect seamlessly with digital transformation efforts, integrating data analytics, AI, and machine learning with a smart mine's unified systems.

Drone technology is already being used throughout the mining industry to help increase safety by going in areas that may be hazardous to humans, along with many other applications. For example, Freeport McMoRan is using drones to help create steeper slope angles to decrease stripping ratios and waste rock before extracting ore. Drone analysis of mine slopes avoids the dangerous prospect of sending a geologist or geotechnical engineer into highly dangerous situations. Other drone uses for mines have included inspecting various areas of the mind unsafe for human inspections, clearing blast areas, leveraging 3D imaging and scanning, and streaming live video and real-time data feeds.

Electric and autonomous vehicles and equipment will continue to impact the mining industry. According to a recent industry report, electrification and automation will be a $15 billion market by 2028. Fuels savings, increased efficiencies, and greater productivity continue to drive innovations forward in this area. Already mines are seeing a 30 percent increase in productivity from autonomous haulage systems alone. Electrification can help cut operational expenditure related to ventilation and cooling of machines by as much as 20 to 25 percent, respectively. Mining companies like Rio Tinto and BHP Billiton are currently using driverless haulers and automated drill extractors to move metals with proven results in efficiency and productivity. The resource dependence hypothesis (Fynes, Burca, & Marshall, 2004) states that in times of uncertainty, businesses might better use resources by skimming off what they need from their IT chain partners. Establishing governance measures and reducing uncertainty across a IT chain may include developing deeper, durable collaborations, such as with lead suppliers. This highlights the growing importance of a strategic IT chain focus (Ponomarov, 2012).

Trust, dedication, collaboration, organizational compatibility, and support from upper management are all components of the IT OT convergence-Orientation that contribute to its success (Ponomarov, 2012).

H1b: A focus on the IT OT convergence chain may improve agility.

H2b.Robustness improves with a platform and smart causal analysis data orientation

2.4 Strategic Planning for the IT Service Management Smart Causal Analysis

It is crucial for businesses to have the ability to foresee and respond to potential disruptions in the future due to increasing information systems availability through accuracy and manageability of ITSM, say Varga, Sergio et al (2019). The members of an IT Service Management chain must be able to proactively anticipate different scenarios and implement reliable solutions and strategies that prevent their IT chains from suffering the negative effects in the future in order to reduce risk and disruption vulnerability by a robust set-up. For this reason, resilient IT OT convergence need both foresight and preparedness, as well as initiatives that cultivate these traits (Pradhan, Dr & Bagbande, 2022). By building in safeguards and allowing for more manoeuvrability, businesses can lessen the severity and frequency of IT Service Management chain interruptions. The implementation of this AI-powered root cause analysis solution has delivered tangible benefits, such as a 50% reduction in incidents, enhanced user experiences, and improved platform stability. This ensures that technology supports business goals effectively by providing higher reliability in IT operations.

To lessen the possibility and effect of disruptions, Christopher and Peck (2004) believe that companies should choose IT Service Management methods that keep numerous choices open, even if this means spending more money in the near term than they would on more lean and efficient techniques.

H1c: Agility is enhanced by using IT Service management strategies.

H2c.: Robustness is enhanced by using IT Service management strategies

2.5 Resilience in IT Service Management Operations and Efficiency

According to this research's definition of the management of IT services requires, besides the standard maintenance of technology and applications, a definition and description of the services the organisation offers to its consumers of the services, and discovery of their hidden value and reasons why they use the provided services (Dr & Bagbande, Arun 2022). Subsequently, these services review finds that ITSM practices are not uniformly adopted, and some processes tend to be adopted more widely than others. The review also finds many measurement models that are either not validated, or only partially validated, and sees a gap between academic research and practitioner community, who are the primary intended users of these models and frameworks. There are proposed solutions for ITSM integration with other management systems that can benefit from further research for validation. We recommend future researchers to collaborate with practitioners, so that proposed models and frameworks can be incorporated into the relevant standards, where feasible (Vadlamudy, Raveendra. 2018).

IT Service Management chain with IT-OT integration as a proactive resilience capability and IT chain agility as a reactive resilience capability were shown to have a direct impact on operational performance, for example by ensuring on-time delivery or short lead-times in general (Prajogo & Olhager, 2012; Eckstein, Goellner, Blome, & Henke, 2015; Shin H., Lee, Kim, & Rhim, 2015; Blome, Schoenherr, & Rexhausen, 2013).

In addition, managing IT services (both internally and externally provided) has become an emerging area for academic research, given the criticality of IT services in modern organizations. One of the better-known IT service management frameworks is the Information Technology Infrastructure Library (ITIL) framework. While there are many claims made about the relationship between ITIL and IT outsourcing, these claims still need further empirical research. Using data gathered from a preliminary focus group, this study investigates how ITIL impacts recommended practices on the success of IT outsourcing arrangement. (Francis & Cater-Steel et al 2010) provide an international analysis of IT service management benefits and performance measurement by comparing the findings from a recent Australian survey with results from a similar survey conducted in the United Kingdom and United States of America. International literature on Information Systems (IS) effectiveness and performance measurement specifically related to ITSM is reviewed and used to guide the development of the Australian survey. Both surveys report rapid uptake of ITIL(R) Version 3. There are many reported benefits supported by metrics at the process level. However, the comparative analysis of the Australian and UK/USA studies reveals that there is limited awareness of performance measurement frameworks. In this way, IT Service Management resilience, which is defined by the ability and the know-how to realign the platform chain (Um & Han, 2021), leads to better operational performance due to the capacity to respond to shifts in market demand. Based on these results, we may propose the following theory:

The operational performance is favourably impacted by an end to end IT Chain understanding (H3).

The Mediating Role of Digital Technologies in IT OT chain Integration and Resilience

2.6 Efficiency in IT Service Management Operations

Operational performance is defined as the extent to which a corporation responds more quickly than its rivals to changes in the business environment. As a result, it is widely accepted by IT service managers that ITSM frameworks such as ITIL and the ITSM standard ISO/IEC 20000 can deliver real operational efficiencies, ultimately translating into revenue-increasing and cost-reducing benefits. However, despite the tremendous potential to realise benefits, the implementation of ITSM frameworks such as ITIL is slowed not only by the size of the investment required but also by the difficulty in quantifying benefits and linking operational and financial benefits together. A study of six German firms revealed that none of these large organisations produced a business case for ITIL investment, due to the difficulty in determining benefits (Hochstein, Tamm and Brenner 2005b). A similar situation has been reported in relation to Australian (Cater-Steel, Toleman and Tan 2006b) and US organisations (Pollard and Cater-Steel

2009).From an investment point of view, ITSM represents a serious financial commitment with some organisations spending more than half a million dollars on implementing new IT service delivery frameworks (Deare 2006), but there have been few empirical studies to date showing the benefits of implementation underpinned by the performance measurement of ITSM. It is important to measure and report the actual benefits and performance of ITSM to encourage organisations to consider implementing ITSM because ITSM frameworks such as ITIL "can help drive productivity gains, cost savings and stakeholder wins more broadly than many people realise" (Fisher 2006).

In addition, expanding into new areas and launching innovative goods or services may boost a business' bottom line. The impact on operational performance may be determined by analyzing these factors separately. According to the research of Chahal, Gupta, Bhan, and Cheng (2020), operational performance is often used as a synonym for competitive advantage when a business excels in one of the operational performance components thanks to a strategic resource.

2.7 Creation of Hypotheses

Previous studies have looked at the relationship between operational performance, digital technology, and IT OT Service Management chain resilience. Hypotheses are developed in the following paragraphs based on the possible connections between the components.

2.8 Informational Tools

Digital technologies have been popularized by the widespread usage of many internet-connected devices at the same time (Ghobakhloo, 2019). Connectivity, integration, and automation inside of business operations are made possible by digital technologies (Ivanov, Dolgui, & Sokolov, 2019; Li, Dai, & Cui, 2020). Examples of digital technologies include Cyber-Physical-Systems (CPS), the Internet of Things (IoT), Big Data Analytics (BDA), and Cloud Computing. Using digital technology, businesses may systematically evaluate data collected throughout the course of the whole product lifecycle, from initial concept to final sale (Tao, Qi, Liu, & Kusiak, 2018).

This data includes process parameters and product qualities. Because of this, new business models have emerged with the development of these digital technologies, which threaten the status quo of traditional factories while also opening up exciting prospects for value addition in the sector

(Ardolino, Saccani, Adrodegari, & Perona, 2020). These digital technologies are sometimes referred to as "enabling technologies" (Li, Dai, & Cui, 2020) for I4.0. The term "Industry 4.0" (or "I4.0") is used to describe "smart factories," in which digital technologies are integrated in a complementary fashion into the production system's underlying architecture (Zheng, Ardolino, Bacchetti, & Perona, 2020), with the goal of achieving interoperability that enables systems to interact fluidly regardless of the hardware or software in use (olakovi & Hadiali, 2018). Technically speaking, digital technologies enable the vertical and horizontal integration of production networks. based on constant two-way communication of data and adaptable manufacturing procedures, allowing for individualized product creation (Jabbour, Foropon, & Filho, 2018).

The improved information processing capabilities of digital technology provide up Intelligent Document Processing (IDP) platform leverages advanced digital technologies to enhance information processing capabilities. Here are the key features:
AI Integration: The platform incorporates AI technologies such as Computer Vision, Optical Character Recognition (OCR), Deep Learning, Natural Language Processing (NLP), and Machine Learning (ML) to process documents efficiently.
IDP automatically digitizes various types of documents, including emails, text files, PDFs, and scanned documents, making it easier to manage and access information .
It classifies documents based on different types, ensuring that information is organized systematically, the platform extracts key data points and information from documents, reducing the need for manual data entry and minimizing errors .Cognitive search capabilities, allowing users to search and retrieve information from documents more effectively .The system continuously learns and improves through self-supervised learning, enhancing its accuracy and efficiency over time. Unlike traditional OCR solutions, IDP is highly customizable and scalable. It can be deployed both on-premises and in the cloud, making it adaptable to various business needs. The platform offers smooth and easy integration with both upstream and downstream systems, eliminating the need for extensive IT intervention when there are changes in input sources or output destinations. These capabilities make IDP a robust solution for processing large volumes of

documents, providing accurate data extraction, and supporting informed decision-making. Decision support is provided for demand forecasting, pricing, and product development to better meet customer demand thanks to the transparency afforded by digital technologies in the IT chain (Joshi & Gupta, 2019; Kagermann, Helbig, Hellinger, & Wahlster, 2013). That not only shortens the time it takes to get items from one place to another in the IT chain Aligning company-wide procedures (Arrais-Castro, et al., 2018) not only strengthens supplier integration (Frank, 2018), but also improves supplier-company collaboration.

Despite the many good effects discovered for digital technologies, its full potential has not yet been realized. Only a minority of the current IT systems are highly networked. Most of the problems stem from the application's complexity in a production environment (Nudurupati, Tebboune, & Hardman, 2016; Warner & Wäger, 2019). For example, this is because of the focal company's and the suppliers' inability to resolve technical differences over IoT standards and interfaces (Fatorachian & Kazemi, 2018). Since IoT gathers information from a wide range of production system touchpoints, it must be organized into a decision-making support system that then processes, analyses, and makes available the relevant information to IT chain participants. As a means of addressing this difficulty, agreements

There has to be consensus between IT chain partners on how to handle such IoT data (Brousell, Moad, & Tate, 2014).

2.9 Capabilities of Information Systems

In order to be highly agile and resilient, a business requires both insight to better identify future changes and speed to be able to react swiftly to such changes (Christopher and Peck, 2004). Therefore, gaining this transparency is crucial to giving businesses the ability to spot and appropriately react to shifts in the market. According to Barratt and Oke (2007), investments in information management skills may improve transparency. Managers' ability to spot and react quickly to change or disruption may be improved by the dissemination of relevant data (Holweg and Pil, 2008; Wieland and Wallenburg, 2013).

Exchanging Data may be defined as "the degree to which vital and confidential data are shared with IT chain partners. Communication between businesses is essential for the effective management of networked risks, especially in the context of increasingly complex and worldwide IT chains (Wieland and Wallenburg, 2013). Internal and external risks may be mitigated by open communication between enterprises in a IT chain (Hallikas et al., 2004). A more robust IT chain is the result of open communication between enterprises on demand, IT, inventory, and production schedules (Christopher and Peck, 2004). Durach, Wieland, and Machuca (2015) state that a high level of communication and cooperation among all participants in the IT chain is crucial to achieving resilience. According to Lavastre et al. (2012), IT chains are becoming more resilient and able to avoid risk as a consequence of initiatives to increase transparency in the IT chain via the sharing of risk-related information.

H1a : Agility is enhanced by the capabilities of information systems

H1b : Robustness is enhanced by the capacities of information systems

2.10 Theoretical Framework

While resources define a company's competitive advantage (Wernerfelt, 1984), capabilities go further by combining and using these resources to realize benefits which is where the dynamic capability theory originates from (Blome, 2013). According to the authors of the dynamic capabilities hypothesis (Teece, Pisano, and Shuen, 1997), a company's ability to adapt to new circumstances and opportunities is a reflection of its dynamic capabilities. Thus, dynamic capacities suggest the firm's ability for innovation, openness to change, and the realization of improvements that benefit the firm's consumers at the expense of its rivals (Teece, Peteraf, & Leih, 2016). In order to become or keep being competitive, businesses must use a process of deploying dynamic capabilities known as detecting, seizing, and transforming the dangers and opportunities of the evolving business environment (Teece D., 2007). As a result, consistent and long-term deployment of flexible capabilities that support the business's overall strategy is crucial. Companies with particularly high dynamic capacities are better able to foresee emerging innovations (Teece, Peteraf, & Leih, 2016). Wilden & Gudergan (2015) caution against over-sensing in a stable economic environment, since doing so may result in excessively high expenses that are not warranted by the comparatively modest returns arising from the incorporation of dynamic capabilities.

This research applies the notion of dynamic capabilities to the field of IT chain management by using statistical methods to examine the bond between IT chain agility and integration, the latter of which stands for the dynamic capabilities of IT chain resilience. As a result, IT chain resilience is a flexible capacity that improves productivity. Companies with strong dynamic capabilities combine, on the one hand, a capable leadership team with, on the other, a solid and dependable business framework (Teece, Peteraf, & Leih, 2016).

A source of chains, resilience is a capacity that can adapt to novel circumstances and new information in real time (Yu, Jacobs, Chavez, & Yang, 2019). Therefore, agility as a dynamic capability within the IT chain was discovered to be directly beneficial for the operational performance (Teece D., 2014), particularly for global operations, in terms of flexibly delivering the correct product at the predefined quality, quantity, and time (Blome, Schoenherr, & Rexhausen, 2013). Consequently, the ability to respond rapidly to and adapt to changes in the business environment is a significant competitive advantage (Blome, Schoenherr, & Rexhausen, 2013). The use of cutting-edge information and communication technology is boosted by the dynamic capacity of agility, which speeds up processes like implementation (Warner & Wäger, 2019). In turn, digital technologies are seen as a key enabler of seamless IT chains. IT chain integration, which includes using the same information technology systems and exchanging knowledge, is a dynamic capacity that boosts performance (Beske, Land, & Seuring, 2014).

2.11 Theory of Reasoned Action

IT OT chain management (IO-OT) is a word that was first used in print in the 1990s (Stephen J, 2008). IT/OT convergence is the integration of information technology systems with operational technology systems. IT systems are used for data-centric computing; OT systems monitor events, processes and devices, and adjust in enterprise and industrial operations. Modern organizations grapple with two worlds. There is the traditional physical world composed of machines, electromechanical devices, manufacturing systems and other industrial equipment. Then there is the more recent digital world using servers, storage, networking and other devices used to run applications, process data and even make critical decisions without human intervention. These two worlds have largely occupied separate domains, shared little -- if any -- meaningful data or control and relied on oversight from business staff with distinctly different skill sets. Today, the worlds of IT and OT are converging. Advances in technologies such as the internet of things (IoT) and big data analytics are systematically enabling the digital information world to see, understand and influence the physical operational world. When implemented properly, IT/OT convergence can merge business processes, insights and controls into a single uniform environment.

Strategic choices at a high hierarchical level are required for OT focuses on the management and control of physical devices existing and operating in the physical world. The control of real-world devices is as old as industry and manufacturing itself. The introduction of electronics and digital technologies over time also found plentiful uses in operational control systems, such as computerized numerical control (CNC) machining systems.

Where IT focused on data and communication, OT focused on behaviors and outcomes. Most control systems employed across industrial and manufacturing installations weren't networked, resulting in silos of specialized devices -- each electronic at some level, but not readily able to communicate or share information. This means human operators were tasked with programming or managing the physical operations of each piece of equipment. Even equipment that provided centralized control used closed or proprietary protocols.

Consider a traditional automobile. Although a modern vehicle contains a wide array of electronic devices, it remains an unintegrated and singular system. The vehicle might record data but doesn't share data and doesn't enable any overarching management or control. It functions in all real-world conditions but relies solely on the capabilities and experience of a human operator for successful operation.

Among the most influential works on P&D networks are those written by Bowersox (1969) on cooperation and coordination, Hanssmann (1959) on inventory management, and Forrester (1958) on the role of dynamics in P&D networks. However, since the notion of IT-OT was first introduced in the 1990s, academic and professional interest in the field of IT research has steadily grown (La Londe, 1997).

This is mostly due to the fact that global rivalry has become more intense and businesses have realized they can no longer remain competitive independently of their suppliers and that crosscompany collaboration offers a big competitive advantage. The technology that fostered the integration between IT and OT was the development and deployment of IoT devices. IoT devices include a wide assortment of sensors for gathering real-world conditions, such as temperature, pressure, dimensional measurements, chemical compositions and countless other physical parameters. IoT devices also include an array of actuators, such as motors and solenoids, that translate digital commands and instructions into physical actions, such as controlling valves and moving mechanisms. Each IoT device is designed to communicate over standard networks, enabling them to exchange OT data with IT resources -- servers and storage -- sometimes over considerable distances. Its application has been studied extensively over the last two decades, leading to the development of a wide range of methodologies and definitions (Gomm, 2008).

2.12 Human Society Theory

Studies by Hannes Waclawek, Georg Sch ̈afer (2023), Information transparency allows for data to be analyzed, which, in the field of data science, is performed through AI or statistical methods that require IT software. A holistic semantic data modelling approach is beneficial for applying these methods. However, proprietary data formats are prevalent in OT systems running hardware of different platforms and manufacturers. Also, running AI methods for data analysis using state-of-the-art AI frameworks like TensorFlow often requires computing power that is not available on OT workstations running time-critical control tasks. In order to allow decentralized decisions, tasks and information are delegated from the machine to a higher level, where decentralized decision makers (humans or programs) can use the information to solve problems or optimize processes. On the one hand, today's Supervisory Control and Data Acquisition (SCADA) and Manufacturing Execution Systems (MESs) already realize this functionality on a factory level. On the other hand, a holistic, multi-factory approach considering geographic distribution requires the use of common communication standards allowing information exchange of different systems.

According to Ponomarov (2012), successful businesses actively cultivate and establish such IT chain skills to boost performance and keep competitive advantages. Empirical studies, such as those conducted by Zhao et al. (2001), reveal the importance of customer focus and information focus to a company's bottom line. Interestingly, the study found that information-oriented abilities by themselves are not a differentiating element directly connected to the performance of the business. These are better put to use in the production of other, more difficult-to-replicate traits. A company's IT chain can respond effectively to IT-interruptions and other issues resulting from an unpredictable external business environment only if the optimal mix of these talents is in place (Ponomarov, 2012). Similarly, Digital twins received particular attention in the context of the digitization of all areas of life and the increased use of cyber-physical systems (CPS)and cyber-physical production system (CPPS). All entities in a digitized world can collect, generate, or process data and information in the context of specific operational and use processes. This creates a digital shadow of these entities, that is, a sufficient image to describe the state of the entity abstractly and, over time, a necessary evaluation database to describe its behavior (Schuhet et al. 2016). Therefore, the purpose of this article is to explore how the presence, manifestation, and combination of certain IT chain skills affect IT chain resilience and, by extension, the performance of organizations. In what follows, we'll discuss several factors that have been brought up in the literature and are thought to improve IT systems chain performance and resilience.

H1: Agility is enhanced through IT Chain skills and competences.

H2: Capabilities and competences in the IT Chain, contribute favorably to Robustness.

2.13 Resilient IT OT Convergence

As stated by Shaji George (2024), p. 9, "IT OT chain resilience" refers to "Both information technology (IT) and operational technology (OT) groups working with modern connected equipment gain advantages from keeping fog servers on premises near data endpoints. Because fog resources stay close to production lines, operators obtain real-time guidance for critical adjustments. A vehicle manufacturer employing computer vision for quality assurance might first process images of welds or surface finishes locally before applying machine learning classification in the cloud. Quality technicians view instantaneous results from the fog node as automobile chassis travel down the assembly line even with intermittent connectivity to remote data centres. Similarly, monitoring equipment sensors via fog allows immediate notifications when temperatures, vibrations or other telemetry exceed defined thresholds. An abnormal measurement detected by the fog application triggers warnings directly to technicians or even temporarily halts processes through automated commands. By not waiting on roundtrips to distant cloud servers for basic analysis, fog enables OT teams to prevent catastrophic failures or quality deviations through rapid response times. They safeguard uptime, output, and safety thanks to computing resources retainedonsite.

While both Christopher & Peck (2004) and Brandon-Jones, Squire, Autry, & Petersen (2014) use identical criteria, none takes into account the time element that would indicate a rapid recovery. Given the diversity of perspectives on the subject, it's clear that there has yet to be agreement on a single definition of resilience (Purvis, Spall, Naim, & Spiegler, 2016; Tukamuhabwa, Stevenson, Busby, & Zorzini, 2015).

Due to the increasing complexity of Standardized aggregation of equipment telemetry, process events, asset health markers, and operational metrics all occur inline as streams get collected. Contextualization via fog allows historical reconstruction of exactly what happened and when during assembly. IT data scientists later accessing batch uploads can run advanced techniques like digital twin simulations to model how tweaks to machinery settings, material treatments or employee procedures impact defect rates systemically. The fused data works backward from products shipped to continually improve processes enterprise-wide. Of course, the automated coordination behind the scenes requires carefully orchestrated fog resources and cloud uploads. IT operations (ITOps) teams must collaborate with OT counterparts to designate data needing real-time local calculations versus centralized views. Access controls and segmented networks would previously isolate the operational zone entirely. Now joint oversight opens data flows to benefit from aggregated plant insights. OT practitioners provide the manufacturing expertise to designate critical streams and thresholds while ITOps staff encode the algorithms and infrastructure for analysis.

Having a reliable IT OT chain has several benefits. Early detection of a disturbance is preferable since it provides more time for preparation and response. IT networks that are resilient are able to quickly recover from by mitigating their effects. In addition, having a resilient IT chain reduces the risk of disruptions occurring. As a result of these benefits, a resilient IT chain may provide a company an edge in the market.

Conversely, reactive capabilities are believed to be flexible ones like agility, rapidity, and reconstruction (Altay, Gunasekaran, Dubey, & Childe, 2018), however only IT chain agility is examined as such in this research. Thanks to Carvalho, Barroso, Machado, Azevedo,

& Cruz-Machado (2012) both use the term "reactive capabilities" to describe this kind of skill. IT OT chain reengineering, which allows for flexibility (Purvis, Spall, Naim, & Spiegler, 2016), is therefore a crucial competence for bolstering IT Service Management chain resilience (Christopher & Peck, 2004; Pavlov, Ivanov, Dolgui, & Sokolov, 2018; Tukamuhabwa B., Stevenson, Busby, & Zorzini, 2015).

However, the unique context in which an IT chain operates, and individual perspectives have a role in deciding which capabilities and, by extension, tactics to execute (Purvis, Spall, Naim, & Spiegler, 2016). When deciding on an IT chain resilience plan, it is also important to consider how much money it will cost to put into action (Tukamuhabwa B., Stevenson, Busby, & Zorzini, 2015).

2.14 Adaptive IT OT Service Management Convergence

Agility in the IT OT convergence refers to a company's capacity to swiftly adapt its Power automation system to operate power distribution systems can be distinguished by distribution SCADA with remote monitoring and control; and distribution automation system with basic functions such as service restoration to the distribution SCADA; and distribution management system which is operated by various applications in order to enhance distribution system operation performance based on the distribution automation system. In the technological change, a technical boundary of information technology (IT) and operation technology (OT) is being blurred by those new concepts such as interoperability. In addition, IT/OT convergence has been proposed by the improvement of ICT and power system technology. At the viewpoint, advanced distribution management system (ADMS) to have the new concepts and to increase distribution system operation efficiency through global information and functions from the other systems has been proposed. To implement the ADMS, IT and OT have to be employed together on the ADMS; and the concept-based IT/OT convergence concept has been presented. Therefore, this paper introduces ADMS and IT/OT convergence and proposes a design of IT/OT convergence based ADMS system design with configurations and functions (Lim, Il-Hyung & Lee, Seung-Joo & Park, Jong-Ho & Shin, Yong-Hak. (2016). Meeting client demand in the most cost-effective way feasible requires swift adjustments to delivery time, design, product enhancements, product launch, and IT capacity (Al-Shboul, 2017).

According to many sources (Busalachi, Dino. (2024). Bridging the gap between IT and OT.), understanding cyber security risks is important for everyone. You will gain perspective on the cyber security challenges facing organisations today that operate within manufacturing and critic al infrastructure industries, across their information technology (IT) and operational technology (OT) teams. You will also gain insight into potential solutions. IT teams have evolved distinctly, prioritising data security, access controls and system hardening in networked computing environ ments. OT teams manage and operate industrial control system (ICS) equipment with specific re quirements around reliability and uptime for the purpose of ensuring physical outcomes in manuf acturing or critical infrastructure production environments. IT and OT have traditionally operated separately within organisations because they serve different functions. The lack of interaction an d understanding between IT and OT has led to cyber security vulnerabilities and frustration betw een organisations. IT may want to patch OT systems but get pushback because downtime halts pr oduction. OT may distrust IT recommendations because they have historically caused operationa l disruptions. This tension has caused many organisations to avoid trying to connect these two w orlds; however, as digital transformation and Industry 4.0 initiatives bring IT and OT systems tog ether, new cyber risks emerge. Industrial Internet of Things (IIoT) devices, legacy equipment, un patched programmable logic controllers (PLCs) and obscured asset inventories create vulnerabili ties IT chain agility is crucial to a company's long-term success when it comes to operational performance in highly dynamic markets.

Additionally, information exchange is only possible via the use of technology. Due to the fact that every company operates in its own unique setting, a wide range of options for implementing such strategies and tools exists (Arrais-Castro, et al., 2018). Therefore, it is important to investigate the potential deployment scope to make sure any expenditures are made in the best possible application (Gunasekaran et al., 2019). Because there are so many options, businesses often struggle to choose one that will allow them to communicate effectively with their IT OT convergence partners (Aravind Raj, 2013).

2.15 Integration of the IT OT within Service Management

According to Pilipets, Oleg. (2024), Intelligent transport systems (ITS) are one of the main elements of transport infrastructure that are essential for improving safety, reducing traffic jams, reducing travel time, and improving the comfort and efficiency of the transport system. ITS development is proceeding at a high speed, primarily due to the emergence of new technologies such as the Internet of Things (IoT), cloud computing, artificial intelligence (AI) and machine learning (ML). One of the notable trends in the development of ITS is the increase in the level of automation of the traffic flow. Automation of the traffic management process improves road safety, reduces the cost of maintaining transport infrastructure and increases the efficiency of using road space. In addition, information technologies are increasingly being introduced in ITS, which improve the quality of user service, strengthen control overcompliance with traffic rules and reduce travel time. Considerable attention is also paid to the development of "smart" transport networks to optimize the flow of goods and passengers. Service disruptions can have a considerable impact on business operations of IT support organizations, thus calling for the implementation of efficient incident management and service restoration processes. The evaluation and improvement of incident management strategies currently in place, in order to minimize the business-impact of major service disruptions, is a very arduous task which goes beyond the optimization with respect to IT-level metrics deemed essential by experts (Bartolini, Claudio & Stefanelli, Cesare & Tortonesi, Mauro. (2009).

Strategic level involves creating long-term partnerships whereas operational level involves arranging upstream and downstream flows of information and materials (Flynn, Huo, & Zhao, 2010a). Strategic connection intensity significantly influences operational integration in terms of exchanging important information and expertise, as suggested by Prajogo & Olhager (2012) and Cagliano, Caniato, & Spina (2005). In reality, there are two facets to information exchange: the technical and the qualitative. When it comes to IT Service managment chain collaboration, the technical dimension guarantees the bare process-oriented capability of sharing data via IT-systems, while the quality dimension depends on the competencies of the IT platform chain partner in terms of how benefits are effectively generated from the shared information. Collaborative learning amongst IT Service management chain partners is an iterative process that is necessary for achieving success in the qualitative dimension in particular (Chavez, Yu, Gimenez, Fynes, & Wiengarten, 2015).

Internal integration within the company and external integration with suppliers have been shown to positively affect a company's performance in the IT chain literature (Danese & Bortolotti, 2014; Leuschner, Rogers, & Charvet, 2013; Wiengarten, Humphreys, Gimenz, & McIvoer 2016; Wong, Snacha, & Thomsen 2017). Some potential advantages of internal integration include the sharing of up-to-date production information across different departments and the maintenance of accurate stock levels at all times (Flynn, Huo, & Zhao, 2010a). Sharing production schedules, demand forecasting, and collaborative problem-solving have external advantages, though (Wiengarten, Pagell, Ahmed, & Gimenez, 2014). Strategically speaking, IT supplier external integration enables the focus business to collect intraorganizational competences that permit cooperative product creation and harness innovation prospects (Petersen, Handfiled, & Ragatz, 2003).

In light of this, Zhu, Krikke, and Caniels (2018) argue that businesses might gain a competitive advantage by cultivating distinctive skills via tight working relationships based on constant information exchange with IT platform partners.

The literature revealed the difficulties of IT supplier integration that businesses confront, despite the benefits (Fawcett, McCarter, Fawcett, Webb, & Magnan, 2015; Danese & Bortolotti, 2014). First, a lack of trust between partners is a common cause of failed collaborative relationships (Day, Fawcett, Fawcett, & Magnan, 2013). Relationships with vendors often exhibit a power dynamic, according to research by Fawcett, McCarter, Fawcett, Webb, and Magnan (2015).

In fact, there is potential for conflict if the relationship between major focus enterprises and smaller suppliers becomes more asymmetric (Rokkan & Haugland, 2002). As a result, information is hidden from the IT platform network on purpose, creating a dysfunctional connection (Fawcett, McCarter, Fawcett, Webb, & Magnan, 2015). Second, IT-linkages that ease the transfer of information among the IT platform chain partners are crucial to the success of IT Service management chain integration (Jitpaiboon, Dobrzykowski, Ragu-Nathan, & Vonderembse, 2013). While the majority of businesses have set up EDI and XML connectivity with their IT chain partners, just a minority of businesses provide online access to their ERP. Due to the lack of real-time data reflecting the possibly shifting requirements of the IT chain, information exchange is restricted (Bagchi, Ha, Skjoett-Larsen, & Soerensen, 2005).

2.16 Integration and resilience in the IT Service management Smart Causal Analysis

Businesses integrate their IT processes chains for a number of reasons, including technical, business economic viability and the need to reduce IT Service management risks in order to prevent disruptions (Jajja, Chatha, & Farooq, 2018). As Rao and Goldsby (2009) and Purvis, Spall, Naim, and Spiegler (2016) point out, the whole IT network must work together to address IT platform chain risks and provide comprehensive solutions. According to Pettit, Fiksel, and Croxton (2010), IT Smart Causal analysis resilience may be improved by the integration of business processes amongst various tier-levels of providers. Long-term collaboration involves creating shared objectives and exchanging data on demand projections and industry shifts (Wiengarten, Pagell, Ahmed, & Gimenez, 2014). IT service partners may work together toward a similar aim of proactively predicting and preventing risks by, for example, fostering tight working connections (Belhadi, et al., 2021). Rapid reaction to these ever-present IT platform chain disturbances is therefore made possible by the ongoing development of integrated risk management skills (Munoz & Dunbar, 2015; Burnhard & Bhamra, 2011). Based on these results, we may propose the following theory:

IT platform and smart causal data integration improves focus on Incident management and other ITIL chain resilience, therefore the first hypothesis.

2.17 Adaptability and Resilience in IT OT Service Management

To undertake alternative delivery plans, the adoption of IT/OT Service Management involves integrating Information Technology (IT) and Operational Technology (OT) systems to enhance cybersecurity and operational efficiency. Visibility Issues, there is less visibility on the cybersecurity posture of Gold and Base Metal Operations, and a lack of visibility for connectivity between IT and OT networks. Risk Identification, identifying high-level risks and challenges in the current technology infrastructure is crucial, essential to providing a robust IT chain, platform chain agility is needed, for example, to swiftly adapt the delivery schedule in case the demands have changed (Al-Shboul, 2017). Adaptive IT chain architecture is another manifestation of platform resilience (Um & Han, 2021). An agile IT Service Management chain has this capability because it can respond quickly to changes in demand by revising its IT chain architecture (Al-Shboul, 2017). Sharing information improves IT Services chain visibility (Christopher & Peck, 2004), which in turn improves the ability to adapt to IT chain disturbances. The ability to quickly identify and respond to disturbances is another benefit of agile platform chains (Juettner & Maklan, 2011). Therefore, the network can enable an agile reaction to anticipated disruptions, increasing platform chain resilience, because of greater end-to-end visibility across IT chain processes.

Purvis, Spall, Naim, and Spiegler (2016). According to several researchers (Tukamuhabwa B., Stevenson, Busby, & Zorzini, 2015), IT Service management chain agility may be one of numerous ways to make an IT processes chain more robust. Based on these results, we may propose the following theory:

Susceptibility to disruption is reduced when IT Service Management chains are more agile, supporting H2.

2.17.1 The Impact of Digital Technologies on IT Service Management Agility and Resilience

Data from various points along the IT chain can be accessed in real time by digital technologies in a networked IT chain (Soroor, Tarokh, & Shemshadi, 2009; Ivanov & Dolgui, 2020a), yielding valuable insights into shifting market demands (Jagtap & Duong, 2019). IoT sensors, tracking and tracing tools, and big data analytics are all examples of digital technologies that can be used to quickly identify the causes of disruptions in a platform chain and then implement temporary fixes (Ivanov & Dolgui, 2020a; Ivanov, Dolgui, & Sokolov, 2019). Therefore, the advantage of using digital technologies to gather and analyze real-time tool chain data may magnify the positive impact that an agile response, in terms of rapidly adapting the IT Service Management chain to a disruption, has on ensuring IT chain resilience (Ivanov, Dolgui, & Sokolov, 2019). Digital technologies, such as big data, are expected to advance this relationship by combining and analyzing all this information that originates from different points in the IT Services chain and revealing crucial business insights (Jagtap & Duong, 2019). This is because IT Service Management chain agility requires visibility throughout the IT chain and quick reactions to disruptions to ensure resilience (Christopher & Peck, 2004). Firms may adjust product design and delivery times more quickly to suit consumer demand if they have access to data that properly represents market activity (Tao, Qi, Liu, & Kusiak, 2018). This is particularly important in uncertain markets, where customers' needs might shift rapidly, necessitating the timely and precise modification of goods or platform chain activities to maintain the company's IT data chain's long-term resilience (Tukamuhabwa B., Stevenson, Busby, & Zorzini, 2015). Based on these results, we may propose the following theory:

H5: There is a correlation between IT chain agility and resilience, but digital technologies mitigate that correlation.

2.17.2 The Role of Digital Technologies as the IT Service Management Smart Causal Analysis within IT OT chain

It is suggested that resilient IT Service Management chains can both prevent disruptions from happening and quickly recover from them. Our client is an is a leading provider of financial information and analytics globally. They offer a wide range of services that help businesses, investors, and governments make informed decisions. We could enhance efficiency, reduce outages and the enhance ticket resolution by identifying hotspots and mitigating large ticket dumps.

By mitigating the effects of disruptions on the IT chain, a resilient IT chain contributes favorably to operational performance (Tukamuhabwa, Stevenson, & Busby, 2017). However, digital technologies like Cloud platforms are needed to easily transmit important data across the IT chain partners, allowing for more resilient adjustment to a disruption by exchanging information. When information is pooled, Big Data Analytics may be used to devise strategies for lowering lead times, which in turn boosts operational efficiency (Raji, Shevtshenko, Rossi, 2015).

IT chain resilience may be improved by using data analytics systems as digital learning systems that refine preventative and corrective procedures in response to disturbances (Ivanov, Dolgui, & Sokolov, 2019). This leads us to hypothesize that the use of digital technology will further strengthen the correlation between the reliability of its platform due to recurring service disruptions. These disruptions were mainly caused by “hotspots,” specific areas within their infrastructure that were particularly vulnerable to problems robustness and operational efficiency.
Hypothesis 6: The connection between IT chain resilience and operational effectiveness is tempered by the presence of digital technology.

2.17.3 Impact of Smart Casual Analysis within IT Service Management

The relationship between risk management skills and resilience is not as well established in the relevant scientific literature as it is for information management capabilities or IT chain strategies (Ponomarov, 2012), despite the fact that these are both critically significant. However, risk management skills play a significant role with respect to resilience, since the development of a risk management culture inside an organization may improve or even promote the resilience feature of the IT chain (Christopher and Peck, 2004).

The implementation of Smart Causal Analysis yielded remarkable results for our many IT Service management processes, minimized downtime through hot spot identification, by leveraging Smart Causal Analysis, we effectively minimized downtime through precise hotspot identification. This approach enabled the team to pinpoint critical areas within the infrastructure prone to issues, allowing for timely interventions before disruptions occurred. By focusing maintenance efforts on these high-risk zones, the client’s platform ensured continuous service availability, reduced user impact, and maintained seamless operations.

Early issue resolution through proactive ticket management, Smart Causal Analysis significantly reduced the number of support tickets by resolving issues early. This ensured efficient resource allocation, allowing efforts to focus on addressing root causes rather than repeatedly managing symptoms, thereby enhancing overall efficiency

Maximized the availability of systems by promptly addressing root causes identified, Implementing Smart Causal Analysis significantly improved system availability by enhancing platform reliability. Continuous real-time monitoring offered insights that enabled rapid responses to potential issues, ensuring systems remained operational and dependable. This enhancement not only increased user satisfaction but also strengthened customer confidence in our client's ability to provide uninterrupted services.

Improved code and module performance by prioritizing refactoring based on identified hotspots

Innovation boost, by proactively reducing outages and the number of tickets, Smart Causal Analysis enhanced our ability to innovate. This newfound capacity allowed teams to focus on developing new features and improvements, rather than constantly firefighting recurring issues.

Improved reliability: By identifying and addressing hotspots, we enhanced the reliability and performance of the client's service, network, and security systems. This improvement led to better user experiences and increased trust in IT Processes.

According to Christopher and Peck's (2004) findings, not all businesses understand the importance of resilience within the context of risk management, and more could benefit from applying a variety of risk management tools to improve resilience through more thorough identification and management of IT chain risk.

The ability to manage risks effectively improves agility, as stated in H1d.

H2d: Capabilities in Impact Management enhance Robustness.

2.18 Summary

Smart Causal Analysis, an advanced tool utilizing GenAI, to identify and address critical hotspots across the client's infrastructure, operating systems, and applications. This proactive approach aimed to enhance the overall stability and performance of the client's infrastructure.

Why Smart Causal Analysis, Multiple issue identification, Smart Causal Analysis can detect multiple issues within a single ticket, offering a comprehensive overview of the platform's problems. This holistic approach ensures that all related issues are addressed simultaneously, preventing recurrence and minimizing downtime.

Issue classification goes beyond identifying the primary call drivers by classifying issues at a deeper level. This classification aids in understanding root causes and contributing factors, resulting in more effective problem-solving strategies.

Module level feedback, Smart Causal Analysis provides module-level feedback to development, design, and documentation teams, enabling targeted improvements. This feedback loop quickly addresses issues at their source, reducing repair time.

Data-driven approach, the Smart Causal Analysis workflow, incorporating data preprocessing and embeddings, facilitates a data-driven approach to problem resolution. This enables proactive detection of potential issues and provides predictive insights by identifying recurring patterns and trends that have caused or could lead to future problems.

Blackhurst et al. (2011) further emphasizes the good impact agile components of resilient capabilities have on IT chain performance by drastically cutting recovery time following a disruption. Therefore, it is postulated that the resilient dimension's adaptable capabilities improve IT chain performance as a whole.

IT Chain Performance improves when IT Chain Agility increases, according to H3a.

According to Hohenstein et al. (2015), having a IT chain that can withstand and recover quickly from disturbances is essential to building resilience. Companies need to take a proactive approach to resilience, developing specific elements and capabilities to not only restore the IT chain to pre-disruption performance levels but even improve upon them (Hohenstein et al., 2015) in order to absorb and mitigate potential disturbances.

Organizations must understand how interruptions may be foreseen and how to best plan for and respond to disruptions, as stated by Yang et al. (2009). Companies can mitigate the negative effects of disruptions on their performance by incorporating robust strategies into their IT chain, such as slack capacities, redundancies, or safety stocks have stressed the need of foresight in spotting trends and hazards that may have a long-term impact on the core business's profitability. According to (Hallikas et al., 2004), the entire performance of a platform chain may be improved by proactive measures, particularly by predicting future risks. This is because of the belief that having access to predictive and forward-looking capabilities buys a company more time and flexibility to respond to unforeseen disruptions (Wieland & Wallenburg, 2013). Companies with strong IT chain capabilities recover more quickly and show weaker stock market responses to disruptions

(Hendricks, Singhal, & Zhang, 2009), whereas organizations that have been exposed to disruptions take a long time to recover from the negative consequences (Hendricks & Singhal, 2005).

Given the above, it stands to reason that robust capabilities improve IT chain performance by mitigating the ill consequences of interruptions.

H3a: IT Smart Causal Analysis Performance improves as the amount of end-to-end IT Chain Robustness increases.

Based on the reviewed literature, a conceptual model is created, which establishes a connection between the antecedents of resilience and the effects of agility and robustness on IT chain performance. The model is shown in Figure 1, and its chosen hypotheses are listed.

CHAPTER III: METHODOLOGY

Methodology

The research strategy is presented in this section. Philosophy, strategy, technique, design, and literature review are all laid out here. In addition, the sampling strategy, survey design, and data collecting procedures are described in detail. Factor analysis, common method bias assessment, validity and reliability analysis, and regression analysis are then expounded upon as methods for analyzing the data. In the end, the model fit indices that were used in this study are detailed.

3.1 Overview of the research Problem

To thrive in the modern global economy, businesses must work together with their suppliers and customers to enhance IT chain efficiency, transparency, and communication. Companies are becoming more aware of their financial and operational susceptibility due to the difficulties in satisfying client demands and managing global IT networks. Unexpected disruptions to organizational operations may result in lost income and, in the worst-case scenario, business shutdown. The implementation of Smart Causal Analysis marked a transformative step in enhancing operational efficiency, including platform reliability and efficiency for the client. By effectively identifying and addressing infrastructure hotspots, we were able to minimize downtime and reduce support tickets, significantly improving operational stability. Building resilience into the IT chain may help lessen and even eliminate exposure to risks by creating plans that enable the system to swiftly return to its pre-disturbance operating condition.

In the Mining industry, Further analysis of network data and security metrics has empowered the client to streamline operations. Notably in the realm of network security, the reduction in packet loss stands as a testament to the strengthened resilience against potential disruptions.

This proactive approach to monitoring and issue resolution maximized system availability and enhanced code performance, reinforcing client trust and satisfaction. This case study exemplifies how strategic collaboration, and innovative solutions can drive excellence.

Consequently, information on the resilience of the IT chain was not given as much weight as the platform chain process. Accurate information cannot be obtained from studies selected to conclude the literature on the effect of resilient IT chain methods on the manufacturing sector. Research emphasizes other industries—such as mining—rather than the consumer sector when it comes to constructing resilient IT chains.

3.2 Operationalization of theoretical constructs

This research also examines the function of IT chain benchmarking as a possible mediating factor in the relationship. These elements and others make it more important than ever for oil and gas producers to focus on initiatives that can protect their margins and prepare for growth opportunities. One effective strategy is to transform the data from refineries into insights and intelligence that drive better decision-making and business results.

For all kinds of industries – including the energy sector – data is the critical resource for the future. Oil and gas refineries generate enormous quantities of data from every component of the value chain. This data helps them measure, manage and make decisions about operations and production, but a more-centralized, holistic and contemporary approach can generate more insights and lead to better decisions. To achieve this, modern refineries should consider a digital performance measurement solution

A digital performance measurement solution also incorporates Industrial Internet of Things (IIoT) technologies to connect assets throughout the transportation, storage and distribution value chain. With the help of data production, refining and product distribution can be linked to assess the end-to-end performance of the business. This helps in evaluating and improving efficiencies and reduce downtime. Data gathering is important, but it's just the first step. Next, the refinery must be more able to put data to work. This means easy access by any business user, not just data or analytics professionals. It also means creating useful key performance measurements.

KPIs are used at multiple levels to evaluate their success at reaching targets. High-level KPIs like refining margins and energy consumption focus on the overall performance and profitability of the refinery. Low-level KPIs like product yields and maintenance costs focus on the business processes or specific teams. These help senior management monitor KPIs that drive behavior through the refinery, help managers and superintendents view and improve team performance, and help supervisors understand how daily actions can impact or improve refinery performance.

No single set of KPIs will fit all roles, nor will one set fit all refining companies, as they operate in different regions, cater to different markets and must comply with different legislation. Defining the KPIs that really matter to the refinery is one of the critical steps, and it's often best taken with a partner to help understand the refining company's business processes in detail.

Developing KPIs requires an understanding of how they will be used to generate success, how performance can be measured, and which data is most pertinent to decision-making. For example, if fuel distribution is taken care by the refining company, good KPIs could be fleet utilization or distribution losses. If the refinery's main product is feed for the petrochemical complex, the cracker unit availability would be an important parameter to measure.

Based on these variables, the study assesses how IT chain resilience affects operational performance and looks at the moderating role of IT chain benchmarking in manufacturing.

The interrelationships between the variables, the hypotheses developed to assess these ties, and the hypothesised connections among the variables Details on the methodology are given in the third chapter of the paper. Examples of these include the research design, sample size, and data analysis decisions. Chapter 4 focuses on data analysis, conclusions drawn from testing the framework and hypotheses, and discussions of these conclusions. There is also discussion of the research questions. The work is summarized in the final chapter, "Chapter Five: Conclusions and Implications for Future Research on Smart Causal Analysis Resilience and Operational Performance: The Moderating Role of IT OT Chain Benchmarking," which also makes relevant recommendations for further research in this field and draws conclusions from the research findings.

We then establish the parameters of this master's thesis. We inform readers about the global disruption of the IT chain and how it affects the mining and consumer sector. We talk about the limitations and scope of this study and use these details to pinpoint the problem.

The philosophical foundations of a researcher's work should be understood since they influence the study design, methodology, and, eventually, the results. In accordance with the stated research philosophy, researchers must further demonstrate that they have participated reflectively in the methodology of the study (Easterby-Smith, Thrope, Jackson, & Jaspersen, 2018, p. 107). There are two main components that define study philosophy as a whole: ontology and epistemology. Researchers' ontologies are reflections of their starting worldviews. Researchers have four possibilities for ontologies: nominalist, relativist, realist, and internal realist. According to Easterby-Smith, Thrope, Jackson, & Jaspersen (2018), p. 115, all facts are the result of human imagination (nominalism) combined with the conviction that there is only one reality and that it can be discovered by direct observation (realism). This research used a realist ontology because realism emphasizes quantitative observations of actual objects and facts, such as performance results (Easterby-Smith, Thrope, Jackson, & Jaspersen, 2018, p. 118). Consequently, the purpose of this research is to determine how IT chain resilience influences operational efficiency. By adopting this ontological perspective, the research is able to accurately depict the observable, objective reality without the need for prior assumptions.

Details about the epistemology are also provided by the chosen ontology. One of the main concerns of epistemology is how humans learn about the world (Gómez & Mouselli, 2018, p. 17). Both positivism and social constructivism represent diametrically opposed epistemic positions. The notion that there is an objective universe that can be investigated and comprehended is a cornerstone of positivism. Information is thus only considered when it can be shown to be backed by firsthand observation of the outside world (Hair, Page, & Brunsveld, 2019, p. 307). Positive research needs to develop ideas that allow for quantitative measurements in order to demonstrate the presence of causal relationships (Easterby-Smith, Thrope, Jackson).

The idea behind social constructionism, on the other hand, is that there isn't an objective reality. Reality is defined by people, not by objective facts (Easterby-Smith, Thrope, Jackson, & Jaspersen 2018, p. 122). Because it built its model of the outside world on presumptions intended to faithfully represent that reality in terms of objective facts, this research used a positivist perspective. Thus, the aim of this research was to determine the causal relationships between the variables in the conceptual model. We included and scrutinized concepts from previous studies that established the causal relationship between the variables to guarantee the precision of the developed model. In order to track the development of digital tools and IT chain competencies like agility and integration within the framework of IT resilience, this research set out to understand the viewpoints of specific respondents.

3.3 Research Purpose & Questions

The research design specifies the procedures to be followed in doing the research necessary to achieve the goals of the study (Easterby-Smith, Thrope, Jackson, & Jaspersen, 2018; Hair, Page, & Brunsveld, 2019; p. 160). Exploratory, descriptive, and causal research strategies are the three main options available. In order to determine whether or not one variable causes another, the researchers used a causal research strategy (Hair, Page, & Brunsveld, 2019, pp. 162 ff.). Thus, the question of causation is examined (Hair, Page, & Brunsveld, 2019, p. 169 ff.) to determine whether or not a change in one parameter predicts a change in another. The research technique (Hair, Page, & Brunsveld, 2019, p. 203 f.) and the epistemological perspective of the study (Easterby-Smith, Thrope, Jackson, & Jaspersen, 2018, p. 124), among other factors, influence the choice of research design. Quantitative research methods collect quantitative data through surveys sent to a large sample size and use either a descriptive or causal research design (Hair, Page, & Brunsveld, 2019, p. 203 ff). Qualitative research methods imply a research design that is exploratory. In this way, a positivist epistemology is associated with a causal research design, whereas social constructionism is associated with an exploratory research approach (Easterby-Smith, Thrope, Jackson, & Jaspersen, 2018, p. 124). Since the study follows a positivist epistemology and uses a quantitative research approach in the form of a survey sent to one enterprises, it is again recommended that respondents be carefully chosen at random.

This study will analyse and evaluate the IT Smart Causal Analysis within Mining and Consumer sector with input from the other sector..

3.4 Research Design

Quantitative and qualitative research methodologies are two options for conducting a study (Easterby-Smith, Thrope, Jackson, & Jaspersen, 2018, p. 125). Which research strategy is most appropriate depends on the epistemology and ontology that is selected. Realist ontology implies positivist epistemology, which suggests a quantitative research technique (Easterby-Smith, Thrope, Jackson, & Jaspersen, 2018, p. 111 ff.), while nominalist ontology is associated with a constructionist epistemology, which necessitates a qualitative research approach. Textual or visual data, collected informally via observation or interviews, is the basis of a qualitative research approach. On the other hand, quantitative research relies on the statistical analysis of data that can be quantified numerically or at least appraised objectively. Therefore, in order to put theories to the test, a quantitative research approach is used. Financial reports, surveys, and sales reports are all good places to look for quantitative data. There are a variety of positive outcomes that may be attained by the use of quantitative research techniques (Hair, Page, & Brunsveld, 2019, pp. 161 ff). The study's findings are believed to be generalizable (Hair, Page, & Brunsveld, 2019, p. 161) since quantitative data is collected from a large sample and is straightforward to organize. Because of this, quantitative research findings are generally considered when implementing new regulations (Easterby-Smith, Thrope, Jackson, & Jaspersen, 2018, p.129). Data obtained quantitatively, whether in the form of figures or ratings, is often seen as being more objective than data acquired qualitatively since it requires no interpretation on the part of the researcher. Therefore, impartiality is preferred when conducting hypothesis tests (Hair, Page, & Brunsveld, 2019, p. 161 ff).

The purpose of this study is to examine the impact of digital technologies on IT Service Management chain integration and agility, as well as the impact of IT platform chain resilience on operational performance. As a result, hypotheses are tested statistically based on the correlations between variables that are represented graphically in a model (Hair, Page, & Brunsveld, 2019, p. 174). The hypothesized correlations to be examined in this investigation are shown in Figure 1. This study draws inferences about the whole population of manufacturing enterprises based on the representativeness of the sample and the objectivity of the data collected (Hair, Page, & Brunsveld, 2019, p. 161).

3.5 Population and Sample

Primary data and secondary data are both viable options for a quantitative investigation. Researcher-conducted surveys and in-person observations are two examples of primary data collection methods. Primary data, on the other hand, is newly collected and not previously available in any form (Easterby-Smith, Thrope, Jackson, & Jaspersen, 2018). Primary data for this research was gathered with the use of a web-based survey that automatically saves responses (Easterby-Smith, Thrope, Jackson, & Jaspersen, 2018). Self-completion methods are those in which respondents are responsible for completing the survey on their own time (Hair, Page, & Brunsveld, 2019; Easterby-Smith, Thrope, Jackson, & Jaspersen, 2018). When doing research using primary sources, researchers have more control over the quality of their data because they may choose a sample and focus their questions in a way that is most relevant to their research goals (Easterby-Smith, Thrope, Jackson, & Jaspersen, 2018). Because of these merits, primary data collecting was used in this investigation.

3.6 Participants Selection

In an ideal research situation, information would be collected from every member of the target population. Since this is usually impractical owing to factors such as cost, time, and accessibility, a sample is taken from the population instead. The findings from the sample data are extrapolated to the whole population. Consequently, the sample size has to be sufficiently large (Hair, Page, & Brunsveld, 2019, p. 179 ff).

Mining and Consumer companies were chosen because they are pioneers in the "Industry 4.0" revolution, which emphasizes the integration of information and communications technology into business operations (Kagermann, Lukas, & Wahlster, 2011). Only Mining companies with more than 50 workers were included in the sample to guarantee a sufficient degree of digital technology. Probability sampling, a standard method for selecting a statistically valid sample in quantitative research (Hair, Page, & Brunsveld, 2019), was used to choose the sample of 500 mining and consumer enterprises. To this end, researchers often determine in advance what percentage of the target population will be included in their samples (Hair, Page, & Brunsveld, 2019). Stratified sampling, a subset of probability sampling, is used in this case. The benefit of this method is that the sample data is more reliable, and it does not cost any more to conduct than other methods. The first step of the stratified sampling method is to split the population to be sampled into distinct groups (Hair, Page, & Brunsveld, 2019). For this reason, the 1000 mining and consumer enterprises were categorized in this research according to their total number of workers. The proportionality or disproportionality of stratified sampling is a matter of choice. This research makes use of a kind of sampling known as proportional stratified sampling. As a result, the number of elements chosen for the sample of each subset is proportional to the proportion of that subset in the target population, which is calculated by multiplying the total number of elements in the target population by the percentage of elements in the subset in question.

The overall size of the sample is equal to the sum of the sizes of the subsamples (Hair, Page, & Brunsveld, 2019). Elements for the sample are selected at random from inside each subset (Hair, Page, & Brunsveld, 2019), such that each subset's elements have an equal chance of being selected.

One benefit of this method is that it encourages researchers to seek out objective data and choose a sample that is really representative of the whole.

3.7 Instrumentation

It is common practice to ask respondents a series of questions in the form of a questionnaire. Everyone who participates in the study is asked the same set of questions in the same order. Because of its many benefits, a structured questionnaire was choose to be used in this study. To begin, a survey may collect a large quantity of information from many people in a short length of time. Second, with the help of appropriate statistical tools, the results of the survey may be readily quantified. Finally, the results may be examined more objectively than with other research methodologies. Both open-ended and closed-ended questions may be used in surveys for business research. Close-ended questions are used in quantitative research to provide respondents with a set of options that have already been established (Dalati & Gómez, 2018, p. 184).

Both firm size and revenue from the most recently completed fiscal year are used as controls in this analysis. Digital technologies, IT chain agility, IT chain integration, IT chain resilience, and operational performance are all discussed in the second section, which consists of closed-ended questions. Here, we corroborate preexisting correlations by drawing questions (items) for each component from research that used structural equation modeling to guarantee content validity. Respondents were given a five-point Likert scale, with 1 representing "Strongly disagree" and 5 representing "Strongly agree," on which to rate the questions. Ordinal scales, such as the Likert scale (Easterby-Smith, Thrope, Jackson, & Jaspersen, 2018) allow for a range of answers from strongly disagreeing to strongly agreeing. The questionnaire used in this study was back-translated by a multilingual IT chain manager to guarantee accuracy.

The completed items utilized in the Smart Casual and wherever possible regression analysis are listed. After doing the analysis, certain items were eliminated from the former because they did not meet the criteria for validity or reliability.

Several seasoned specialists in operations management were asked to assess the questionnaire and provide improvements to increase its face validity. Minor adjustments were made to the questionnaire based on their comments to increase its validity and make it easier to understand.

Finally, a pilot study involving 50 businesses was carried out to further investigate the reliability of the survey.

All research variables were needed to be assessed using the Smart Causal Analysis framework. Standardized scales (Dalenogare et al., 2018; Mittal et al., 2018; Frank et al., 2019; Li et al., 2020) served as the basis for the digital technologies' measurement items. In particular, we wanted to know how far respondents' companies had taken the use of big data, cloud computing, IoT, and analytics technologies. Smys & Raj (2019) and Li et al. (2020) argue that the development of these four digital technologies together may result in greater aggregation advantages.

Components for internal, external, and customer integration were sourced from See also: Flynn et al. (2010), Wong et al. (2011), and Narasimhan & Kim (2002). In the sections on supplier integration and customer integration, respondents were asked to assess the extent to which their businesses supported and cooperated with customers/suppliers in areas such as information exchange, collaborative planning, strategic alliances, product development, etc. The degree to which respondents agreed with statements on the responsiveness of all departments to other departments within their organizations, integrated system application, information flow management, and physical flow management was also used to evaluate internal integration.

The firm resilience measurement scale is based on previous work by Ambulkar et al. (2015), Ali et al. (2017), and Parker & Ameen (2018). The firm's capacity to recover quickly from IT chain interruptions and implement necessary adjustments was utilized as a metric. Firms' capacity to bounce back from setbacks and understand the bigger picture and future direction of IT chain operations were also factored in. Complexity metrics were borrowed from Li (2016), Huang (2000), and Tsai et al. (2008). We used the authors' three-item scale for gauging the informational challenges of people and applied it to businesses. Participants were asked to provide examples of the informational challenges that companies face, such as the volume of data, the complexity of IT chain data, and the breadth of informational dimensions.

We used the number of workers and yearly revenue of the companies as measures of firm size for the variables. Researchers have used sample size as a proxy for resilience in previous studies (Gu et al., 2021a). Greater competitiveness and resource advantages, as well as the ability to achieve resilience, are hallmarks of bigger organizations compared to smaller ones (Huo et al., 2015; Azadegan et al., 2020). In addition, we eliminated any bias introduced by the ownership structure of the company by controlling for it (Liu et al., 2014; Amoako-Gyampah et al., 2019).

3.8 Data Collection and Procedures

The research methodology refines the connection between theory and empirical evidence. Research methods such as induction, deduction, and abduction are covered (Kennedy, 2018, pp. 49 ff). A deductive methodology was used for this study. Therefore, unlike induction, this study did not uncover previously unknown occurrences. Instead, a novel empirical setting was used to test for the presence of causal links between previously researched variables (Kennedy, 2018, p. 50). The following procedures were carried out, as shown in Figure 2, in line with logical reasoning. A literature study was performed, and a conceptual model was built based on previously established causal links, all through the lens of dynamic capacities. Second, inferences were drawn from the connections between variables. After that, questionnaires were sent to businesses in industrial sector to collect the necessary information. Questions from prior research were included in the survey. In the end, survey data was used to assess the hypotheses. SPSS was used to perform statistical analysis and quality control on the data presented here.

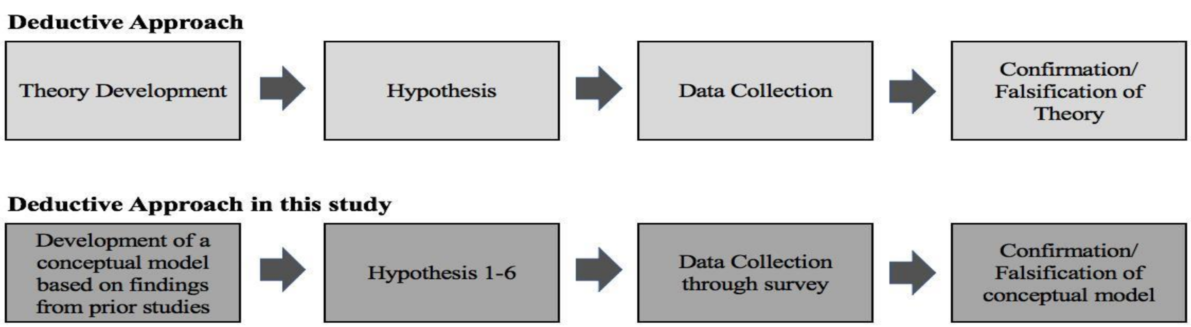


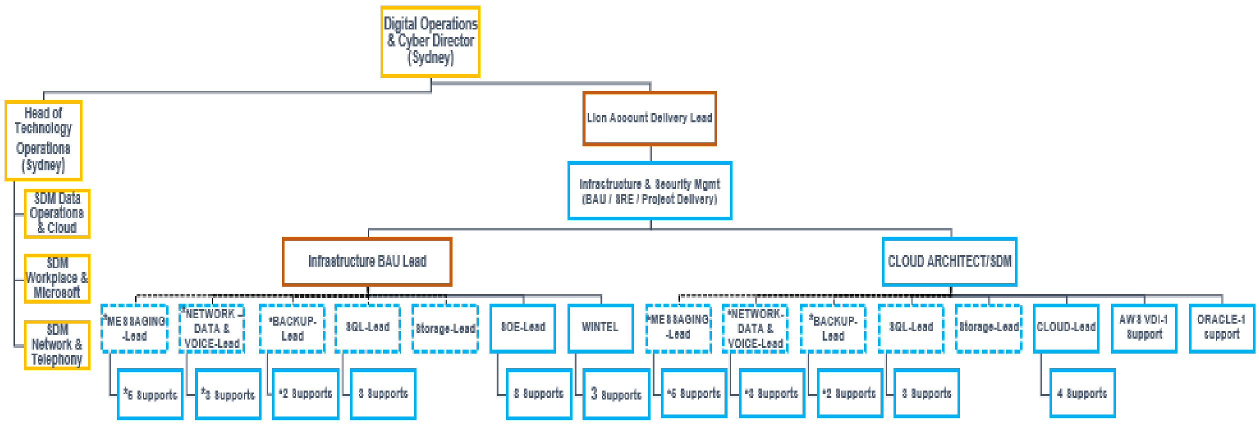
Figure 3. 1: Research Approach

Source: https://www.google.com.au/books/edition/Reason_Rigor/QYQQKQkL8d8C?hl=en&gbpv=1&dq=reason+and+rigor+by+sage&printsec=frontcover

Approach for Smart Causal Analysis – methods

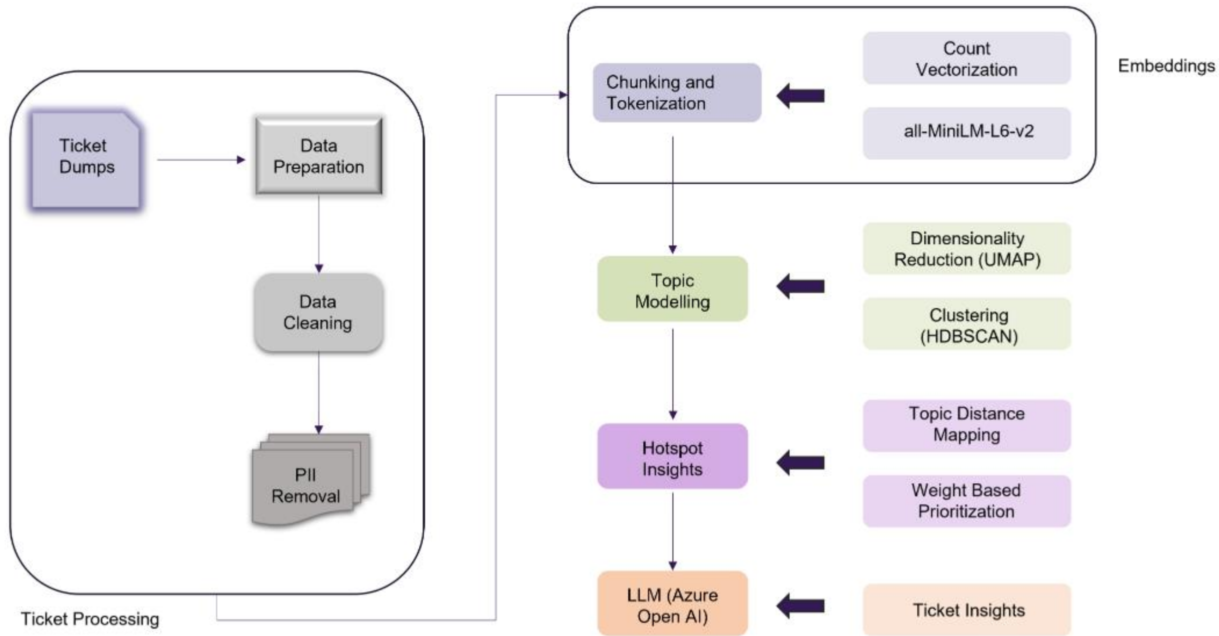
No	Key Activities	Deliverables/ Artifacts	Output/ Deliverable
1	**Performing Ticket Analysis** • Receipt of service desk report from questionnaire gathered through Consumer and Mining customers based on Incidents, Service requests. • Importing Tickets onto Platform • Analyse tickets to understand key issues and patterns • Service Desk report/ data dump should have the following fields: - number - assignment_group - urgency - priority - impact - short_description - sys_created_on - reopen_count - short description - long description - reassignment_count Objective: Emphasizes our commitment to leveraging cutting-edge GenAI technology to pinpoint and address the primary factors contributing to customer inquiries and support calls. By identifying these hotspots, we aim to proactively optimize our response strategies and enhance service quality.	Identification of GenAI based Hotspots for Top Call Drivers	Daily Insights: Provide daily analysis and insights on the top incidents and service requests (SRs), including urgent actions to address and mitigate these issues. Trend Analysis: Compare incident types to identify trends, noting which have increased or decreased compared to the previous month or week. Incident Mindmap: Create a mindmap of incidents and SRs to help prioritize key issues within ITSM. Prioritization Framework: Develop a framework to prioritize incidents based on impact, urgency, and frequency. Actionable Reports: Generate reports that offer actionable insights for immediate and long-term ITSM improvements.
2	**Developing insights from Smart Causal Analysis through Ticket Data** **Objective:** This underscores our strategic initiative to utilize sophisticated pattern-based analytics to systematically decrease the overall volume of tickets. This proactive approach is aimed at enhancing service efficiency and customer satisfaction by identifying and addressing recurring issues.	Pattern based insights to reduce overall ticket volumes	
3	**Identify prioritised intervention areas to reduce cycle time reduction** **Objective:** Identifying and prioritizing key areas for intervention that will significantly reduce cycle times. By focusing on elimination of redundancies and implementation of automation, we aim to streamline processes and	Define potential prioritized intervention areas for cycle time reduction for elimination and automation	
4	**Develop and share high level recommendation and analysis** **Objective:** This deliverable will showcase our comprehensive analysis and recommendations, demonstrating a strategic approach to IT service management. Our focus will be on proactive measures, seamless tool integration, and an unwavering commitment to enhancing the overall user experience. This will ensure that our services not only meet but exceed the expectations of our clients, fostering a relationship of trust and excellence.	Showcase the recommendation and analysis based on the overall analysis	Proactive Ticket Reduction: Implement strategies that proactively reduce the number of tickets, leading to fewer outages and increased system availability. Tool Integration: Integrate with productivity tools like SOP generator/Smart Genie to enhance efficiency. Efficiency Boost: Achieve an overall increase in efficiency through improved processes and tool utilization. Productivity Gains: Attain higher productivity levels, contributing to a more streamlined workflow. User Experience Improvement: Enhance the user experience (UX) through the combined effects of reduced tickets, increased system availability, and integrated productivity tools.

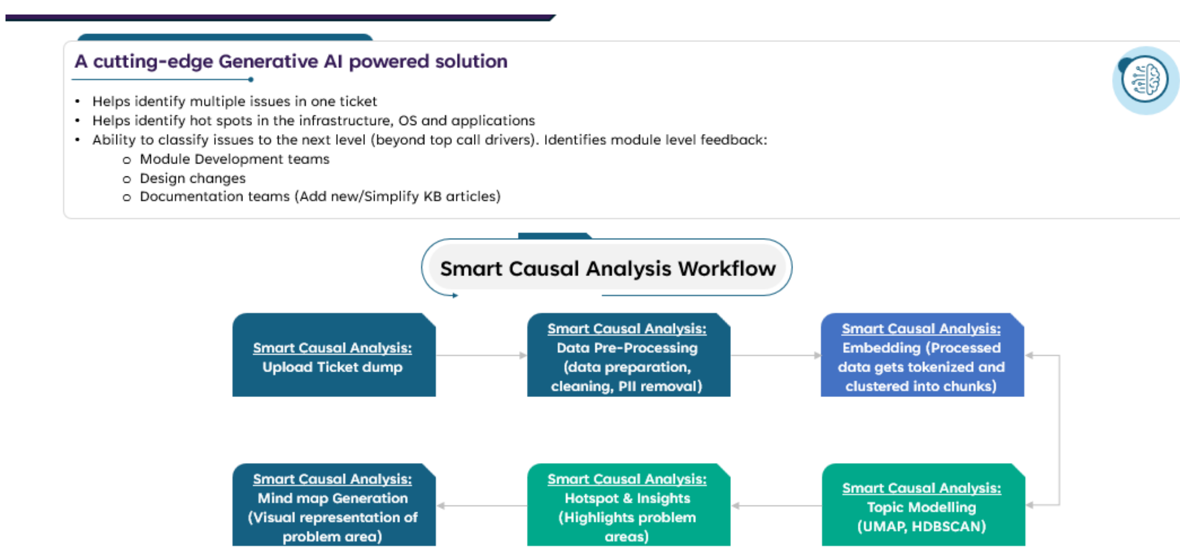
Questionnaire based approach following the mining and consumer sector standard organogram for data collection (interview and tool-based research methods):



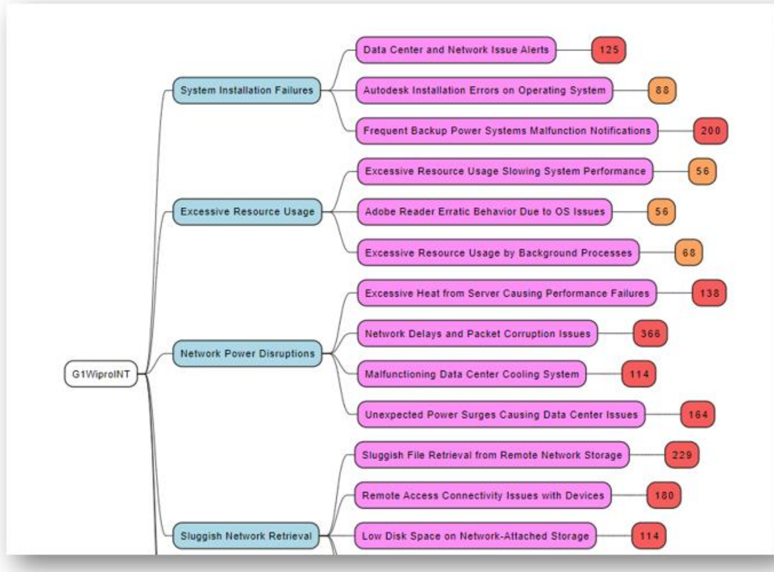
Model of Smart Causal Analysis

Process flow of Causal Analysis

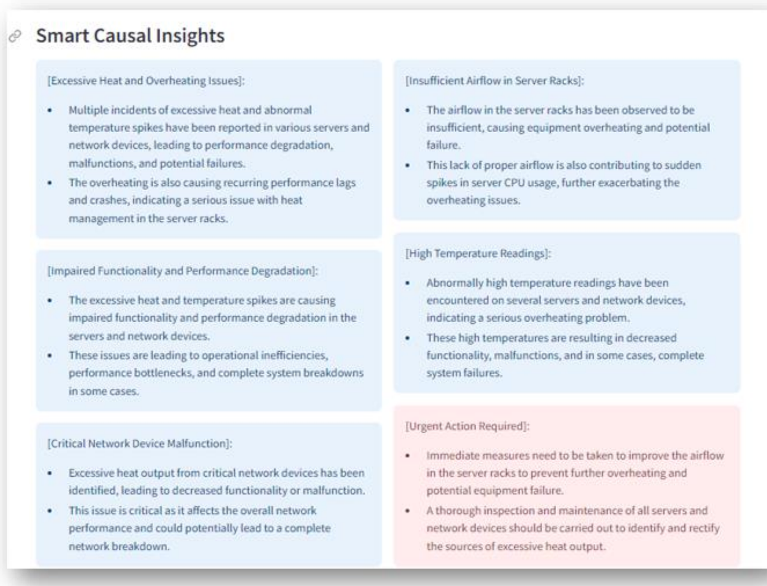




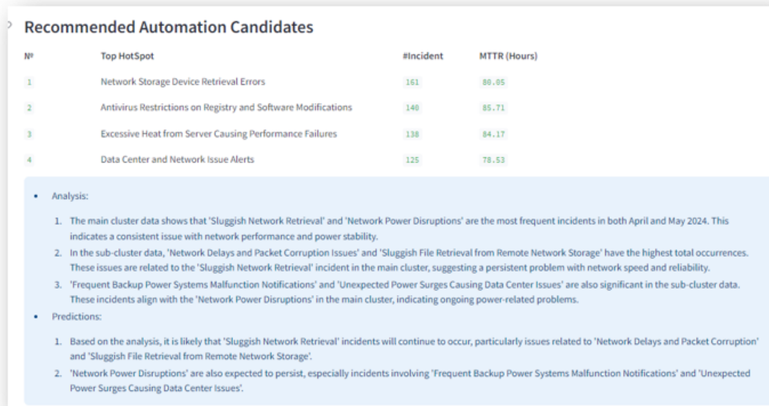
Smart Causal Analysis – Platform Hotspots



Smart Causal Analysis – Insights (predictive View)



Smart Causal Analysis – Insights (prescriptive View)



Recommended Automation Candidates

№	Top HotSpot	#Incident	MTTR (Hours)
1	Network Storage Device Retrieval Errors	161	80.05
2	Antivirus Restrictions on Registry and Software Modifications	140	85.71
3	Excessive Heat from Server Causing Performance Failures	138	84.17
4	Data Center and Network Issue Alerts	125	78.53

- Analysis:
  1. The main cluster data shows that 'Sluggish Network Retrieval' and 'Network Power Disruptions' are the most frequent incidents in both April and May 2024. This indicates a consistent issue with network performance and power stability.
  2. In the sub-cluster data, 'Network Delays and Packet Corruption Issues' and 'Sluggish File Retrieval from Remote Network Storage' have the highest total occurrences. These issues are related to the 'Sluggish Network Retrieval' incident in the main cluster, suggesting a persistent problem with network speed and reliability.
  3. 'Frequent Backup Power Systems Malfunction Notifications' and 'Unexpected Power Surges Causing Data Center Issues' are also significant in the sub-cluster data. These incidents align with the 'Network Power Disruptions' in the main cluster, indicating ongoing power-related problems.
- Predictions:
  1. Based on the analysis, it is likely that 'Sluggish Network Retrieval' incidents will continue to occur, particularly issues related to 'Network Delays and Packet Corruption' and 'Sluggish File Retrieval from Remote Network Storage'.
  2. 'Network Power Disruptions' are also expected to persist, especially incidents involving 'Frequent Backup Power Systems Malfunction Notifications' and 'Unexpected Power Surges Causing Data Center Issues'.

Source: Questionnaire response – Nikhil Sharma ©

3.9 Data Analysis

Finding the links between factors is the ultimate goal of inferential surveys. Therefore, it is important for researchers to identify the causal factors at play. Focused efforts in addressing the identified hotspots have resulted in a commendable reduction in service load. This implies that identifying the dependent and independent variables is necessary. The influence on the dependent variables is attributable to an independent variable. continuous effort to enhance service quality, adopting the latest AI technologies to analyze ticket trends. By leveraging an advanced built AI tool – Smart Causal Analysis tool, the team processes extensive ticket data using Natural Language Understanding and Generative AI (GenAI). The integration of the Smart Casual Analysis tool provides advanced problem-solving and serves as a cornerstone in our approach to managing the customer's critical technical support accounts. To process extensive ticket data, the tool harnesses the power of natural language understanding and GenAI. Accordingly, what scientists are interested in predicting is the value of the dependent variable (Easterby-Smith, Thrope, Jackson, & Jaspersen, 2018, p. 169). Furthermore, it is recommended in more intricate statistical models that examine if the strength of the association between an independent and dependent variable may be improved by including a third variable, a so-called moderator variable (King, 2013).

There are two sections to this study. In the first section, its capabilities extend to identifying critical areas within the infrastructure or specific product components, commonly referred to as ‘hotspots’. These hotspots are pivotal focal points responsible for a significant portion of reported issues.

Thus, resilience is the dependent variable, whereas IT chain agility and integration are the independent factors. In addition, the role of digital technology as a moderator is studied in the context of the connections between IT chain agility and resilience, and between IT chain integration and resilience. Part 2 examines how Through the nuanced application of GenAI, the tool not only identifies but also prioritizes key fields, guiding our support efforts to concentrate on the most impactful and prevalent issues faced by customers. This strategic utilization of technology aligns with our larger goal of not just resolving incidents but actively mitigating the root cause. By pinpointing and addressing latent issues, we build a more resilient and optimized infrastructure. Moreover, the insights gained from this analysis provide valuable feedback to our engineering team, fostering a collaborative approach to product improvement and design enhancements. In this context, we also examine the role that digital technologies play as a moderator variable between IT chain resilience and operational performance.

In addition, new control variables were included. In order to lessen the likelihood of confounded results that undermine the validity of the created model, control variables are included in the investigation of causal linkages (Atinc, Simmering, & Kroll, 2012). Control variables are kept constant during statistical testing since they reflect typical features of a company's operation that affect its performance (Pervan, Pervan, & urak, 2017). The regression analysis in this study included control factors such as Incident, Problem, Change, Service request volumes from the previous fiscal year, and company size. Researchers in the past have often utilized firm size and revenue as proxies for other factors. The bigger a company is, the more likely it is that it has the means and capacity to invest in digital technologies or activities connected to the IT chain (Li, Dai, & Cui, 2020).

Data analysis is the process of thoroughly evaluating the main data collected from the questionnaire using statistical techniques. Descriptive statistics and inferential statistics are taken into consideration as methods of data analysis. Descriptive statistics are used to summarize and describe the study's data. Data were analyzed (through data screening) and the characteristics of the sample were tabulated using descriptive statistics (Aboujaoude, Feghali, & Kfouri, 2018). In addition, inferential statistics were used as part of the quantitative research approach to extrapolate findings from the sample to the whole population. Using a model and hypothesis testing, inferential statistics attempts to discover tendencies, patterns, and probable correlations between variables (Aboujaoude, Feghali, & Kfouri, 2018). A factor analysis was first performed to reduce the high number of observable variables into a smaller number of components (Yang H., 2012). Regression analysis was carried out to assess the presupposed relationships (Aboujaoude, Feghali, & Kfouri, 2018). SPSS, a statistical package, was used for all analyses.

Screening the data and identifying any out-of-the-ordinary answers after data collection is recommended prior to data analysis. Several different kinds of screening procedures may be used. First, while looking for outliers, descriptive statistics should be used taking into consideration the spread of how each item was categorised (DeSimone, Harms, & DeSimone, 2015). Responses that were beyond the middle 50% of the distribution were deemed severe in this research. At the same time, this research didn't include several questions since they had a response rate of less than 25%. When a value was absent, the average of the other values for that item was substituted. Second, as recommended by DeSimone, Harms, and DeSimone (2015), data from individuals who only answered to certain items and when replies for other items are absent should be discarded. In this research, this meant that respondents who did not fill out more than 25% of the questionnaire were not included in the final tally.

3.9.1 Research Design limitations

The research is limited to a fixed number of respondents and is also impacted by the biases of the respondents and their knowledge.

3.9.2 Conclusion

In order to combine the data and make the subsequent analysis more manageable, a factor analysis is performed. Consequently, a number of interconnected elements are collapsed into a smaller number of elements (Hair, Page, & Brunsveld, 2019). This research used the principle components analysis (PCA), one of the two most popular factor analysis methods (the other being the common factor analysis; see Easterby-Smith, Thrope, Jackson, & Jaspersen, 2018, pp. 445 ff.). Through a process known as principle components analysis, a large set of data may be reduced to a manageable subset of variables. This means that the initial variance may be explained by a smaller set of principle components (Hair, Page, & Brunsveld, 2019, p. 428). Individual survey questions were used to reflect these factors, which were broken down into the broad categories of "IT Smart Causal Analysis chain resilience," "IT chain agility," "IT chain integration," "digital technologies," and "operational performance" for the sake of this research. Principal components analysis is useful because it takes into account not just the typical but also the out-of-the-ordinary and the error variance. since of this, PCA is commonly used in business research (Hair, Page, & Brunsveld, 2019, p. 428) since it produces more reliable results.

3.9.3 Trustworthiness and Efficacy

According to the definition provided by (Easterby-Smith, Thrope, Jackson, & Jaspersen, 2018), validity is "the extent to which a concept is measured accurately in a quantitative study." Researchers use content validity and factor validity to examine a questionnaire's reliability and accuracy before using it. At start, we looked at the content validity. The content validity of a questionnaire determines whether or not it accurately measures the targeted constructs (Bolarinwa, 2015). Previous study results should be reviewed to guarantee topic validity (Saunders, Lewis, & Thornhill, 2009).

Second, we checked each item's factor validity. The so-called factor loadings are an essential product of the factor analysis. Reducing the number of items to express the correlations between factors is accomplished with the help of factor loadings (Yang H., 2012, p. 480). Factor loadings with a value of 0.6 or above are recommended for further analysis as stated by Hair, Page, & Brunsveld (2019, p. 430 ff). Items would explain at least 50% of the overall variation if this were the case. Items with a factor loading of less than 0.5 should be eliminated from consideration; however, they may be included in future study to determine whether or not they should be retained. In addition, a correlation matrix is used to examine the so-called discriminant validity, which states that unique factors should not be correlated with dissimilar ones (Hair, Page, & Brunsveld, 2019). In addition, the Kaiser-Meyer-Olkin (KMO) (Kaiser, 1970; Kaiser, 1974) test and Bartlett's test of sphericity (Bartlett, 1954) were conducted as part of the factor loading analysis. If the data set is normally distributed, this may be determined by using the Bartlett test of sphericity. Additionally, it checks whether the identity matrix is identical to the correlation matrix to rule it out as a possible explanation. A p-value of less than 0.05 shows a significant difference between the correlation matrix and the identity matrix (Hadi, Abdullah, & Ilham, 2016). SPSS was used to conduct the KMO test, the Bartlett's test of sphericity, and the factor loadings, all of which were prescribed by the aforementioned sources. In section 4.3.2, we provide the findings.

Researchers should also assess the reliability of the constructs, which contributes to the questionnaire's validity (Bolarinwa, 2015). Cronbach's alpha may be used to test for reliability (Easterby-Smith, Thrope, Jackson, & Jaspersen, 2018, p. 185), which measures the internal consistency of a measurement within a group of items. Cronbach's alpha was calculated using a reliability analysis in SPSS for this study. Reliability analysis was conducted independently for each factor using the factor analysis's findings on the number of items remaining in each component. Cronbach's alpha values between 0.8 and 0.9 suggest strong reliability and, by extension, high internal consistency within a group of items, as stated by the rule of thumb by Hair, Page, & Brunsveld (2019, p. 262). Reliability levels between 0.7 and 0.8 are regarded excellent, with values between 0.6 and 0.7 being acceptable. We cannot accept values below 0.6 since we do not know whether or not the entries inside the set are internally consistent.

3.10 Analyzing with a Regression

Regression analysis is used to determine the linear connections between two or more variables. Thus, the correlation of the variables establishes the existence and intensity of a link (Hair, Page, & Brunsveld, 2019, p. 395). Hypotheses are formulated and then evaluated to see whether there is a connection between these factors. The so-called null hypotheses in this scenario assert that there is no connection between the variables. The null hypothesis is rejected and the alternative hypothesis, which states that there is a link between the variables, is verified if the alternative hypothesis is statistically significant (Hair, Page, & Brunsveld, 2019, p. 383). As stated by Hair, Page, and Brunsveld (2019, p. 403), statistical significance is shown when the p-value is less than 0.05.

Different from a bivariate analysis, which only looks at the correlation between two variables, a multiple regression analysis looks at the correlation between many independent variables that predict a single dependent variable. In this way, we may evaluate how various explanatory factors affect the dependent variable of interest. Multiple regression analysis is preferable to univariate regression because it considers a more realistic model by taking into consideration a larger number of independent variables (Hair, Page, & Brunsveld, 2019, p. 401). That's why researchers here used a multiple regression analysis, too. The dependent variable in such a model is represented on a continuous scale, whereas the independent variables might be either continuous or categorical (Easterby-Smith, Thrope, Jackson, & Jaspersen, 2018, p. 521). IT chain agility, IT chain integration, and IT chain resilience are the independent variables in this model, whereas operational performance and IT chain resilience are the dependent variables. The role of digital technology as a moderator in the link between independent and dependent variables is explored.

Table 3. 1:Questionnaire Part A

IT processes	**IT chain functions**	**Example of digital technology adoption**	**Related papers**

Product design	General product design	The real-time data collected through IoT devices in IT chain can improve product development.	(Yerpude and Singhal, 2018)
	User involved product design	The digital IT chain can enable the open innovation that includes user and supplier into the product development	(Reeves et al., 2011; Holmström et al., 2016; Chavez et al. 2017)
Demand management	Demand forecasting	Big data predictive analysis is used for demand forecasting in the pharmaceutical industry.	(Min, 2010; Waller and Fawcett, 2013; Seethamraju, 2014; Caro and Sadr, 2019;Shafique et al., 2019)
Procurement	Supplier selection	Big data analysis can forecast margins for different supplier and optimize the selection of supplier. After that, digital procurement system can inform the selected supplier promptly.	(Sanders et al., 2016; Boone et al., 2017; Moretto et al., 2017)
	Procurement decision making	Artificial intelligence is used in procurement decision making especially in the ambiguous tasks. The AI system can use different solutions according to different level of task ambiguity to increase the accuracy.	(Nissen and Sengupta, 2006; Min, 2010; Moretto et al., 2017)
	Sourcing cost reduction	Online digital procurement collaboration system can help to forecast the orders and reduce the cost of negotiation process.	(Yan, Chien, et al., 2016)
	Production planning	With direct digital manufacturing, product-centric control and IoT can simplify production planning and material handling and recovery.	(Lyly-Yrjänäinen et al., 2016; Fang et al., 2016)

Mining and Consumer Sector	Quality management	Sensor technologies combining with telematics and digital services can ensure the quality of Mining.	(Verdouw et al., 2013; Teucke et al., 2018)
	Equipment maintenance	Use digital technology to diagnostics and prognostics equipment. IoT technology can be used to track the location of every equipment.	(Arya et al., 2017)
	Digital manufacturing	The implementation of digital manufacturing in the complex product IT chain will change the relationship between firms, OEMs and logistic service providers.	(Holmström and Partanen, 2014; Arya et al.,2017)
Warehousing and logistics	Storage assignment Inventory control and planning	Visual control used in the warehouse can collect the data of real-time inventory. RFID label can automatically identify and track material information. Assignment can be completed after the calculation in the cloud platform	(Lyly-Yrjänäinen et al., 2016; Choy et al., 2017; Hopkins and Hawking, 2018; Yu et al., 2017; Min, 2010)
	Logistics planning	Big data analysis can support routing optimization, real-time traffic operation monitoring and proactive safety management.	(Lai et al., 2010; Graham et al., 2015; Hahn and Packowski, 2015; Badia-Melis et al., 2018; Hopkins and Hawking, 2018; Nguyen et al., 2018)
General IT Process chain	E-business process	The digital retailer platform can be regarded as a new business model that changes the IT	(Ittmann, 2015; McIntyre and Srinivasan, 2017;

		chain structure among supplier and consumers.	Hänninen et al., 2018)
	Traceability of business process	Implementation of a traceability system in a product line can improve the overall quality of the product and minimize the impact of a product recall. The digital retailer platform can be regarded as a new business model that changes the IT chain structure among supplier and consumers.	(Campos and Míguez, 2006; Yan, Yan, et al., 2016; Li et al., 2017; McIntyre and Srinivasan, 2017; Hänninen et al., 2018; Garcia-Torres et al., 2019)
	Customer relationship Management	Use data mining system to discover the knowledge from customer base. Implementation of a traceability system in a product line can improve the overall quality of the product and minimize the impact of a product recall.	(Min, 2010)

Source: Questionnaire development by Nikhil Sharma ©

Table 3. 2:Constructs, Definitions, and Sources

Construct/Items		Definition	Indicator	Adapted from
ITSM Design View				
ITSM D1	Digital products and Services	Products and services based on digital technology that bring digital capabilities to consumers	We have adopted digital products and services	Ageron et al. (2020) Hallikas et al. (2021) Weking et al. (2020) Frank et al. (2019)
ITSM D2	Digital operation process	Management and operation mode based on digital technology, including digital manufacturing, digital working and so on	We have adopted digital operation management	
ITSM D3	Digital business model	Business models based on digital technology, including mass customization, product service systems, open innovation and so on	We have adopted digital business model	

Source: Questionnaire development by Nikhil Sharma ©

Table 3. 3: Items and Sources

Items		Sources
DT	**Digital technologies**	Dalenogare et al., (2018), Frank et al., (2019), Li et al., (2020) and Mittal et al., (2018)
DT1	The extent to which our firm has implemented Internet of Things in operations	
DT2	The extent to which our firm has implemented cloud computing in operations	

DT3	The extent to which our firm has implemented big data in operations	
DT4	The extent to which our firm has implemented analytics in operations	
CI	**Customer integration**	Flynn et al., (2010), Narasimhan & Kim (2002), Seo et al., (2014) and Wong et al., (2011)
CI1	We have a high level of information sharing with major customers about market information.	
CI2	We share information with major customers through information technologies.	
CI3	We have a high degree of joint planning and forecasting with major customers to anticipate demand visibility.	
CI4	Our customers provide information to us in the procurement and production processes.	
CI5	Our customers are involved in our product development processes.	
SI	**Supplier and IT Platform integration**	Flynn et al., (2010), Narasimhan & Kim (2002), Seo et al., (2014) and Wong et al., (2011)
SI1	We share information with our major suppliers through information technologies.	
SI2	We have a high degree of strategic partnership with suppliers.	
SI3	We have a high degree of joint planning to obtain rapid response ordering processes (inbound) with suppliers.	

SI4	Our suppliers provide information to us about production and procurement processes.	
SI5	Our suppliers are involved in our product development processes.	
II	**Internal integration**	Flynn et al., (2010), Narasimhan & Kim (2002), Seo et al., (2014) and Wong et al., (2011)
II1	We have a high level of responsiveness within our plant to meet other departments' needs.	
II2	We have an integrated system across functional areas of plant control.	
II3	Within our plant, we emphasize information flows amongst purchasing, inventory management, sales, and distribution departments.	
II4	Within our plant, we emphasize physical flows amongst production, packing, warehousing, and transportation departments.	
FR	**Firm resilience**	Ali et al., (2017), Ambulkar et al., (2015) and Parker & Ameen (2018)
FR1	We are able to manage changes brought by the IT chain disruption.	
FR2	We are able to adapt to IT chain disruptions easily.	
FR3	We are able to provide a quick response to IT chain disruptions.	
FR4	We are able to maintain high situational awareness at all times.	

IC	Information complexity	Li (2016), Huang (2000) and Tsai et al., (2008)
IC1	The information on the IT Smart Causal chain is complex	
IC2	The information on the IT Smart Causal chain is crowded	
IC3	The information on the IT Smart Causal chain is large in scale	

Source: Questionnaire development by Nikhil Sharma ©

Table 3. 4 : Smart Causal Service Management Orientation

IT Processes Orientation – adapted from Ponomarov 2012, Wieland and Wallenburg (2013)					
	Volume Data Available				
	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1. Simplicity and efficiency as touchstones, the Causal Analysis tool can be seamlessly deployed in a client environment with minimal dependencies. Joint decision making, CPFR, knowledge sharing, benefit sharing, VMI, etc. are just a few examples of the customer-focused initiatives that our company has implemented and is pursuing.	**1**	**2**	**3**	**4**	**5**
2. We have faith in our most important clients.	**1**	**2**	**3**	**4**	**5**
3. Our goals align with those of our most valuable clients.	**1**	**2**	**3**	**4**	**5**
4. Executives stress the need of open					

communication with clients and a commitment to long-term partnerships.	**1**	**2**	**3**	**4**	**5**
5. Our Incident Volumes chain is an integrated ecosystem that allows for end-to-end communication between IT systems and distribution.	**1**	**2**	**3**	**4**	**5**

Source: Questionnaire development by Nikhil Sharma ©

Table 3. 5:Information Management Capabilities

Information Management Capabilities – adapted from Ponomarov 2012, Wieland & Wallenburg 2013					
	Incident Management				
1. One of the strengths of our company is the prompt and efficient communication of operating information across different divisions.	**Strongly Disagree**	**Disagree**	**Strongly Disagree**	**Disagree**	**Strongly Disagree**
2. We regularly and promptly update chosen external clients on the status of our operations.	**1**	**2**	**1**	**2**	**1**
3. The data we have at our company is reliable.	**1**	**2**	**1**	**2**	**1**
4. Our company uses a unified database for both internal and external data exchange and communication with clients.	**1**	**2**	**1**	**2**	**1**
5. We have complete use of all IT chain joint planning systems.	**1**	**2**	**1**	**2**	**1**

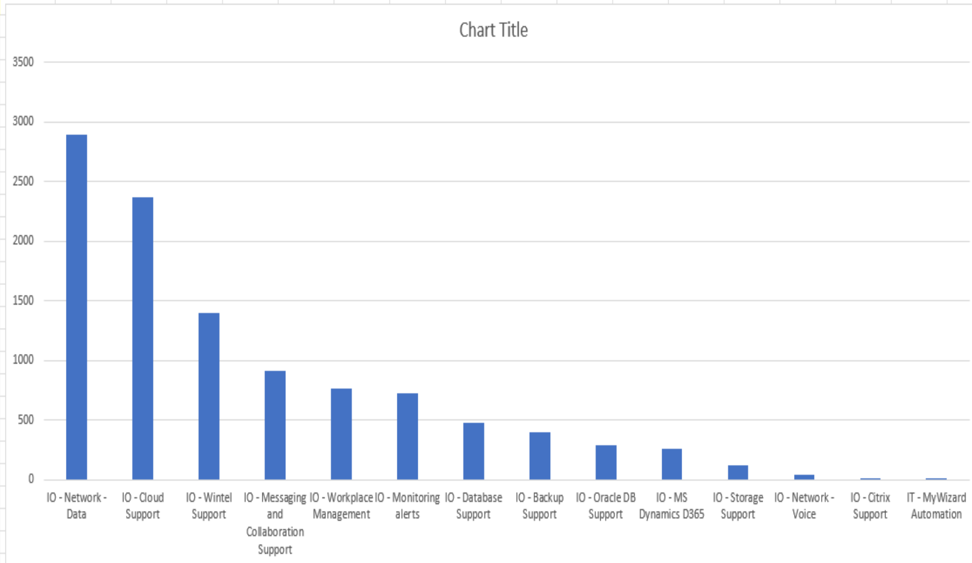
Source: Questionnaire development by Nikhil Sharma ©

Questionnaire data for Incident management (sample snapshot):

Number	Short description	Priority	State	Business Applicati	Assignment group	Updated	Created
INC0032576	pdcpbak04 - A Warning alert trap from Command Central; 212471 Active Job Completed with Exit Status 6.	3 - Moderate	Closed	Workstation	IO - Backup Support	12/06/2023 17:00:01	30/05/2023 19:57:30
INC0032742	Unable backup take for LDAU200351 server	4 - Low	Closed	ShadowProtect Desktop Edition	IO - Backup Support	16/06/2023 16:00:48	01/06/2023 09:50:51
INC0032801	dunponesnode01.aunz.lncorp.net is Down - not pingable	3 - Moderate	Closed	ShadowProtect Virtual Server	IO - Backup Support	12/06/2023 19:00:02	02/06/2023 05:35:58
INC0032805	tooponesnode01.aunz.lncorp.net is Down - not pingable	3 - Moderate	Closed	ShadowProtect Virtual Server	IO - Backup Support	12/06/2023 19:00:01	02/06/2023 06:43:59
INC0032953	Health notification for 12.22.007 opcle: opcle is in Aborted state.	3 - Moderate	Closed	Flash Drive | Memory Stick	IO - Backup Support	12/06/2023 10:00:01	03/06/2023 05:42:28
INC0032954	utilization: 100% on syapbak01.aunz.lncorp.net	4 - Low	Closed	Symantec Netbackup	IO - Backup Support	10/06/2023 15:00:01	03/06/2023 06:21:06
INC0033087	PDCPBAK04 catalogue recovery	4 - Low	Closed	Workstation	IO - Backup Support	12/06/2023 17:00:01	05/06/2023 16:26:22
INC0033100	Alert- Caspcamera	4 - Low	Closed	ShadowProtect Virtual Server	IO - Backup Support	14/06/2023 12:00:03	05/06/2023 19:48:39
INC0033160	Alert - LDAU700201	4 - Low	Closed	ShadowProtect Virtual Server	IO - Backup Support	16/06/2023 11:00:01	06/06/2023 12:08:27
INC0033482	utilization: 100% on syapbak01.aunz.lncorp.net	4 - Low	Closed	Symantec Netbackup	IO - Backup Support	17/06/2023 09:00:02	10/06/2023 06:20:58
INC0033557	Alert - Exchange online Backup failure	4 - Low	Closed	Workstation	IO - Backup Support	28/06/2023 11:00:02	12/06/2023 12:45:42
INC0033563	Caspfile - Replication no recovery point	4 - Low	Closed	ShadowProtect Virtual Server	IO - Backup Support	11/07/2023 13:00:01	12/06/2023 12:45:54
INC0033566	Alert - one drive backup failure	4 - Low	Closed	Workstation	IO - Backup Support	03/07/2023 16:00:04	12/06/2023 12:49:46
INC0033569	Alert - Groups Backup failure	4 - Low	Closed	Workstation	IO - Backup Support	07/07/2023 13:00:03	12/06/2023 12:52:26
INC0033570	Alert - Teams Backup failure	4 - Low	Closed	Workstation	IO - Backup Support	10/07/2023 17:00:04	12/06/2023 12:54:51
INC0033576	SDCPONESYSTEM Reboot	4 - Low	Closed	ShadowProtect Desktop Edition	IO - Backup Support	26/06/2023 20:00:02	12/06/2023 15:10:00
INC0033591	Alert- Syapvaronismgr.	4 - Low	Closed	Symantec Netbackup	IO - Backup Support	26/06/2023 18:00:02	12/06/2023 20:13:55
INC0033609	Moved from NZ to AUS and login details not working starting new role	4 - Low	Closed	Microsoft Active Directory	IO - Backup Support	30/06/2023 17:00:03	13/06/2023 08:38:53
INC0033759	One Note Won't Sync	4 - Low	Closed	Microsoft OneNote	IO - Backup Support	30/06/2023 12:00:02	14/06/2023 13:10:31
INC0033899	utilization: 100% on syapbak01.aunz.lncorp.net	4 - Low	Closed	Symantec Netbackup	IO - Backup Support	22/06/2023 19:00:00	15/06/2023 18:20:46

Source: Questionnaire output by Nikhil Sharma ©

		10656
Group	Support	Count
Infra	IO - Network - Data	2891
Infra	IO - Cloud Support	2368
Infra	IO - Wintel Support	1402
Infra	IO - Messaging and Collabora	914
Infra	IO - Workplace Management	768
Infra	IO - Monitoring alerts	724
Infra	IO - Database Support	472
Infra	IO - Backup Support	398
Infra	IO - Oracle DB Support	293
Infra	IO - MS Dynamics D365	255
Infra	IO - Storage Support	121
Infra	IO - Network - Voice	41
Infra	IO - Citrix Support	6
Infra	IT - MyWizard Automation	3



Source: Questionnaire output by Nikhil Sharma ©

	Assignment Group					
Category	Enable Me	IT - CMDB	IT - Service Management	IT - ServiceNow Admin	TSS - AUNZ	Grand Total
IT General Request	4801	14	1	197	835	5848
IT Application Access	1014			19	62	1095
Email Request Access to IT Application	1055				4	1059
Distribution List	748			1		749
ServiceNow Access	9			450	2	461
DL - Distribution List	430					430
Laptop/Desktop Hardware Request					331	331
IT Accessory Request					322	322
New Starter					320	320
Mailbox requests	281					281
Software Request	172				48	220
Network Drive, Folder Access	182				4	186
Other Phone requests	110				57	167
Return Equipment					166	166
Phone Request	76				67	143
ServiceNow Other Request	12	2		114		128
Non-Standard Software					115	115
LION - Supplier Query & Requests					71	71
ServiceNow Catalogue Item	1			60		61

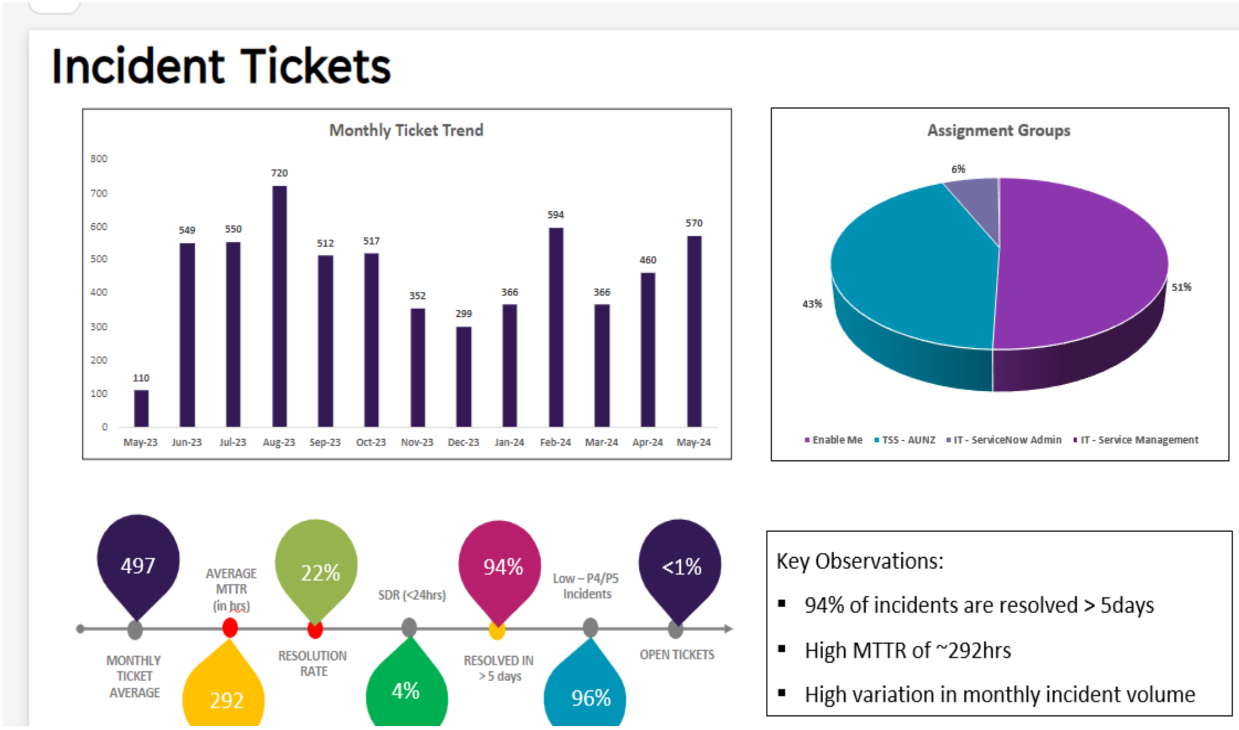
Table 3. 6:Ticket Patterns Management Strategies

Source: Questionnaire output by Nikhil Sharma ©

Questionnaire (sample snapshot) for Infrastructure alerts:

Number	Opened	Short description	Priority	State	Business Application	Assignment group	Updated
INC0060354	17/03/2024 01:22:14	An error occurred in the processing of the policy Sys_FileSystemUtilizationMonitor_WinOS . Please check the following errors and take corrective actions. (OpC3	3 - Moderate	Closed	Workstation	IO - Cloud Support	27/03/2024 10:00:01
INC0060303	16/03/2024 01:27:10	An error occurred in the processing of the policy Sys_FileSystemUtilizationMonitor_WinOS . Please check the following errors and take corrective actions. (OpC3	3 - Moderate	Closed		IO - Monitoring alerts	23/03/2024 03:00:00
INC0060291	15/03/2024 22:55:12	An error occurred in the processing of the policy Sys_FileSystemUtilizationMonitor_WinOS . Please check the following errors and take corrective actions. (OpC3	3 - Moderate	Closed		IO - Monitoring alerts	23/03/2024 01:00:01
INC0059173	04/03/2024 23:30:36	an error occurred in the processing of the policy sys_filesystemutilizationmonitor_winos . please check the following errors and take corrective actions. (opc3	3 - Moderate	Closed	Workstation	IO - Wintel Support	12/03/2024 19:00:02
INC0059017	03/03/2024 16:05:32	an error occurred in the processing of the policy sys_filesystemutilizationmonitor_winos . please check the following errors and take corrective actions. (opc3	3 - Moderate	Closed	Workstation	IO - Wintel Support	11/03/2024 14:00:00
INC0057448	20/02/2024 03:34:13	An error occurred in the processing of the policy Sys_FileSystemUtilizationMonitor_WinOS . Please check the following errors and take corrective actions. (OpC3	3 - Moderate	Closed	Workstation	IO - Wintel Support	27/02/2024 19:00:12
INC0055831	06/02/2024 07:05:23	an error occurred in the processing of the policy sys_filesystemutilizationmonitor_winos . please check the following errors and take corrective actions. (opc3	3 - Moderate	Closed	Workstation	IO - Wintel Support	14/02/2024 09:00:00
INC0055830	06/02/2024 07:05:20	an error occurred in the processing of the policy sys_filesystemutilizationmonitor_winos . please check the following errors and take corrective actions. (opc3	3 - Moderate	Closed	Workstation	IO - Wintel Support	14/02/2024 12:00:02
INC0037441	20/07/2023 01:20:42	An error occurred in the processing of the policy Sys_FileSystemUtilizationMonitor_WinOS . Please check the following errors and take corrective actions. (OpC3	3 - Moderate	Closed		IO - Monitoring alerts	27/07/2023 14:00:03

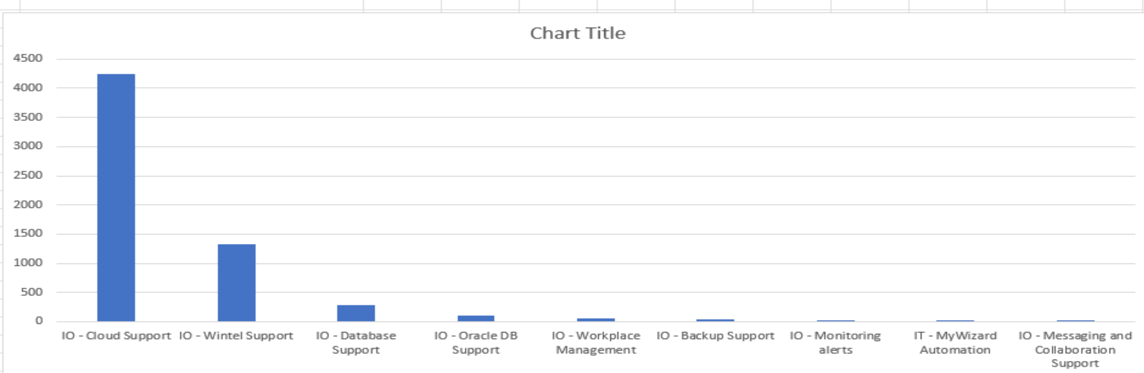
Source: Questionnaire output by Nikhil Sharma ©



Source: Questionnaire output by Nikhil Sharma ©

Data Analysis based on responses and categorisation based on asset types:

Assignment Group	Count
	6092
IO - Cloud Support	4243
IO - Wintel Support	1325
IO - Database Support	286
IO - Oracle DB Support	112
IO - Workplace Management	57
IO - Backup Support	33
IO - Monitoring alerts	18
IT - MyWizard Automation	15
IO - Messaging and Collaboration Support	3



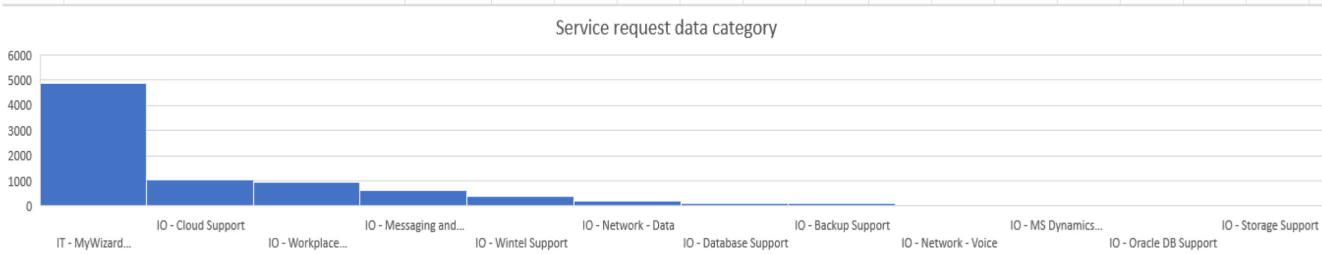
Questionnaire (sample snapshot) for Service requests:

Number	Item	Approval	Created	Quantity	Stage	Assignment gro	Short description
RITM0086670	AWS	Requested	11/04/2024 10:57:45	1	Complete	IO - Backup Support	AWS Workspace Reboot
RITM0095384	Restore request	Requested	28/05/2024 10:35:08	1	Waiting for Approval	IO - Backup Support	Sharepoint restore required
RITM0095244	IT General Request	Requested	27/05/2024 14:45:10	1	Fulfillment	IO - Backup Support	General Service Request
RITM0093623	IT General Request	Requested	17/05/2024 14:17:01	1	Complete	IO - Backup Support	General Service Request
RITM0093083	IT General Request	Requested	15/05/2024 13:20:16	1	Complete	IO - Backup Support	General Service Request
RITM0092592	IT General Request	Requested	13/05/2024 15:41:40	1	Complete	IO - Backup Support	General Service Request
RITM0091560	IT General Request	Requested	07/05/2024 13:50:11	1	Complete	IO - Backup Support	General Service Request
RITM0091556	IT General Request	Requested	07/05/2024 13:42:50	1	Complete	IO - Backup Support	Q2 restore FREPSAPPC11
RITM0091555	IT General Request	Requested	07/05/2024 13:41:02	1	Complete	IO - Backup Support	Q2 restore CASPSQL02
RITM0091554	IT General Request	Requested	07/05/2024 13:39:21	1	Complete	IO - Backup Support	Q2 restore Frepfix01
RITM0091552	IT General Request	Requested	07/05/2024 13:36:53	1	Complete	IO - Backup Support	Q2 restore DUNMBX01
RITM0091051	IT General Request	Requested	03/05/2024 16:53:19	1	Complete	IO - Backup Support	General Service Request
RITM0090926	IT General Request	Requested	03/05/2024 10:58:01	1	Complete	IO - Backup Support	General Service Request
RITM0089203	IT General Request	Requested	24/04/2024 13:20:14	1	Complete	IO - Backup Support	General Service Request
RITM0089069	IT General Request	Requested	24/04/2024 00:57:02	1	Complete	IO - Backup Support	General Service Request
RITM0088264	IT General Request	Requested	19/04/2024 18:05:34	1	Complete	IO - Backup Support	General Service Request
RITM0087525	IT General Request	Requested	16/04/2024 19:21:09	1	Complete	IO - Backup Support	General Service Request

Source: Questionnaire output by Nikhil Sharma ©

Data Analysis based on responses and categorisation based on asset types:

		8384
Group	Resolver Group	Ticket Count
Infra	IT - MyWizard Automation	4864
Infra	IO - Cloud Support	1049
Infra	IO - Workplace Management	945
Infra	IO - Messaging and Collaboration Support	628
Infra	IO - Wintel Support	370
Infra	IO - Network - Data	206
Infra	IO - Database Support	129
Infra	IO - Backup Support	112
Infra	IO - Network - Voice	49
Infra	IO - MS Dynamics D365	26
Infra	IO - Oracle DB Support	3
Infra	IO - Storage Support	3



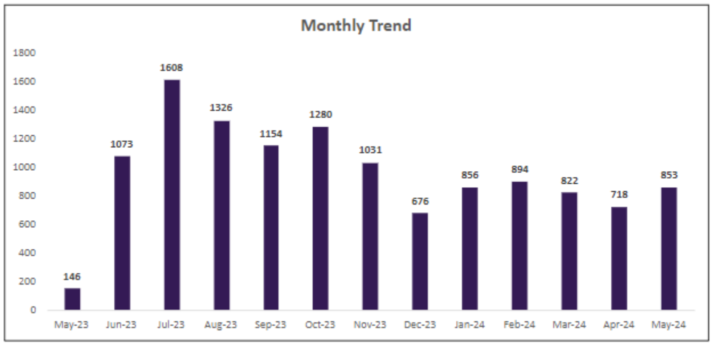
Source: Questionnaire output by Nikhil Sharma ©

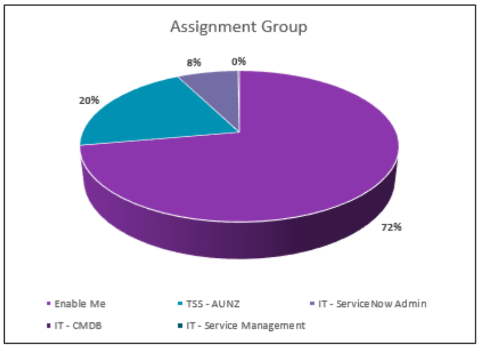
Incident Ticket Analysis

Pattern Name	Ticket Count	Potential Automation candidates	Potential Automation %
network issue	1161	464	8%
Access Issue	793	397	7%
Account Unlock/Pwd Reset	397	318	5%
Laptop Issue	343	137	2%
deloitte Integration related Tickets **	322	32	1%
VPN Issue	237	71	1%
Office apps	192	77	1%
Printer Issue	178	71	1%
Login Issue	175	70	1%
MFA issue	156	62	1%
Email Issue	241	121	2%
wifi	87	44	1%
Total	**4282**	**1863**	**31%**

Source: Questionnaire output by Nikhil Sharma ©

SR Tickets





Key Observations:

- Resolution date/time not available
- High variation in monthly SR volume
- 30% of tickets has generic description

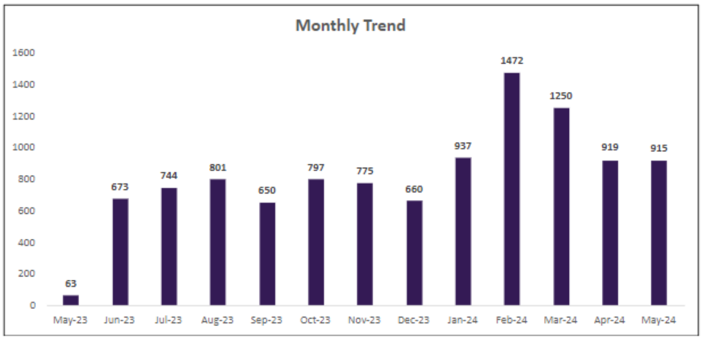
Source: Questionnaire output by Nikhil Sharma ©

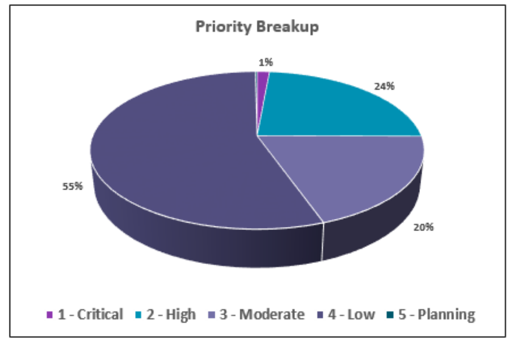
SR Ticket Analysis

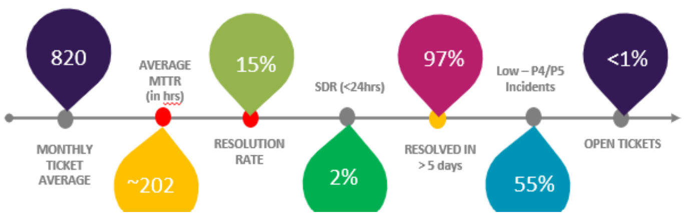
Pattern Name	Ticket Count	Potential Automation Candidates	Potential Automation %
Access Issue	1966	786	6%
User Add/Del Request	1639	983	8%
Distribution List	1470	882	7%
Software Request	531	212	2%
Account Unlock/Password Reset	207	145	1%
Servicenow related	204	41	1%
Account Request	200	80	1%
mobile related**	122	12	1%
Create/Delete Mailbox	100	50	1%
Total	**6439**	**3192**	**28%**

Source: Questionnaire output by Nikhil Sharma ©

Data Centre - Incident Tickets







Key Observations:

- 97% of incidents are resolved > 5days
- High MTTR of ~202hrs
- High variation in monthly incident volume

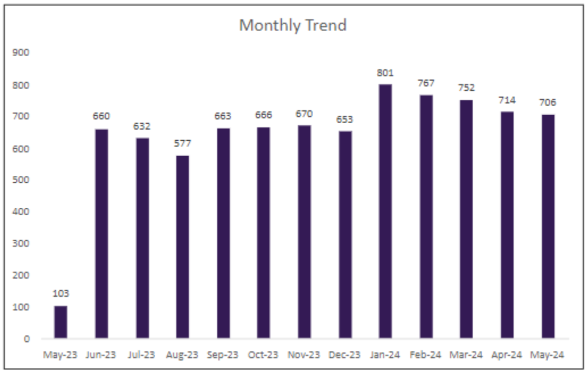
Source: Questionnaire output by Nikhil Sharma ©

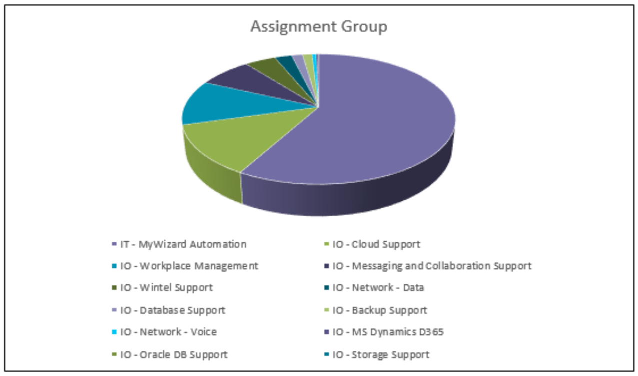
DC - Incident Ticket Analysis

Pattern	Ticket Count	Potential Automation candidates	Potential Automation %
multi alerts	1739	783	7%
high utilization	1107	554	5%
connectivity alerts	925	370	3%
threshold alert	916	366	3%
Node Down	685	171	2%
agent health alerts	544	163	2%
Memory Utilization	383	172	2%
service start-stop	317	127	1%
Access Issue	317	95	1%
mailbox issues	258	65	1%
DB Issue	217	54	1%
Backup Issues	201	60	1%
Server Down	192	58	1%
Interface Down	189	66	1%
tablespace issue	127	38	1%
Total	**10042**	**3142**	**30%**

Source: Questionnaire output by Nikhil Sharma ©

DC - SR Tickets





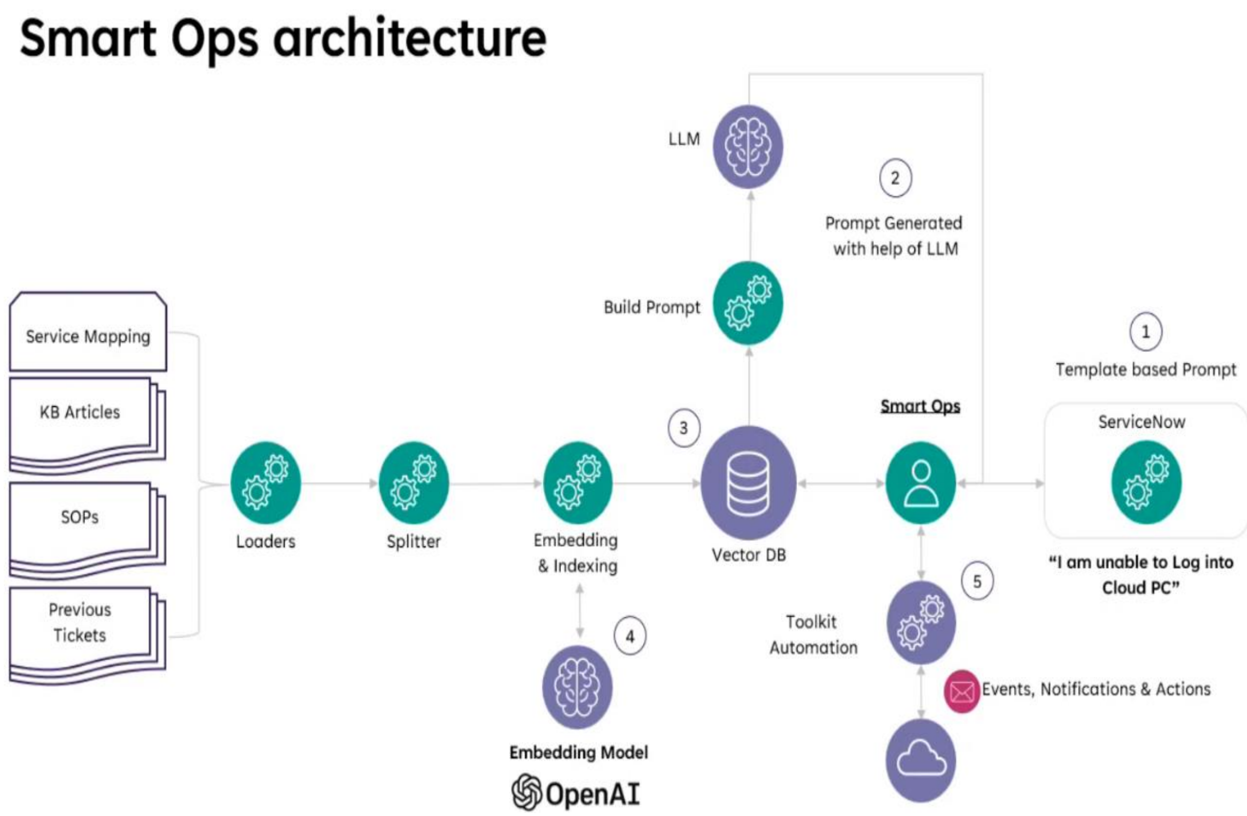
Key Observations:

- Resolution date/time not available
- 58% of ticket resolution is automated
- 20% of tickets has generic description

Source: Questionnaire output by Nikhil Sharma ©

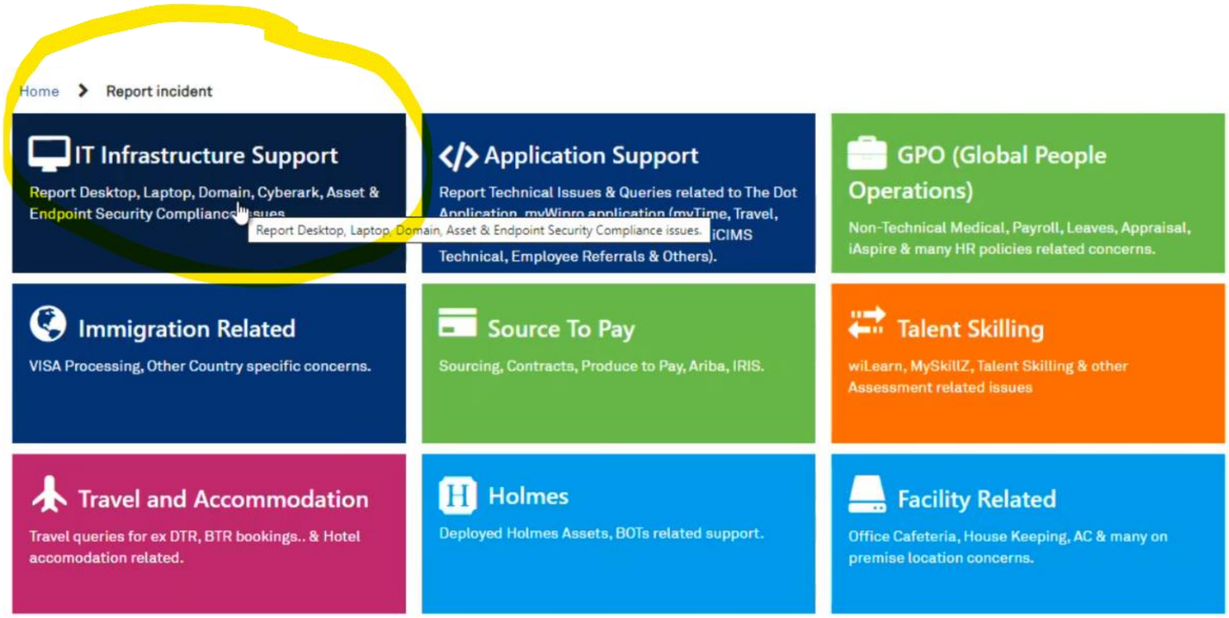
DC – SR Ticket Analysis

Pattern Name	Ticket Count	Potential Automation Candidates	Potential Automation %
Access Issue	1966	786	6%
User Add/Del Request	1639	983	8%
Distribution List	1470	882	7%
Software Request	531	212	2%
Account Unlock/Password Reset	207	145	1%
Servicenow related	204	41	1%
Account Request	200	80	1%
mobile related**	122	12	1%
Create/Delete Mailbox	100	50	1%
Total	**6439**	**3192**	**28%**



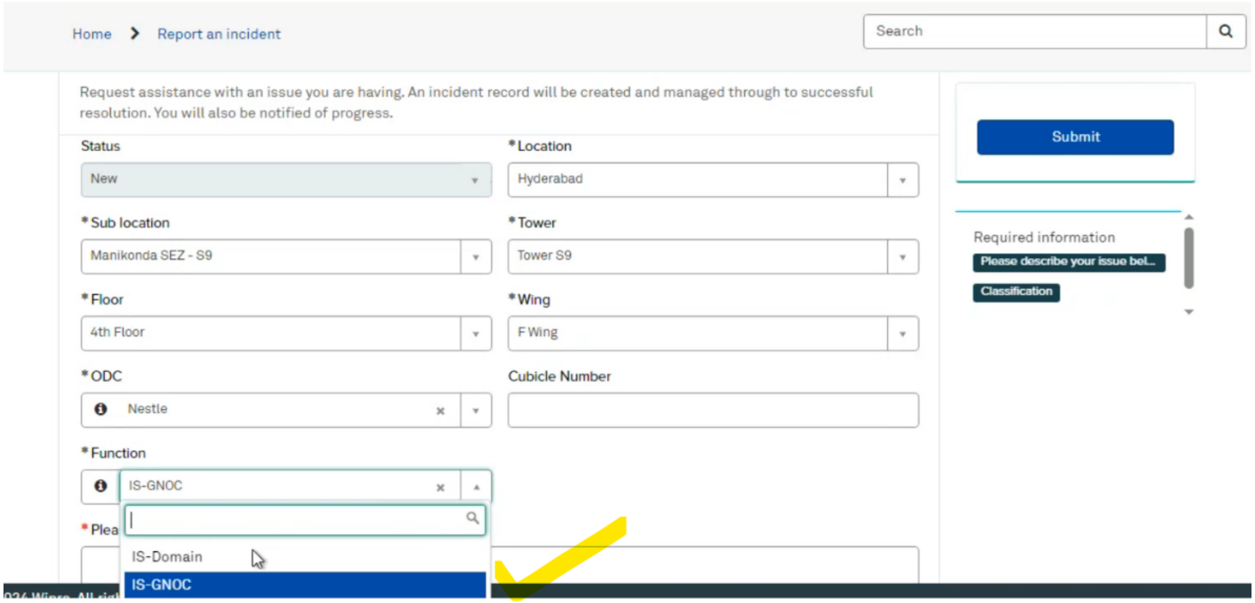
Source: Questionnaire model by Nikhil Sharma ©

Data is processed within and from IT Service Management toolset

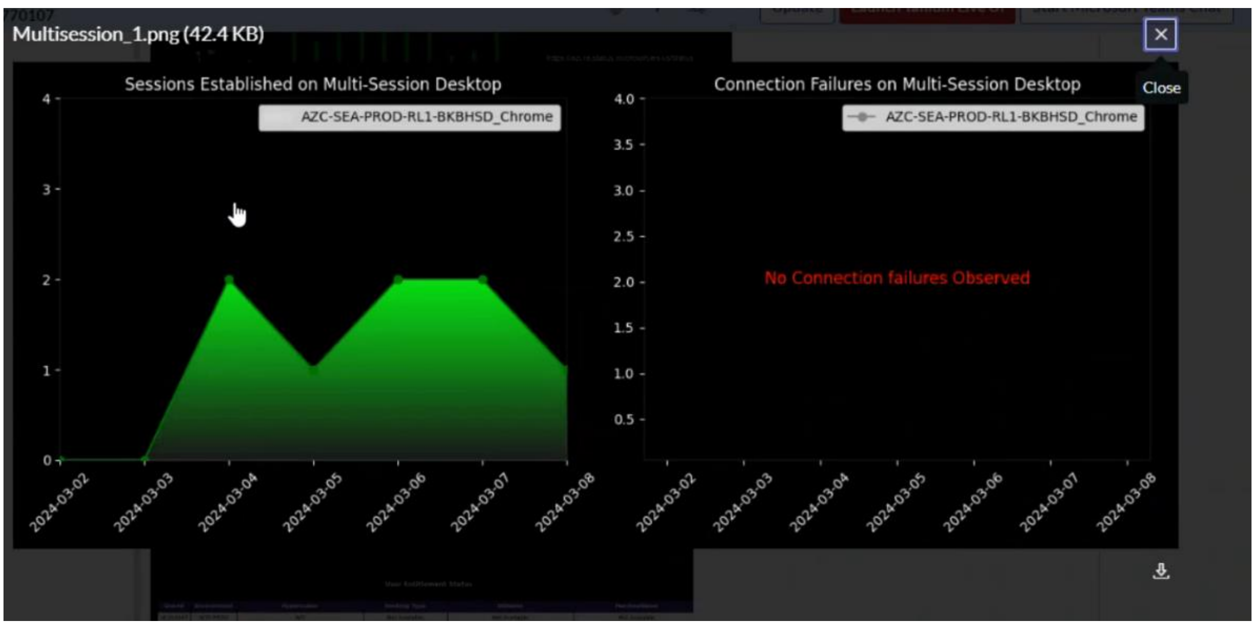


Infrastructure Configuration item is processed within IT Service Management toolset

IT Service Management ticket recording within IT Service Management toolset

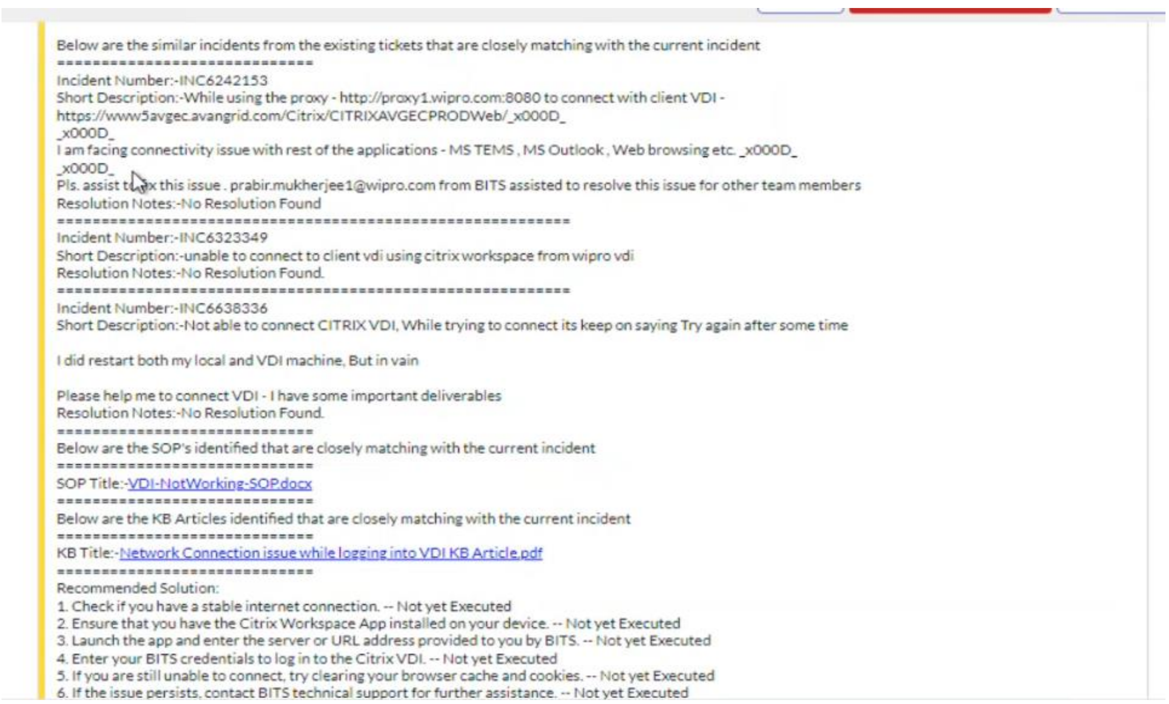


Smartops enabled deep dive through LLM layering of each Incident



Example of Citrix VDI Smartops enabled automation.

Deep technical automation through LLM built.

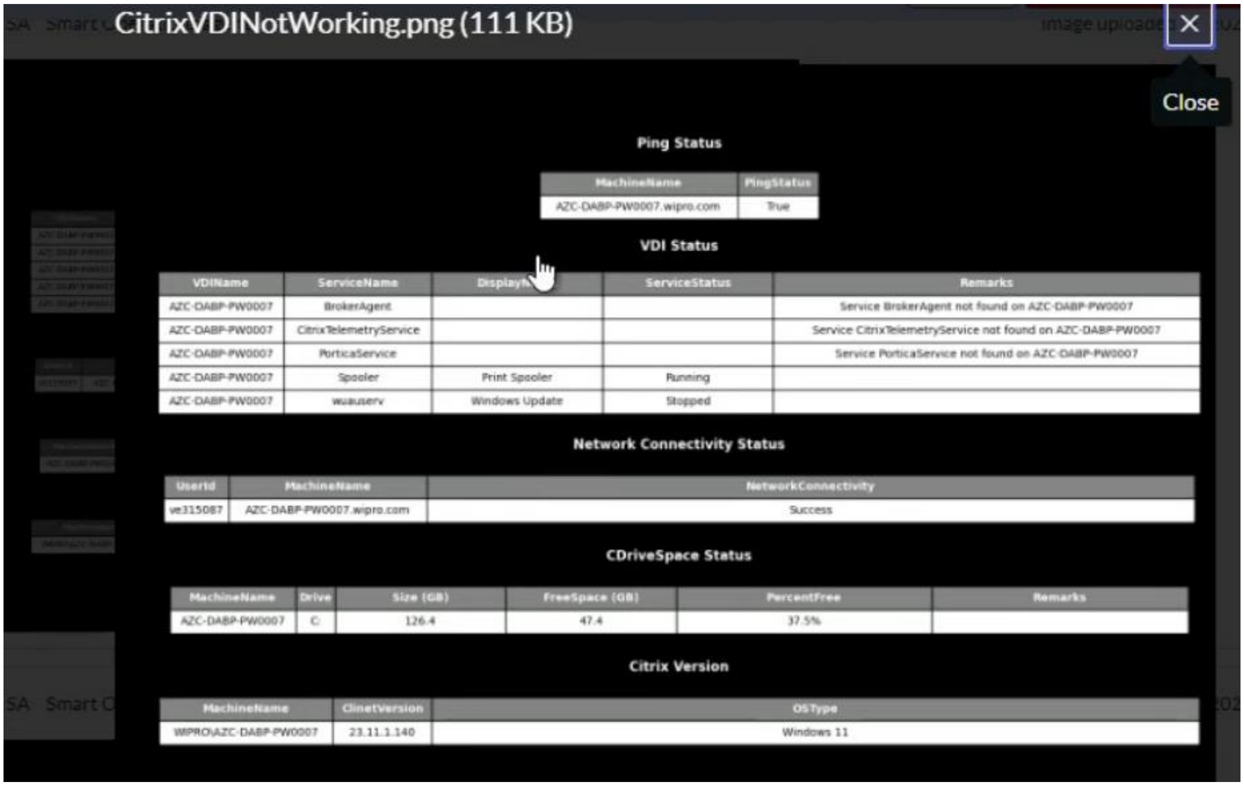


Below are the similar incidents from the existing tickets that are closely matching with the current incident
==============================
Incident Number:-INC6242153
Short Description:-While using the proxy - http://proxy1.wipro.com:8080 to connect with client VDI -
https://www5avgec.avangrid.com/Citrix/CITRIXAVGECPRODWeb/_x000D_
_x000D_
I am facing connectivity issue with rest of the applications - MS TEMS , MS Outlook , Web browsing etc. _x000D_
_x000D_
Pls. assist to fix this issue . prabir.mukherjee1@wipro.com from BITS assisted to resolve this issue for other team members
Resolution Notes:-No Resolution Found
==
Incident Number:-INC6323349
Short Description:-unable to connect to client vdi using citrix workspace from wipro vdi
Resolution Notes:-No Resolution Found.
==
Incident Number:-INC6638336
Short Description:-Not able to connect CITRIX VDI, While trying to connect its keep on saying Try again after some time

I did restart both my local and VDI machine, But in vain

Please help me to connect VDI - I have some important deliverables
Resolution Notes:-No Resolution Found.
==============================
Below are the SOP's identified that are closely matching with the current incident
==============================
SOP Title:-VDI-NotWorking-SOP.docx
==============================
Below are the KB Articles identified that are closely matching with the current incident
==============================
KB Title:-Network Connection issue while logging into VDI KB Article.pdf
==============================
Recommended Solution:
1. Check if you have a stable internet connection. -- Not yet Executed
2. Ensure that you have the Citrix Workspace App installed on your device. -- Not yet Executed
3. Launch the app and enter the server or URL address provided to you by BITS. -- Not yet Executed
4. Enter your BITS credentials to log in to the Citrix VDI. -- Not yet Executed
5. If you are still unable to connect, try clearing your browser cache and cookies. -- Not yet Executed
6. If the issue persists, contact BITS technical support for further assistance. -- Not yet Executed

Example of Citrix VDI not working and enablement of traces by Smartops



Staged model creation for Causal Analysis workflow with Smartops

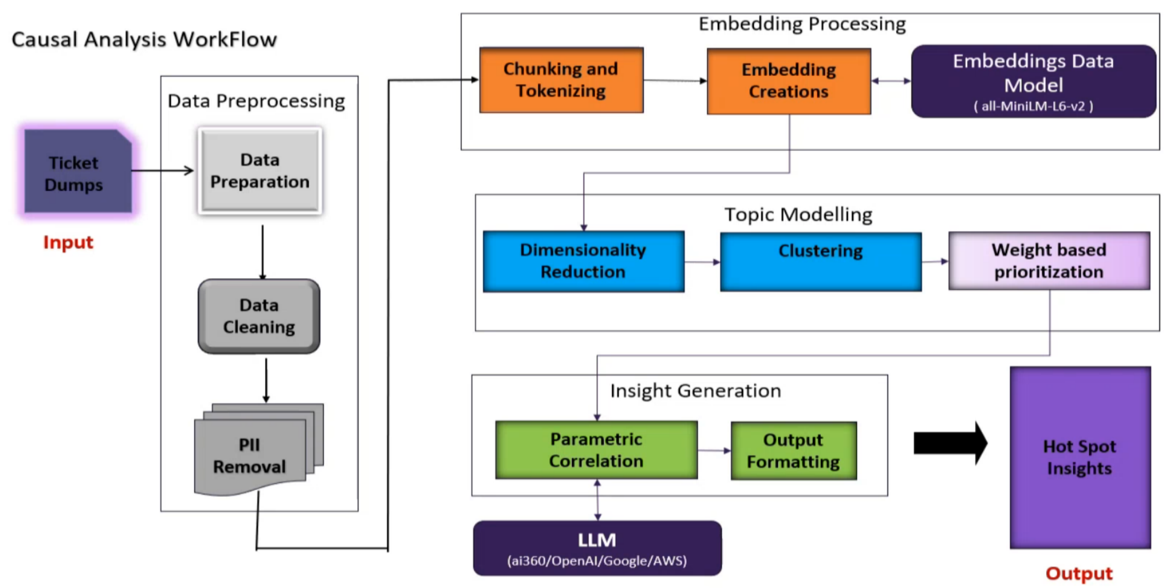
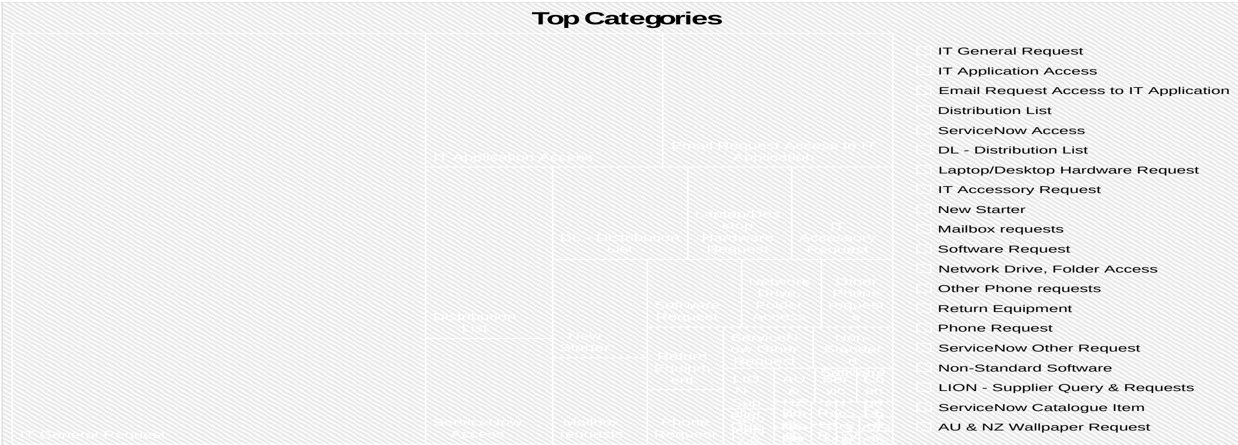
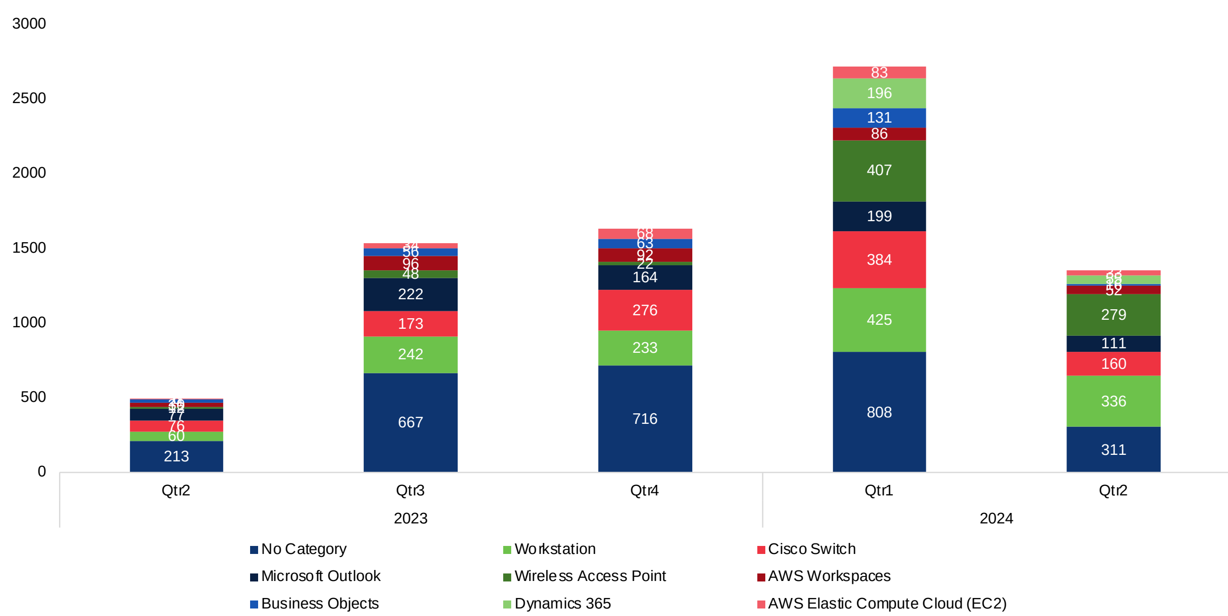


Table 3. 7:IT Smart Causal Analysis Capabilities



Source: Questionnaire output by Nikhil Sharma ©

Table 3. 8:Agility



Source: Questionnaire output by Nikhil Sharma ©

Table 3. 9:Robustness

	Assignment Group														
Ticket Pattern	IO - Backup Support	IO - Citrix Support	IO - Cloud Support	IO - Database Support	IO - Messaging and Collaboration Support	IO - Monitoring alerts	IO - MS Dynamics D365	IO - Network - Data	IO - Network - Voice	IO - Oracle DB Support	IO - Storage Support	IO - Wintel Support	IO - Workplace Management	IT - MyWizard Automation	Grand Total
multi alerts	152		244	3	4	154	2	697		61	47	374	1		1739
high utilization	76		73	4		208		660		1		85			1107
connectivity alerts	84	2	450									388	1		925
threshold alert			588	4		71		44				209			916
Uncategorised			290					98					386		774
Node Down	6		4			1		623	8		41	2			685
agent health alerts	5		55	1	1	263				1		218			544
security					493										493
nw hardware					2			441			1		6		450
Memory Utilization			360			1		6	13			3			383
service start-stop	1		36	183	17		1				29	49	1		317
Access Issue	2	2	58	3	39		33	19				19	142		317
mailbox issues					258										258
DB Issue				126						91					217
apps							208								208
Backup Failure	64		16	90	3	21				5		2			201
Server Down	1		109	56								26			192
Interface Down								187	2						189
tablespace							1			126					127

Source: Questionnaire output by Nikhil Sharma ©

Table 3. 10:IT Chain Performance

IT Chain Performance– adapted from Ponomarov 2012					
Inconsistent **Consistent**					
1. The time it takes for our goods to reach our most important clients.	1	2	3	4	5
2. Duration of output in accordance with a predetermined timetable.	1	2	3	4	5
3. Catering to the day-to-day requirements of significant clients.	1	2	3	4	5
4. Keeping customer delivery dates as promised.	1	2	3	4	5
5. Consistently delivering the required amount of product.	1	2	3	4	5

Source: Questionnaire development by Nikhil Sharma ©

CHAPTER IV: RESULTS

4.1 RESULTS

The chapter to follow is one for the conduct of a detailed analysis of the data gathered in a way that is true to predetermined goals. This study is geared towards the impacts of the Covid 19 pandemic on the international IT chain, with the primary focus on the manufacturing sector. Pandemic has demonstrated the existence of weaknesses within the IT system, among other things, the critical role of resilience to tackle this issue. While we move into a post COVID-19 era IT chain strategies being used to create resiliency is an area that can't be neglected.

By utilizing statistical methods and analysis, we examine the effectiveness of different tactics within manufacturing to strengthen the resilience of IT chains. These components (i.e inventory management, supplier diversity, digitalization and agility) are closely analyzed to reveal their influence on efficiency. Utilization of comprehensive empirical analyses which involves surveys we intend to improve the IT chain strategies that would help to diminish risks and realize the resilience.

In 2024, tech companies that invested heavily in Generative AI (GenAI) will be under pressure to prove that they can make money off their products. To do this, AI giants Google and OpenAI are betting big on going small: both are developing user-friendly platforms that allow people to customize powerful language models and make their own mini chatbots that cater to their specific needs – no coding skills required. Both have launched web-based tools that allow anyone to become a generative-AI app developer as per the MIT Technology review.

In the coming months and years, GenAI might actually become useful for the regular, non-tech person, and we are going to see more people tinkering with a million little AI models. State-of-the-art AI models which are multimodal, meaning they can process not only text but images and even videos. This new capability could unlock a whole bunch of new apps. For example, a real estate agent can upload text from previous listings, fine-tune a powerful model to generate similar text with just a click of a button, upload videos and photos of new listings, and simply ask the customized AI model to generate a description of the property.

But of course, the success of this plan hinges on whether these models work reliably. Language models often make stuff up, and generative models are riddled with biases. They can also be easier to hack, especially if they are allowed to browse the web. Tech companies have not solved any of these problems. When the novelty wears off, they will have to offer their customers ways to deal with these problems. There is a growing need for digital transformation in the Banking and Financial Industry (BFSI) industry, with an emphasis on efficiency, transparency, security, and employee experience.

The key tenets of Banking 4.0 will cater to the dynamic digital workplace environment, offering better visibility of business needs, more efficient IT chain management, and modular and flexible persona-mapped service designs. The redesigned digital workplace portfolio for BFSI organizations will enable firms to re balance cost, risk, and productivity impacts in the future of work. Energy organizations facing market volatility, digital disruptions, and global economic shifts can rely on organizations oil and gas business solutions to deliver innovative new ways of operating. As energy companies seek to reshape their businesses, our industry and technology experts lead the digital transformations needed to integrate previously siloed data and adopt cloud platforms and cloud-native capabilities. We help companies accelerate the delivery of business value through agile product and service models that streamline operations, improve efficiency, and lead to greater productivity and reliability. With these models in place, we can enable energy enterprises to stay competitive and resilient in a dynamic industry by unifying data from disparate systems, unlocking new operational insights, and managing complex technology landscapes. Leveraging our oil and gas consultancy services, our global teams deliver oil and gas IT solutions that result in modernized industry processes and seamless user experiences while helping build a sustainable future.

Companies modernized the legacy APM solution by upgrading it to a web-based platform on AWS cloud. This migration leveraged a DevOps model, automation, cloud-native services and continuous integration/continuous delivery (CI/CD) to ensure a swift implementation. The upgraded web-based solution gave business a more modern cloud-based architecture, with enhanced features that were more intuitive, faster, and free of performance issues.

Organizations also standardized the business workflow for integrity and reliability modules within the APM solution, enabling business to optimize efforts and cost for reliability and integrity management. Meanwhile, the use of predictive technologies improved the overall reliability of assets and increased plant availability.

With a standardized workflow, business realized smoother operations, increased efficiency, and more effective collaboration across its business. In addition, moving to a cloud infrastructure improved performance by offering 80% faster calculations and analysis through risk-based inspection/thickness monitoring. The new APM solution also boosted reliability by minimizing asset downtime. Business achieved its cost-savings objectives in several areas. Standardized work processes across all sites enabled business to achieve an overall 20% cost reduction, while migrating the infrastructure to cloud led to a 30% reduction in IT infrastructure costs. And with automation and CI/CD implementation, the solution enabled IT support cost savings of 20%.

The oil and gas industry has driven significant digital disruption and reinvention in recent years. The industry had no choice. Catalysts for this change have included the race to decarbonize, the evolution of the value chain to enable lower-carbon energy products, the need to drive deeper efficiency in assets and operations, the need for talent to manage distributed capital assets, and more. Companies have shifted significant momentum into cloud adoption, portfolio rationalization, cloud-native solutions, and edge technologies. They have even pursued disruptive hardware technologies: new age marine vibrators that prevent potential disruptions to the natural patterns of marine life during seismic imaging, advanced remote-operated underwater vehicles, and nanoparticles in drilling fluids and well cementing.

As energy businesses shift to the promise of artificial intelligence, many have laid significant groundwork for AI – through data governance, confidence, stewardship, and ingestion into data platforms, and also through business representatives taking on product owner roles, as they shape the future of solutions and portfolios. Mindsets have shifted to embrace new ways of working and there is an intense focus on data-driven and autonomous operations.

Companies are increasingly focused on developing robust and reliable AI muscle to help them make better decisions, face fewer equipment or operations failures, move products efficiently along greener paths, bring enhanced experiences to B2C and B2B customers, and attract early-career talent. With the arrival of GenAI, the interest in AI has increased exponentially. The good news is that the universe of possible Generative AI use cases in the energy sector is significant. The challenge is that the GenAI innovation curve will be faster than any previous technology innovation, and an enterprise that falters is at risk of being left behind. An organized approach can enable an accelerated and well-defined AI strategy.

AI will impact the entire industry, from exploratory upstream use cases to customer-facing scenarios in energy retail. AI will unlock efficiencies that pave the way to new, less carbon-intensive business models, and GenAI will play a growing role in the sector's AI programs. GenAI can analyze large volumes of data from sources such as seismic surveys, well logs, and production logs to identify patterns, anomalies, and correlations. GenAI models can play a role in improving production, modeling reservoirs, and spurring higher-quality decision-making. GenAI will play a critical role in the asset lifecycle, analyzing sensor data and historical maintenance records to predict equipment failures and recommend proactive maintenance actions to boost operational efficiency, reduce downtime, enable a lower carbon intensity, and improve safety. GenAI could also generate personalized promotional content while a customer is at a retail forecourt.

This impact is not just theoretical. One energy company, to pick an example, recently leveraged GenAI to re-envision procurement, achieving capabilities such as intelligent GenAI-enabled supplier recommendations, 360-degree views of supplier bids, and a digital scope-of-work builder.

Vetting GenAI Feasibility, AI investment decisions must balance potential impact with an informed sense of real-world feasibility. For oil and gas companies, this means that there is no single list of ideal use cases that are fit for an GenAI solution. Instead, the most advantageous use cases will be intimately tied to the company's strategic intent and their preexisting data ecosystem. While the potential impact of GenAI on the energy industry is undeniable, energy enterprises also need to consider feasibility across the following dimensions:

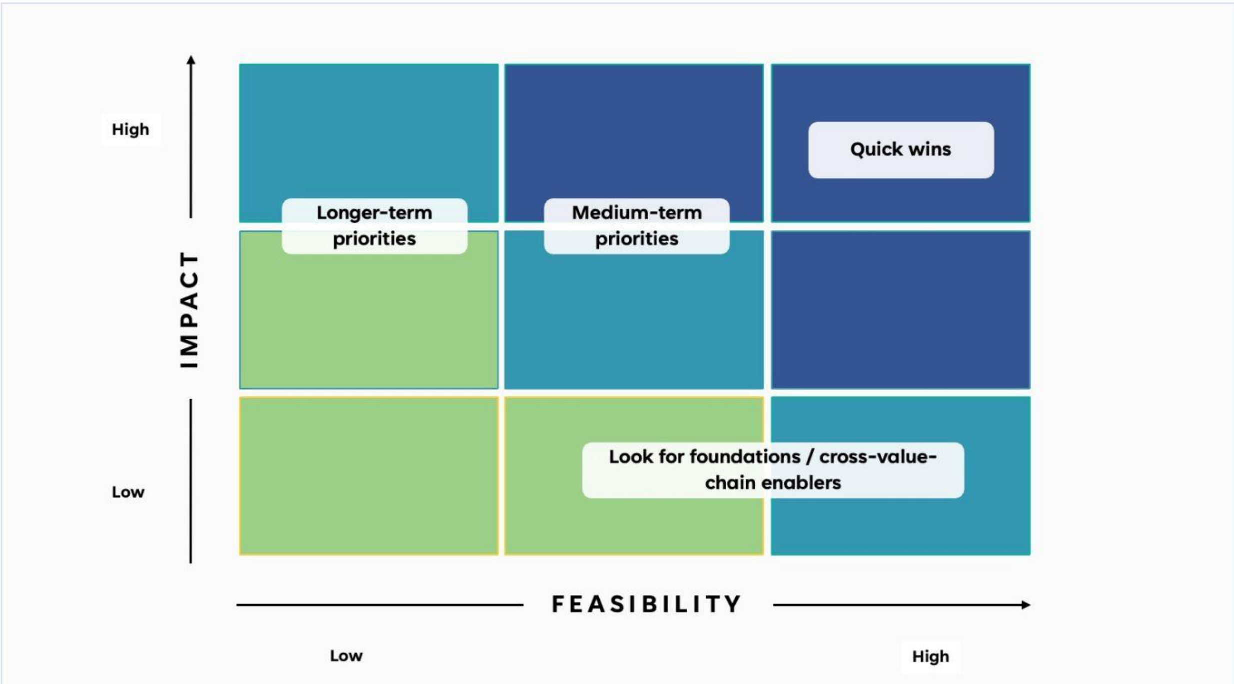
Technical maturity and feasibility: Is GenAI mature enough for this use case? Is a large language model (LLM) approach relevant? Do we require a deterministic or stochastic result?

Data feasibility, are the data sources of high integrity? Is the data correctible? Are the data sources and corrections highly trusted? User acceptance feasibility, Is the role of the user service-focused or techno-functional? Does the user community readily embrace digital solutions? Is the user community averse to business risk, or can they be compelled to trust an AI solution over time?

Risk of adoption, given the risks in day-to-day operations (to life, health, safety, and the environment), what risk is added by false or hallucinated GenAI results? This question can underpin a reticence to move forward with an AI strategy. That said, given the massive growth of data volumes and data types in today's energy businesses, an alternate question is: What risks are we incurring by not using GenAI to rapidly reveal hazards, to identify pending failures, to recognize problematic trends, or to solve problems that are not easily handled by traditional surveillance and monitoring capabilities? Both angles should be considered.

By carefully evaluating use cases across these parameters through scoring, companies can create a GenAI roadmap, prioritize the most impactful yet feasible GenAI "quick wins," build in risk-reduction strategies, and begin to pursue their AI-driven future.

Feasibility vs. Impact: A GenAI Use Case Selection and Development Roadmap



Source: Source output by Nikhil Sharma ©

Extracting Value from GenAI, Generative AI interventions are expected to drive rapid and noticeable impact across the value chain. In upstream exploration, data augmentation and enrichment by domain-specific LLMs will reduce both the cost of seismic data acquisition and the associated processing time, maintaining resolution and quality. GenAI-enabled seismic imaging, model building, and interpretations will yield better decisions about resource development and ease the cost of monitoring, measurement, and verification planning to demonstrate the migration of CO_2 plumes in carbon capture and storage (CCS).

In assets like plants, facilities, vehicles, and pipelines, AI has already been a game-changer for asset health, advancing predictive and prescriptive approaches that go far beyond traditional reliability-centered maintenance. With the arrival of GenAI, asset-centric LLMs will not only contribute to predicting asset health but will also define rapidly curated prescriptive responses and operating procedures for taking corrective or preventive action on equipment.

In energy retail, GenAI will advance demand analysis and dynamic pricing. By analyzing demand triggers with a precision that far surpasses traditional demand forecasting models, AI will ensure optimum inventory levels in the IT chain network. Meanwhile, algorithm-driven pricing strategies will continue to improve, advancing downstream profitability.

For decarbonization efforts, energy businesses can tap numerous data sources including satellite imagery, emissions data, climate data, and regulatory guidelines, leveraging Generative AI to assess or forecast impacts to air quality or water resources given regulatory parameters.

Across the entire value chain, AI will also drive new knowledge management capabilities. The industry's changing workforce is a well-understood pain point. GenAI tools and platforms are becoming increasingly sophisticated at delivering targeted knowledge. These tools will accelerate the learning curve for early-stage industry talent, translating mass amounts of documentation and standard operating procedures (SOPs) into clear directives and insights. This capability will be key to simplifying the many new processes that will be required to manage the increasingly distributed nature of energy systems.

The Critical Imperative, Matching the Speed of AI, With GenAI, the era of a two-to-three-year R&D and product development cycle and static analysis is being left behind. Two years ago, there were zero powerful and publicly available LLMs. Now there are at least 25. What seems like a far-off GenAI solution may be a "quick win" in six to nine months. The methodology for analyzing and evaluating GenAI use cases needs to keep pace with GenAI itself.

To keep pace, energy companies need dynamic assessments that map GenAI solutions into existing use cases. The only way to vet feasibility in real time is to build deep internal GenAI capabilities. We are well aware that GenAI is also disrupting our own industry — which is why we are investing heavily in embedding GenAI into our service delivery model.

While there are clearly very real risks related to GenAI, we believe the most dangerous risk is falling behind the innovation curve. The energy companies that are most prepared to work with the GenAI revolution – rather than be displaced by it – will find new opportunities for achieving cost takeout, unlocking capital that can be redeployed to emerging strategic opportunities, and attracting and cultivating talent pools that can confidently navigate the continuing energy transition.

Similarly, our investigations automatically evaluate the changing flow of platform that emerge to tackle the coming obstacles. We plan to achieve this through a comprehensive examination our results that will give consumer and mining organizations practical recommendations for actions through our findings. The analysis will allow them to have the capacity to build up the IT chain of their companies from perspective.

Comprehending the significance of IT chain resiliency and strategic management is crucial for those businesses that operate in the times of uncertainty. In the process of major changes and transformations of the global economy communication and resilient IT chain strategies are of paramount importance for organizations in order to keep their success and prosper at the market level.

CHAPTER V: DISCUSSION

5.1. DISCUSSION OF RESULTS

There is an immediate need for more resilience and flexibility in global IT platform chains in light of the GenAI tools such as Smart Causal Analysis and SmartOps within the consumer and mining sectors. The study emphasizes the importance of addressing the impact of IT-OT convergence risks before they materialize and maintaining superior performance in a world that increasingly poses consolidation challenges. It provides a systematic approach to diagnosing and resolving IT issues, ensuring that technology supports business goals effectively around the globe. The outcomes proved to be quite helpful in understanding these strategies and indicated the increasing need for a strategic approach to IT Service management in the mining chain to maintain high performance over time, given the current global context. Through this study our outcome is to the research aims to analyze the impact of mining chain resilience on operational performance, focusing on identifying the most critical issues first, enabling engineers to focus on resolving the most impactful problems, such as ERP connectors and open-source file systems. This leads to a significant reduction in incidents and improved service uptime. The research provides guidelines that mining firms can use to strengthen their IT Service Management tool chain and prepare for potential disruptions, enhancing user experience and improving platform stability. We have also examined the relationship between resilience and operational performance, encompassing smart causal analysis solutions that analyze historical data using specialized correlation and clustering techniques to detect patterns and pinpoint common sources of performance problems. The outcomes of the study provide guidance on diagnosing and resolving IT issues, ensuring that technology supports business goals effectively around the globe.

Management tools and platform approaches used during and after the IT-OT integration to increase mining resilience. It extends a wide-ranging literature review to identify how several elements, including digital technology applications, risk management, and mining chain flexibility, have been used to manage disruption and sustain business operations. Examined SmartOps approach to delivering best-in-class managed services by integrating Infrastructure, Network, Application, and

Cloud operations teams through a unified SmartOps layer. This integration enables the embedding and scaling of innovation across services, transitioning from point automation to holistic end-to-end automation. Disruptions of this scale hit these IT platform chains in early 2020 with the introduction of GenAI. These networks include interdependent businesses, suppliers, and service providers from all around the world. Companies need to reevaluate and improve their strategy to make sure they can handle future interruptions; the epidemic highlighted how vulnerable many platform networks are.

Shorter product life cycles, rising demand for creative and customisable solutions, and the volatility of global markets are driving forces that are putting complex IT platform chains more susceptible to uncertainty and risks, all of these things make it harder to predict and meet consumer demand, end-to-end employee experience platform that offers persona-aligned, proactive support to employees by leveraging artificial intelligence, machine learning, and advanced analytics. It improves the user experience by tracking real-time sentiments and work/behavior patterns. The platform also includes a rich data lake and a catalogue of service modules with built-in evergreening and the possibility for future expansion to device IT experience is designed to provide a modern, collaborative, and digitally enabled solution for the workplace. We use user and site persona analyses and analytics from Digital Experience Management tools to contextualize Service Desk support and design our services using a Service Design approach. Research has observed a trend in employees and customer's preference is to use the channel that they feel most comfortable with and mimics their personal preference. Our Service Desk strategy is to enable all the channels by leveraging channel specific solutions. We provide service on the channels preferred by employees for the best experience and cost optimization. Most of the channel is transformed by leveraging the proven Generative AI technologies to support the Chat and Voice channels. We identify pain points and areas for improvement through the Employee Journey and leverage the latest Chat BOT, Voice BOT, Self-Service portal, Mobile App, and Self-Healing technologies, as well as traditional channels like phone, email, and chat, to make Service Desk access easy and convenient. The financial benefits of global sourcing and outsourcing aren't without the danger of disruptions, however. The pandemic has highlighted the need to reassess key IT platform chain design decisions in light of these vulnerabilities. These options include lean operations, global sourcing, and just-in-time delivery.

Disruptions to the IT platform chain may have far-reaching consequences due to the increasing importance of firms' commerce in intermediate commodities. SmartOps solution comprises of L1.5 team for Standard Operating Procedure/Known Error Data Base based resolution of tickets resulting in improved MTTR/FLR. The team leverages Automation use cases driven by framework and independent automation PODs implement eligible automation use cases. The Smart Operations layer will support more than 50% tickets through a combination of SOP-based support, observability, and auto remediation. SmartOps Layer is a digital command center that will field second level support for application issues escalated by Service Desk and will perform various request based, schedule based and on demand activities through standard operating procedures. We will achieve over 50% of tickets resolved in this layer aided by full scale observability, automation of repeated tasks and shifting left of the tasks. SmartOps will adopt process view for the estate to support and achieve service delivery excellence of critical business processes. Dedicated Automation CoE will be set up to identify key automation opportunities along with implementation plan. Automation initiatives will be implemented in agile manner and scaled across the enterprise, when benefits overweigh significantly. We will leverage existing tools and adopt integrated tools architecture to implement full scale observability, predictive AIOps for self-heal. Business Experience Enrichment (BEE) Model – Real-time, AI-powered business insights using data from user experience and application performance monitoring. We will devise persona-based application support use cases and achieve enhanced experience of IT, Operations and Business stake holders. To drive efficiency across the delivery services and Change operations, we have proposed a journey towards a new delivery model which will enable.

To conquer these obstacles, one must take measures to strengthen the IT platform chain, anticipate and analyse any disruptions, and apply these experiences to improve future operations. The capacity to foresee, react to, and recover from interruptions in a reasonable amount of time and at a reasonable cost, while keeping operations constant, is what defines a resilient tools chain.

To construct a robust IT Service Management platform chain, it is essential to be flexible in the following areas: sourcing, manufacturing, logistics, and distribution. Minimising risks associated with IT, manufacturing, and delivery requires attaining an appropriate degree of flexibility along these dimensions. But businesses need to figure out how much wiggle room they need according to their own operating situations. To overcome this challenge and enable efficient data exchange, new relationships need to be formed and an environment of trust and cooperation must be nurtured among IT chain players.

Creating a robust IT chain design requires finding a middle ground between being efficient and being resilient. A comprehensive assessment of supplier risk exposure and the creation of backup IT platform plans are necessary for this. As a result of the pandemic's lessons learnt, businesses have strengthened and adjusted their IT networks. Building a worldwide IT chain system that can better handle future issues is the end aim.

The study concludes that IT platform chain resilience is of the utmost significance, particularly for the consumer and mining sector. In this chapter, we review the study's main points and draw conclusions about how IT Service Management chain tactics might help build resilience.

An outline of the thesis's structure is provided at the beginning of the chapter, which summarises the ways in which digital technologies enhance IT chain resilience. Following a comparison of the with and without Smartops scenarios, the report summarises the key takeaways from the data analysis and hypothesis testing. It emphasises the substantial influence of digital technologies like the IoT, big data, and cloud computing on strengthening IT Service Management chain resilience. In its last section, the chapter suggests avenues for future research and highlights topics that require more study. To encourage more research into the relationship between digital technologies and IT Service Management chain resilience, the authors provide room for future studies to build upon the current one by addressing open issues and suggesting new areas of investigation.

The last chapter provides a thorough review of the study's results, including their theoretical significance, practical applications, and potential avenues for further investigation. The report is a great resource for academics and business leaders alike who are trying to fortify IT OT Service Management chains against the world's ever-changing and unpredictable climate.

Comparison of Trends

Smart Operations (SmartOps) helps organizations by leveraging automation, observability, and advanced operational practices to enhance efficiency, reduce costs, and improve overall performance.

Here are some key benefits:

1. Automation and Efficiency: Smart Ops utilizes automation use cases driven by frameworks like MEIR and independent automation PODs to implement eligible automation use cases. This helps in automating routine tasks, reducing manual effort, and increasing operational.
2. Observability: Observability platform solution provides performance traceability across core application performance monitoring, network monitoring, log analytics, event correlation, and remediation. This end-to-end AIOps-driven observability platform enables business process monitoring and visibility, ensuring a comprehensive view of operations.
3. Incident Management and Resiliency: The introduction of Site Reliability Engineering (SRE) practices focuses on resolving critical incidents and providing emergency responses to mission-critical applications. SRE experts manage toil by automating tasks such as application availability monitoring and routine checks, thereby improving resiliency and reliability.
4. Cost Reduction and Productivity Improvement: Smart Ops can lead to significant cost reductions and productivity improvements. For example, in various industries, Smart Ops has resulted in up to 50% cost reduction, 20% reduction in tickets, and 50% productivity improvement.
5. Proactive Monitoring: Smart Ops applies proactive, preventive, and predictive monitoring to ensure 100% availability, especially for critical applications. This approach helps in early detection and resolution of potential issues, minimizing downtime and enhancing service reliability.

6. Standardized Processes: Smart Ops standardizes operational activities through SOPs (Standard Operating Procedures), enabling less experienced resources to execute tasks efficiently. This includes handling SOP-based activities, application monitoring, routine healthchecks.

   Overall, Smart Operations helps organizations achieve a more efficient, resilient, and cost-effective operational environment by leveraging advanced technologies and best practices.

5.4 DISCUSSION FROM Smart Causal Analysis and Smartops within IT OT based on the IT Service Management data dump (Incidents, Service requests) from Infrastructure and Data Center.

We have done detailed analysis on the ticket data (Incidents + Service Requests + Alerts) based on the IT Service Management ticket dump, the insights and analysis contribute to our design for the operating model, support coverage -shift, user experience (Observability) and productivity. Our review of the ticket data reveals that Infrastructure, Data Centre and Cloud processes such as Network, Access, Account, Laptop Issue have most of the volumes i.e., 24% of the total Incidents. We also have done pattern analysis to arrive at potential opportunities for stability, standardization, elimination and automation of tickets with respective to Incidents and Service Requests.

Key Finding Ticket Data Analysis - Infrastructure Services	**Solution Inference - Infrastructure Services**
Incident Ticket Analysis:	
We have done the analysis on Incident Tickets: 4,282 tickets shared by Lion and also identification of potential automation candidates, with network issues, access issues, and account unlock/password reset being the top categories. **High Level observations from the Incident Volume data is as follows:** 94% of incidents are resolved in more than 5 days. The mean time to resolution (MTTR) is approximately 292 hours. There is a high variation in monthly incident volume. Here are the key findings and Inference: Network Issues: This category has the highest number of tickets, with 1,161 incidents. Out of these, 464 are identified as potential automation candidates, representing 8% of the total tickets. Access Issues: There are 793 tickets in this category, with 397 identified as potential automation candidates, making up 7% of the total tickets1. Account Unlock/Password Reset: This category has 397 tickets, with 318 identified as potential automation candidates, accounting for 5% of the total tickets. Laptop Issues: There are 343 tickets in this category, with 137 identified as potential automation candidates, representing 2% of the total tickets. Other Categories: The analysis also includes other categories such as Deloitte Integration related tickets, VPN issues, Office apps, Printer issues, Login issues, MFA issues, Email issues, and WiFi issues. Each of these categories has a smaller number of tickets identified as potential automation candidates. Overall, out of 4,282 incident tickets, 1,863 are identified as potential automation candidates, which is approximately 31% of the total tickets	**Automation Opportunities: The analysis identifies several categories of incident tickets that are potential candidates for automation. For example, network issues, access issues, and account unlock/password reset tickets have a significant number of potential automation candidates. Automating these categories can help reduce the workload on support teams and improve resolution times.** **High MTTR and Resolution Times: The mean time to resolution (MTTR) for incident tickets is approximately 292 hours, and 94% of incidents are resolved in more than 5 days. This indicates a need for process improvements and possibly additional resources to handle incidents more efficiently.** **Variation in Monthly Incident Volume: There is a high variation in the monthly incident volume. This suggests that there may be underlying issues causing spikes in incidents during certain periods. Identifying and addressing these root causes can help stabilize the incident volume.** **Focus on High-Volume Categories: Network issues have the highest volume of tickets, followed by access issues and account unlock/password reset. Prioritizing automation and process improvements in these high-volume categories can have a significant impact on overall efficiency.** **Continuous Monitoring and Optimization: Implementing automation solutions is just the first step. Continuous monitoring and optimization are essential to ensure that the automation solutions are effective and to make necessary adjustments based on performance data.**

Service Request Analysis – Infrastructure	
We have done the analysis on Service Request (SR) Tickets: 6,439 tickets shared by Lion and also identification of potential automation candidates, with access issues, user add/delete requests, and distribution list requests being the top categories **High Level observations from the Service Request Volume data is as follows:** - Resolution date/time is not available for many tickets. - There is a high variation in monthly SR volume. - 30% of tickets have a generic description. **Here are the key findings and inference from Service Request data:** Access Issues: This category has the highest number of tickets, with 1,966 tickets. Out of these, 786 are identified as potential automation candidates, representing 6% of the total tickets. User Add/Delete Requests: There are 1,639 tickets in this category, with 983 identified as potential automation candidates, making up 8% of the total tickets. Distribution List Requests: This category has 1,470 tickets, with 882 identified as potential automation candidates, accounting for 7% of the total tickets. Software Requests: There are 531 tickets in this category, with 212 identified as potential automation candidates, representing 2% of the total tickets. Account Unlock/Password Reset: This category has 207 tickets, with 145 identified as potential automation candidates, making up 1% of the total tickets. ServiceNow Related: There are 204 tickets in this category, with 41 identified as potential automation candidates, representing 1% of the total tickets. Account Requests: This category has 200 tickets, with 80 identified as potential automation candidates, accounting for 1% of the total tickets. Mobile Related: There are 122 tickets in this category, with 12 identified as potential automation candidates, making up 1% of the total tickets. Create/Delete Mailbox: This category has 100 tickets, with 50 identified as potential automation candidates, representing 1% of the total tickets. Overall, out of 6,439 SR tickets, 3,192 are identified as potential automation candidates, which is approximately 28% of the total tickets.	**Automation Opportunities: The analysis identifies several categories of SR tickets that are potential candidates for automation. For example, access issues, user add/delete requests, and distribution list requests have a significant number of potential automation candidates. Automating these categories can help reduce the workload on support teams and improve resolution times.** **High Variation in Monthly SR Volume: There is a high variation in the monthly SR volume. This suggests that there may be underlying issues causing spikes in SRs during certain periods. Identifying and addressing these root causes can help stabilize the SR volume.** **Generic Descriptions: 30% of SR tickets have a generic description. This indicates a need for better ticket categorization and description practices. Implementing standardized templates and training for ticket creation can help improve the quality of ticket descriptions.** **Focus on High-Volume Categories: Access issues have the highest volume of tickets, followed by user add/delete requests and distribution list requests. Prioritizing automation and process improvements in these high-volume categories can have a significant impact on overall efficiency.** **Continuous Monitoring and Optimization: Implementing automation solutions is just the first step. Continuous monitoring and optimization are essential to ensure that the automation solutions are effective and to make necessary adjustments based on performance data.**

Key Finding Ticket Data Analysis - Data Centre and Cloud Services	Solution Inference - Data Centre and Cloud Services
Incident Analysis	
High Level Observations from Data Centre and Cloud Incident Tickets: **- Monthly Ticket Average: 820 tickets.** **- Mean Time to Resolution (MTTR): Approximately 202 hours.** **- Resolution Rate: 97% of incidents are resolved in more than 5 days.** **- High Variation: There is a high variation in monthly incident volume** **The analysis identifies several categories of incident tickets that are potential candidates for automation:** **Multi Alerts: 1,739 tickets, with 783 identified as potential automation candidates (7% of the total tickets).** **High Utilization: 1,107 tickets, with 554 identified as potential automation candidates (5% of the total tickets).** **Connectivity Alerts: 925 tickets, with 370 identified as potential automation candidates (3% of the total tickets).** **Threshold Alert: 916 tickets, with 366 identified as potential automation candidates (3% of the total tickets).** **Node Down: 685 tickets, with 171 identified as potential automation candidates (2% of the total tickets).** **Agent Health Alerts: 544 tickets, with 163 identified as potential automation candidates (2% of the total tickets).** **Memory Utilization: 383 tickets, with 172 identified as potential automation candidates (2% of the total tickets).** **Service Start-Stop: 317 tickets, with 127 identified as potential automation candidates (1% of the total tickets).** **Access Issue: 317 tickets, with 95 identified as potential automation candidates (1% of the total tickets).** **Mailbox Issues: 258 tickets, with 65 identified as potential automation candidates (1% of the total tickets).** **DB Issue: 217 tickets, with 54 identified as potential automation candidates (1% of the total tickets).** **Backup Issues: 201 tickets, with 60 identified as potential automation candidates (1% of the total tickets).** **Server Down: 192 tickets, with 58 identified as potential automation candidates (1% of the total tickets).** **Interface Down: 189 tickets, with 66 identified as potential automation candidates (1% of the total tickets).** **Tablespace Issue: 127 tickets, with 38 identified as potential automation candidates (1% of the total tickets).** **Overall, out of 10,042 incident tickets, 3,142 are identified as potential automation candidates, which is approximately 30% of the total tickets**	**Automation Opportunities: The analysis identifies several categories of incident and SR tickets that are potential candidates for automation. For example, multi alerts, high utilization, and connectivity alerts for incident tickets, and access issues, user add/delete requests, and distribution list requests for SR tickets. Automating these categories can help reduce the workload on support teams and improve resolution times.** **High MTTR and Resolution Times: The mean time to resolution (MTTR) for incident tickets is approximately 202 hours, and 97% of incidents are resolved in more than 5 days. This indicates a need for process improvements and possibly additional resources to handle incidents more efficiently.** **High Variation in Monthly Ticket Volume: There is a high variation in the monthly incident and SR ticket volume. This suggests that there may be underlying issues causing spikes in tickets during certain periods. Identifying and addressing these root causes can help stabilize the ticket volume.** **Focus on High-Volume Categories: Multi alerts have the highest volume of incident tickets, followed by high utilization and connectivity alerts. For SR tickets, access issues have the highest volume, followed by user add/delete requests and distribution list requests. Prioritizing automation and process improvements in these high-volume categories can have a significant impact on overall efficiency.** **Continuous Monitoring and Optimization: Implementing automation solutions is just the first step. Continuous monitoring and optimization are essential to ensure that the automation solutions are effective and to make necessary adjustments based on performance data**

Digital Products and Services and Digital Operations Management:

- **Key Finding**: There was a significant agreement among respondents regarding the adoption of digital products and services, as well as digital operations management practices, indicating a strategic focus on digital transformation initiatives to enhance operational efficiency and customer experience.

Digital Technology:

- **Key Finding**: Organizations demonstrated a significant adoption of digital technologies such as Internet of Things, cloud computing, big data analytics, and analytics in operations, reflecting a concerted effort to leverage technology for improving operational processes and decision-making capabilities.

Customer Integration:

- **Key Finding**: Companies emphasized joint planning and collaboration with customers across various stages of the IT chain, indicating a customer-centric approach to IT chain management aimed at enhancing responsiveness and value delivery.

Supplier Integration and Internal Integration:

- **Key Finding**: There was a significant emphasis on joint planning and collaboration with suppliers, as well as internal integration across functional areas within the organization, highlighting the importance of collaboration and alignment in mitigating risks and optimizing operational performance.

IT Management Strategies:

- **Key Finding**: Companies employed various IT chain management strategies such as flexible IT base approaches, maintenance, operational buffers, postponement tactics, adaptable transportation strategies, and GenAI methods to enhance IT chain resilience and responsiveness.

Risk Management Capabilities:

- **Key Finding**: Organizations demonstrated strong risk management capabilities through the presence of dedicated risk management teams, utilization of risk analysis tools, implementation of supportive methods, and proactive risk monitoring practices, underscoring the importance of proactive risk management in ensuring business continuity and resilience.

Overall Interpretation:

- **Key Finding**: Across all domains of procurement, operations, technology adoption, integration with customers and suppliers, IT Service Management chain strategies, and risk management capabilities, organizations displayed a proactive approach to adapting to the challenges posed by varied platforms. There was a significant emphasis on leveraging technology, collaboration, agility, and risk mitigation strategies to ensure operational continuity, resilience, and responsiveness in the face of uncertainties and disruptions.

Table 5. 1:Key Findings Table

Aspects	**Key Findings**
Procurement	Significant agreement on utilizing advanced technologies for procurement processes.
Warehousing and Logistics	Strong emphasis on using visual control systems and big data analysis in warehouse management.
Digital Products and Services, Digital Operations Management	Significant adoption of digital technologies for enhancing operational efficiency.
Digital Technology	Substantial adoption of Internet of Things, cloud computing, big data analytics, and analytics in operations.
Customer Integration	Emphasis on joint planning and collaboration with customers to enhance responsiveness.
Supplier Integration, Internal Integration	Significant focus on collaboration with suppliers and internal integration across functional areas.

IT Chain Management Strategies	Utilization of various strategies such as flexible IT base approaches, IT maintenance.
Risk Management Capabilities	Strong risk management capabilities demonstrated through dedicated teams, risk analysis tools usage.

Source: Analysis on questionnaire response – Nikhil Sharma ©

Table 5. 2:Key Findings Table during Post SmartOps

Aspects	**Key Findings**
Part A: Procurement	Significant adoption of digital technologies (e.g., big data analysis, AI) for supplier forecasting and decision-making. Digital collaboration systems and direct digital manufacturing with IoT integration have streamlined procurement operations.
Part A: Warehousing and Logistics	Utilization of visual control systems and big data analysis in optimizing inventory management and traffic operations.
Part A: Digital Operations Management	Adoption of digital operations management, including digital manufacturing, to enhance operational efficiency.
Part A: Digital Business Model	Prevalence of digital business models (e.g., mass customization, open innovation) to adapt to dynamic market demands.
Part B: Digital Technology	Prominence of IoT implementation, cloud computing adoption, and utilization of big data and analytics tools in operations.

Part B: Customer Integration	Strengthening of collaborative planning and information sharing with customers to improve demand visibility.
Part B: Supplier Integration	Enhanced joint planning and information sharing with suppliers to synchronize IT Chain.
Part B: Internal Integration	Improved internal responsiveness and resource utilization within organizations.
Part C: IT Chain Management	Emphasis on flexible IT base approaches and proactive risk management to ensure IT chain resilience.
Part C: Risk Management Capabilities	Implementation of proactive risk management practices and utilization of risk analysis tools to mitigate tickets.

Source: Analysis on questionnaire response – Nikhil Sharma ©

CHAPTER VI SUMMARY, IMPLICATIONS AND RECOMMENDATIONS

6.1. SUMMARY

The research explores the critical role of IT Service management tooling in mining and consumer sector, with a particular focus on the IT disruptions and involvement of GenAI tools. The research aimed to identify effective strategies that companies could adopt to enhance their IT platform chain resilience, ensuring continuity of operations in the face of unexpected global challenges. The study began by highlighting the vulnerabilities that the varied IT platform if not integrated poses to the business and customer stakeholders. These included an over-reliance on a limited number of IT processes, suppliers, inadequate IT Service management practices, and a lack of real-time visibility across the IT Platform chain. These weaknesses were identified as key areas where companies needed to focus their resilience-building efforts. Through a comprehensive literature review, the thesis examined existing theories and practices related to IT OT Smart Causal Analysis within the IT Service Management resilience, including the integration of digital technologies and the importance of strategic partnerships. The research drew on various case studies and empirical data to assess the effectiveness of different resilience strategies in mitigating the impact of IT Smart Causal analysis disruptions. The findings revealed that companies that had invested in proactive resilience measures, such as investing in their right platform strategy, networks, increasing visibility, and adopting advanced digital technologies, were better able to navigate the challenges. These strategies not only helped companies maintain operational performance but also positioned them to respond more flexibly to the evolving situation. A key outcome of the research was the identification of digital technologies as crucial enablers of IT OT Service Management chain resilience. Technologies such as the Internet of Things (IoT), big data analytics, cloud computing, and artificial intelligence were shown to significantly enhance the agility and robustness of IT chains. These technologies provided companies with real-time data and advanced analytics capabilities, enabling them to detect disruptions early, make informed decisions, and adapt their operations accordingly.

The thesis also underscored the importance of a tailored approach to building IT OT Platform chain resilience. It highlighted that while digital technologies are powerful tools, their effectiveness depends on how well they are integrated into the broader IT chain strategy. Companies must consider their specific contexts and challenges when designing resilience strategies, ensuring that these strategies align with their overall business objectives.

The research emphasized the role of cross-functional collaboration and strategic partnerships in enhancing IT Service management processes chain resilience. Strong collaboration across different functions within an organization, as well as with external partners, was found to be critical in identifying risks, sharing information, and implementing effective mitigation strategies. In conclusion, this thesis has provided valuable insights into the strategies and technologies that can enhance IT Smart Causal chain resilience, particularly in the mining and consumer sector. The findings offer practical guidance for businesses seeking to strengthen their IT chains against future disruptions, emphasizing the need for a proactive, integrated, and tailored approach to resilience.

6.2 MANAGERIAL IMPLICATION

In addition to adding to our theoretical knowledge of IT chain resilience, this research provides mining and consumer organisations with useful practical implications. These suggestions aim to make the IT platform chain more resilient by making it more agile, more integrated, and more tech-savvy. In order to provide managers with practical insights, the following discussion expands upon these points and goes into further depth.

Enhancing IT Chain Agility and Integration

Improving IT chain integration and agility is a key piece of advice for managers. With demand swings and unexpected interruptions happening all the time in today's industry, agility is key. If they want to be agile, managers need to make sure their platform chains can adapt with the times. To quickly adapt to fluctuating consumer incidents and service requests, businesses may, for instance, need to adjust delivery windows or ramp up or down production. Working closely with partners in the IT platform chain is essential for achieving this level of agility. Businesses may improve their ability to foresee and react to changes in the market and other disruptions by exchanging pertinent data and keeping lines of communication open.

SmartOps is an approach to delivering managed services by integrating Infrastructure, Network, Application, and Cloud operations through an intelligent automation layer. This integration supports end-to-end automation, enhancing service efficiency and innovation. SmartOps leverages AI-driven insights to observe, detect, identify, and remediate issues across devices, applications, and services. The approach includes pre-built scripts for AI-led automation, driving experience and efficiency.

Implications

1. Enhanced Efficiency: By integrating various operational teams and automating processes, SmartOps significantly improves service delivery efficiency.
2. Innovation at Scale: The holistic automation approach allows for scalable innovation across services, transitioning from point automation to comprehensive automation.
3. Proactive Issue Management: AI-driven insights enable proactive detection and remediation of issues, reducing downtime and improving service reliability.
4. Customer Satisfaction: The approach has led to high customer satisfaction, with significant improvements in productivity and cost savings for clients.

Recommendations

1. Adopt SmartOps for Integrated Operations: Organizations should consider adopting SmartOps to integrate their operational teams and automate processes, leading to improved efficiency and innovation.
2. Leverage AI and Automation: Utilize AI-driven insights and pre-built automation scripts to proactively manage and remediate issues, enhancing service reliability.
3. Focus on Experience-Centric Models: Transition from SLA-based to XLA-based engagement models to deliver experience-centric, cost-efficient services.

4. Continuous Improvement: Regularly update and refine automation scripts and processes to maintain high levels of efficiency and customer satisfaction.

By implementing these recommendations, organizations can achieve significant improvements in operational efficiency, innovation, and customer satisfaction.
IT integration is inherently related to improving platform agility. When a company's IT chain partners and the company itself are well-integrated, real-time data flows without a hitch. since of this information flow, the IT chain as a whole is more resilient since all participants can respond to interruptions in a coordinated and effective manner. Supervisors should make it a top priority to increase IT chain openness and visibility if they want to reach this degree of integration. Achieving this may be achieved by establishing shared objectives and coordinating approaches to risk mitigation. IT Service Management chain partners may communicate vital information more easily via regular meetings and common digital platforms like cloud-based solutions. By following these procedures, you can be confident that everyone involved is on the same page and can work together to overcome any obstacles.

Strengthening IT OT Service Management Resilience for Improved Operational Performance

Improving operational performance is only one benefit of a resilient IT chain, which goes beyond just being able to resist interruptions. To better adjust and realign their networks, organisations should concentrate on resilience skills like integration and agility. Products are better, service is better, and on-time delivery is more dependable as a result of this flexibility. Managers should consider IT chain resilience a strategic asset that affects their company's capacity to satisfy customers and stay competitive.

Leveraging Digital Technologies to Enhance IT Chain Resilience

To further fortify IT chain resilience, the report stresses the need of investing in and utilising digital technology. Digital technologies are essential for maximising the positive effects of IT chain integration on resilience. Cloud computing, tracing and tracking technologies, and big data analytics are all part of this category. By facilitating the real-time interchange of information across production and delivery processes, cloud computing, for instance, enhances IT chain visibility and connectedness. Businesses that use these technologies may see improvements in operation monitoring, disruption prediction, and the ability to make rapid, informed decisions.

The capacity of big data analytics to automate the examination of large volumes of data and hence aid in decision-making is particularly noteworthy. For instance, IT chain choices like optimising inventory levels or lowering delivery lead times may be informed by big data analytics, which can assist discover trends and patterns. Better operations and a stronger IT chain are possible outcomes of these realisations.

When deploying digital technology, managers should also consider the costs and benefits. It is critical to make sure the advantages of adopting these technologies do not exceed the costs, even if they may greatly improve IT chain resilience. If managers want to know which technology will work best for their company, they need weigh the costs and benefits. This method strengthens the IT chain and guarantees that investments in digital technology boost the bottom line.

6.3. RECOMMENDATION FOR FUTURE RESEARCH

The findings of this study have significantly contributed to the understanding of IT chain resilience, particularly within the mining and consumer sector. However, the dynamic nature of global IT chains and the ongoing evolution of technological and environmental factors highlight the need for further research in several areas. This section provides recommendations for future research to build on the insights gained from this study and address some of the limitations that have been identified.

While this research has focused on the mining and consumer sector, future studies could broaden their scope to include other industries, such as retail, healthcare, and hospitality. Each sector is likely to face distinct challenges regarding IT chain resilience, which may necessitate different strategies and approaches. For example, the healthcare sector, which has been critically impacted by the platform, may benefit from studies that explore how IT chain resilience can be enhanced to prevent disruptions in the delivery of essential medical supplies and services. Similarly, the retail sector, with its complex network of suppliers and fluctuating consumer demands, presents a unique environment where the principles of IT chain resilience could be tested and refined. Investigating these sectors would not only enhance the generalizability of existing theories but also provide industry-specific insights that could guide practitioners in those fields.

In addition to expanding the industry focus, future research should consider the value of longitudinal studies. The current research provides a snapshot of how IT chain resilience strategies were deployed. However, there is a need to understand how these strategies evolve over time and how they impact operational performance in the long run. Longitudinal studies could track the implementation and effectiveness of resilience strategies over several years, providing insights into their sustainability and long-term benefits. Such research could reveal whether the measures taken during the pandemic have lasting effects on IT chain operations or if they need continuous adaptation to remain effective. Furthermore, this approach could help identify which strategies are most resilient over time, offering valuable guidance for businesses looking to fortify their IT chains against future disruptions. Another critical area for future research is the role of emerging digital technologies in enhancing IT chain resilience. The integration of technologies such as artificial intelligence (AI), blockchain, and the Internet of Things (IoT) in IT chain management is increasingly recognized as a key factor in building more resilient systems. However, there is still much to learn about how these technologies can be leveraged to prevent and mitigate disruptions. Future research could explore how AI can be used to predict IT chain risks and automate response strategies, or how blockchain can ensure transparency and traceability across the IT chain, reducing the likelihood of disruptions due to fraud or mismanagement. Moreover, the IoT's ability to provide real-time data across various points in the IT chain could be examined in terms of its potential to enhance visibility and agility, thereby contributing to overall resilience. Understanding these technologies' full potential and limitations is crucial as businesses increasingly rely on them to navigate complex IT chain challenges.

The vulnerability of global IT chains to large-scale disruptions, but it is not the only threat on the horizon. Future studies should explore the impact of other global disruptions, such as geopolitical conflicts, climate change, and economic crises, on IT chain resilience. Geopolitical tensions, for example, can lead to sudden trade restrictions or sanctions, which can severely impact global IT chains. Climate change, with its potential to cause extreme weather events and alter production conditions, poses a long-term risk that IT chains must adapt to. Economic crises, like recessions or financial market collapses, can disrupt IT and demand patterns, affecting the stability of IT chains. Research in these areas would provide a more comprehensive understanding of the various factors that can disrupt IT chains and how businesses can prepare for them. Additionally, it would help identify strategies that are effective across different types of disruptions, thereby enhancing the robustness of IT chain management practices. Cross-cultural studies present another rich area for exploration. The management of IT chain resilience can vary significantly across different cultural and regulatory environments, especially for multinational companies operating in diverse regions. Future research could compare how IT chain resilience is approached in different countries, taking into account varying levels of economic development, regulatory frameworks, and cultural attitudes towards risk. For instance, IT chain strategies that are effective in highly regulated environments may not be directly transferable to regions with less stringent regulations or different cultural attitudes toward business continuity and risk management. By understanding these differences, companies can tailor their resilience strategies to be more effective in specific contexts, thereby improving their global IT chain management.

The intersection of IT chain resilience and sustainability is an area ripe for future research. As businesses increasingly focus on sustainability, understanding how resilient IT chains can also contribute to environmental and social sustainability goals is essential. Future studies could explore how strategies designed to enhance IT chain resilience can be aligned with efforts to reduce environmental impact, such as minimizing waste, reducing carbon emissions, and promoting ethical sourcing practices. This research could also examine how resilient IT chains contribute to social sustainability, such as by ensuring fair labor practices and supporting local communities.

By linking resilience with sustainability, businesses can develop more holistic strategies that not only protect their operations but also contribute to broader societal goals.

Further research is needed to explore the relationship between IT chain agility and resilience. While agility and resilience are often discussed together, they are distinct concepts that interact in complex ways. Agility refers to the ability to quickly adapt to changes, while resilience involves the capacity to recover from disruptions. Future studies could examine how these two concepts complement each other and contribute to overall IT chain performance. For example, research could investigate whether agile IT chains are inherently more resilient or if there are trade-offs between the two. Understanding this relationship would help businesses design IT chains that are not only agile but also resilient, ensuring they can respond to immediate challenges while maintaining long-term stability

Limitation of Study

- The research is limited to the manufacturing sector, which may restrict the generalizability of the findings to other industries. IT chain dynamics and resilience strategies can vary significantly across sectors, such as healthcare, retail, and hospitality, which were not explored in this study.
- The study primarily focuses on the impact of IT chain resilience within a specific geographical region. This could limit the applicability of the results to global contexts, where different regulatory, economic, and cultural factors may influence IT chain management practices.
- The research provides a snapshot of IT chain resilience does not account for long-term trends or the evolution of resilience strategies over time. A longitudinal approach could offer deeper insights into the sustainability and effectiveness of these strategies.
- While the study acknowledges the role of digital technologies in enhancing IT chain resilience, it does not deeply investigate the specific impacts of emerging technologies like AI, blockchain, and IoT. This limits the understanding of how these technologies can be leveraged to further improve resilience in diverse IT chain contexts

Future Scope of Study

The future scope of this study includes expanding research to different sectors and regions to gain broader insights into IT chain resilience. Longitudinal studies could track changes over time, while exploring emerging technologies like AI and blockchain could enhance understanding of technological impacts. An interdisciplinary approach and the development of resilience measurement models would offer deeper analysis, and studying the influence of government policies could provide valuable guidance for both policymakers and industry leaders in strengthening global IT chains.

6.4. CONCLUSION

The Global IT chains, revealing vulnerabilities and pushing businesses to adopt resilience strategies at an unprecedented pace. This thesis has explored the intricate relationship between IT chain resilience, digital technologies, and operational performance in the manufacturing sector. The conclusions drawn from this study not only highlight the critical role of resilience in sustaining business operations during disruptions but also underscore the transformative impact of digital technologies in enhancing IT chain agility and robustness.

The research has shown that IT chain resilience is not merely a reactive measure but a proactive strategy that can significantly bolster a company's ability to withstand and recover from IT Service Management disruptions. The consumer and mining sector, with its complex and interdependent networks, has been particularly exposed to the shocks of the siloed data. However, companies that had already invested in resilience-enhancing strategies, such as diversifying their platform base, increasing tools, and adopting digital technologies, were better positioned to navigate the incidents and service level criticality. These strategies have proven to be essential in maintaining continuity of operations, managing IT chain risks, and meeting customer demands in a volatile environment. One of the key findings of this study is the pivotal role of digital technologies in strengthening IT chain resilience. The adoption of technologies such as the Internet of Things (IoT), cloud computing, big data analytics, and artificial intelligence has been accelerated by the varied platforms, data breaches, transforming how companies manage their IT chains. These technologies have enabled real-time monitoring, improved decision-making, and enhanced collaboration across the IT chain, all of which are crucial for responding swiftly to disruptions. For instance, IoT has provided companies with greater visibility into their IT chains, allowing them to track incidents, monitor service levels, and identify potential bottlenecks before they escalate into significant problems. Similarly, cloud computing has facilitated remote collaboration and data sharing, ensuring that teams can continue to work together effectively even when physical offices are closed and still be able to resolve incidents with Poke Yokes.

Moreover, big data analytics has played a vital role in enabling companies to make informed decisions based on real-time data. Companies that leveraged big data were able to optimize their IT chain operations by predicting demand fluctuations, identifying alternative suppliers, and optimizing release schedules. This ability to rapidly analyze and act on data has proven to be a critical factor in maintaining IT chain resilience. Additionally, artificial intelligence has been instrumental in automating complex decision-making processes, such as supplier selection and risk assessment, further enhancing the agility and responsiveness of IT chains.

The findings also suggest that IT chain resilience is not a one-size-fits-all solution but rather a tailored approach that must be adapted to the specific needs and context of each company. While digital technologies are a powerful enabler of resilience, their effectiveness depends on how they are integrated into the overall IT chain strategy. Companies must carefully assess their unique challenges and opportunities and design resilience strategies that align with their business objectives. For example, while some companies may benefit from investing in advanced technologies, others may find that simpler solutions, such as improving platform and internal stakeholders' relationships or increasing service levels, are more effective in enhancing their resilience.

Furthermore, the study highlights the importance of cross-functional collaboration in building IT chain resilience. The IT OT integration has demonstrated that IT chain disruptions are not isolated events but rather complex, interconnected challenges that require a coordinated response across different functions within the organization. Companies that foster strong collaboration between their IT chain, procurement, production, and technical teams are better equipped to identify risks, share information, and implement effective mitigation strategies. This cross-functional approach not only improves operational efficiency but also enhances the overall resilience of the IT chain.

In addition to technological and organizational strategies, the research emphasizes the role of strategic partnerships in enhancing IT chain resilience. The platform play has underscored the importance of having strong relationships with internal stakeholders, customers, and other stakeholders in the IT chain. Companies that have cultivated strategic partnerships have been able to leverage these relationships to secure critical incidents, share information, and collaborate on joint problem-solving efforts when a major incident happens within any organization. These partnerships have proven to be invaluable in maintaining IT chain continuity to be a key component of resilient IT chains in the future.

While the research provides valuable insights into the factors that contribute to IT chain resilience, it also acknowledges the limitations of the study. The focus on the mining and consumer sector means that the findings may not be fully applicable to other industries, such as retail, healthcare, or logistics, which face different challenges and require different resilience strategies. Additionally, the study's reliance on data collected during the infrastructure and data centre incidents and service requests sample may limit the generalizability of the findings to other types of disruptions. Future research should explore these areas to provide a more comprehensive understanding of IT chain resilience across different contexts.

In conclusion, this thesis has demonstrated that IT OT chain convergence is a critical factor in ensuring business continuity and operational performance. The findings highlight the importance of adopting a holistic approach to platform strategy across IT and OT space, one that integrates digital technologies, cross-functional collaboration, and strategic partnerships. As businesses continue to navigate the uncertainties, the lessons learned from this study will be invaluable in guiding the development of more resilient and agile IT chains.

The challenges posed by the adoption of digital technologies and underscored the need for robust IT chain resilience strategies. However, as the global landscape continues to evolve, companies must remain vigilant and proactive in adapting their IT OT convergence resilience strategies to meet new challenges. By doing so, they can not only survive but thrive in an increasingly complex and uncertain world. The insights gained from this research provide a solid foundation for companies looking to strengthen their IT chain resilience and ensure their long-term success in the face of future disruptions.

References

1. Lim, Il-Hyung & Lee, Seung-Joo & Park, Jong-Ho & Shin, Yong-Hak. (2016). A Design of Advanced Distribution Management System Based on IT/OT Convergence. The Transactions of The Korean Institute of Electrical Engineers. 65. 753-759. 10.5370/KIEE.2016.65.5.753.
2. Gray, Robert & Subadra, S. & Sreekala, S.. (2024). Unveiling the Potential of Open Strategy: An Exposé of Strategic Planning in the South African Mining Sector. Texila International Journal of Academic Research. 11. 10.21522/TIJAR.2014.11.02.Art003.
3. Pilipets, Oleg. (2024). The main features of the creation and operation of the service band of the ITS integration platform. BIO Web of Conferences. 113. 10.1051/bioconf/202411304022.
4. Busalachi, Dino. (2024). Bridging the gap between IT and OT to improve industrial cyber security. Cyber Security: A Peer-Reviewed Journal. 7. 10.69554/EAZH4262.
5. Taylor, T.. (2012). IT/OT convergence: How their coming together increases distribution system performance. 23-27.
6. Aglibar, Kent & Rodelas, Nelson. (2022). Impact of Critical and Auto Ticket: Analysis for Management and Workers Productivity in using a Ticketing System. 10.48550/arXiv.2203.03709.
7. Pradhan, Dr & Bagbande, Arun & Khan, Amaan & Majid, Abdul & Chandekar, Unnati. (2022). ITSM Using AI Chat-Bot and Data Visualizers. International Journal for

Research in Applied Science and Engineering Technology. 10. 704-708. 10.22214/ijraset.2022.42293.

8. Varga, Sergio & Barreto, Gilmar & Battaglin, Paulo. (2019). Increasing Information Systems Availabiliy Through Accuracy, Awareness, Completeness and Manageability of ITSM. 1-4. 10.23919/CISTI.2019.8760686.
9. Lanure, Mutmainnah & Maulana, Furqan & Lubis, Muharman. (2022). Assessment of IT Maturity Level and Roadmap Preparation for Improving Governance Based on COBIT 5 (Case Study: XYZ Company). 31-36. 10.1109/ICISIT54091.2022.9872860.
10. Pradhan, Dr & Bagbande, Arun & Khan, Amaan & Majid, Abdul & Chandekar, Unnati. (2022). ITSM Using AI Chat-Bot and Data Visualizers. International Journal for Research in Applied Science and Engineering Technology. 10. 704-708. 10.22214/ijraset.2022.42293.
11. Jain, Vipul & Wali, O. & Vadlamudy, Raveendra. (2018). Information Technology Service Management [ITSM] Research: A Literature Review of Practices, Solutions and Measurement. Asian Journal of Computer Science and Technology. 7. 79-86. 10.51983/ajcst-2018.7.1.1825.
12. Alojail, Mohammed & Rouse, Anne & Corbitt, Brian. (2012). The impact of ITIL (information technology infrastructure library) recommended practices on the IT outsourcing relationship. ACIS 2012 : Proceedings of the 23rd Australasian Conference on Information Systems.
13. Gacenga, Francis & Cater-Steel, Aileen & Toleman, Mark. (2010). An International Analysis of IT Service Management Benefits and Performance Measurement. Journal of Global IT Management. 13. 28-63. 10.1080/1097198X.2010.10856525.
14. Waclawek, Hannes & Schäfer, Georg & Binder, Christoph & Hirsch, Eduard & Huber, Stefan. (2023). Digital Twins of Business Processes as Enablers for IT / OT Integration. 10.48550/arXiv.2305.06001.
15. Bartolini, Claudio & Stefanelli, Cesare & Tortonesi, Mauro. (2009). Business-impact analysis and simulation of critical incidents in IT service management. 2009 IFIP/IEEE

International Symposium on Integrated Network Management, IM 2009. 9 - 16. 10.1109/INM.2009.5188781.

16. Aboujaoude, M. K., Feghali, K., & Kfouri, C. (2018). Planning the Research. In S. M. Jorge Marx Gómez, Modernizing the Academic Teaching and Research Environment. Methodologies and Cases in Business Research. (pp. 25-46). Cham: Springer.
17. Atinc, G., Simmering, M. J., & Kroll, M. J. (2012). Control Variable Use and Reporting in Macro and Micro Management Research. Organizational Research Methods, pp. 57-74.
18. Bolarinwa, O. A. (2015). Principles and Methods of Validity and Reliability Testing of Questionnaires Used in Social and Health Science Researches. Nigerian Postgraduate medical Journal, 22(4), 195-201.
19. Burnhard, K., & Bhamra, R. (2011). Organizational Resilience: Development of a Conceptual Framework for Organizational Responses. International Journal of Production Research, 49(18), 5581-5599.
20. Dalati, S., & Gómez, J. M. (2018). Survey and Questionnaires. In J. M. Gómez, & S. Mouselli, Modernizing the Academic Teaching and Research Environment. Methodologies and Cases in Business Research. (pp. 175-186). Cham: Springer.
21. DeSimone, J., Harms, P., & DeSimone, A. (2015). Best practice recommendations for data screening. Journal of Organizational Behavior, 36(2), pp. 171-181.
22. Easterby-Smith, M., Thrope, R., Jackson, P. R., & Jaspersen, L. J. (2018). Management and Business Research. United Kingdom: SAGE Publications Ltd.
23. Gómez, J. M., & Mouselli, S. (2018). Modernizing the Academic Teaching and Research Environment. Methodologies and Cases in Business Research. Cham: Springer.
24. Hadi, N. U., Abdullah, N., & Ilham, S. (2016). An Easy Approach to Exploratory Factor Analysis: Marketing Perspective. Journal of Educational and Social Research, 6(1), p. 215.223.
25. Hair, J., Page, M., & Brunsveld, N. (2019). Essentials of Business Research Methods (Vol. 4th Edition). New York: Routledge.

26. Kagermann, H., Helbig, J., Hellinger, A., & Wahlster, W. (2013). Deutsche Akademie der Technikwissenschaften. Retrieved from https://www.acatech.de/fileadmin/user_upload/Baumstruktur_nach_Website/Acatech/root/de/Material_fuer_Sonderseiten/Industrie_4.0/Final_report__Industrie_4.0_accessible.pdf
27. Kagermann, H., Lukas, W., & Wahlster, W. (2011). Industrie 4.0: Mit dem Internet der Dinge auf dem Weg zur 4. industriellen Revolution. 13.
28. Kaiser, H. (1970). A Second Generation Little Jiffy. Psychometrika, 35(4), pp. 401-415. Kaiser, O. (1974). Kaiser-Meyer-Olkin measure for identity correlation matrix. Journal of the Royal Statistical Society, pp. 296-298.
29. Kennedy, B. L. (2018). Deduction, Induction, and Abduction. In U. Flick, The SAGE Handbook of Qualitative Data Collection (pp. 49-64). London: SAGE.
30. Bay Mutsaers, July 2017. Relevance of the various ISA standards to productivity, analytics, security, and digital technology adoption in mining
31. Nwaila, Glen & Frimmel, Hartwig & Zhang, Steven & Bourdeau, Julie & Tolmay, Leon & Durrheim, Raymond & Ghorbani, Yousef. (2022). The minerals industry in the era of digital transition: An energy-efficient and environmentally conscious approach. Resources Policy. 78. 102851. 10.1016/j.resourpol.2022.102851.
32. Kamal, S. & Mubarak, Muhammed & Scodova, B. & Naik, P. & Flichy, Philippe & Coffin, G.. (2016). IT and OT Convergence - Opportunities and Challenges. 10.2118/181087-MS. Information Technology (IT) and Operational Technology (OT) are converging as integration from the real-time to the enterprise gains ground across many industries.
33. Paredes, Ignacio. (2020). IT/OT Convergence – Cybersecurity Beyond Technology. 10.2118/203093-MS. When the first PCs were deployed in industrial automation environments during the 1980s, it was difficult to imagine how the information technology (IT) would influence the day to day operations of industrial organizations.

34. Kim, Dong-Kwan & Baek, Dong & Jin, Heui-Chae. (2010). A Study on Technology Characteristics of IT Convergence Service and Application Technology for Industrial Convergence. Journal of the Korea society of IT services.
35. Lukichev, S.V. & Nagovitsyn, Oleg. (2022). Digital transformation and technological independence of the mining industry. Mining Industry Journal (Gornay Promishlennost). 74-78. 10.30686/1609-9192-2022-5-74-78.
36. Wang, Zibo & Zhang, Yaofang & Liu, Zhiyao & Wei, Xiaojie & Chen, Yilu & Wang, Bailing. (2021). An Automatic Planning-Based Attack Path Discovery Approach from IT to OT Networks. Security and Communication Networks. 2021. 1-18. 10.1155/2021/1444182.
37. Sahu, Abinash & Bhardwaj, Anand. (2022). Impact of New & Emerging Technologies on Mining Industry" "Impact of New & Emerging Technologies on Mining Industry".
38. Hrica, Jonathan & Bellanca, Jennica & Benbourenane, Iman & Carr, Jacob & Homer, John & Stabryla, Kathleen. (2022). A Rapid Review of Collision Avoidance and Warning Technologies for Mining Haul Trucks. Mining, Metallurgy & Exploration. 39. 10.1007/s42461-022-00633-w. Magableh, G. M. 2021. IT chains and the COVID-19 pandemic: A comprehensive framework. *European Management Review*, *18*(3), 363-382.
39. Wang, Hao & Yang, Bo & Liu, Liang & Ma, Qian & Sun, Ke & Chen, Ying. (2007). Knowledge Enhanced IT Service Management. 173 - 180. 10.1109/ICEBE.2007.20. To manage the increasing complexity of IT systems and align IT services with business is the main theme of IT Service Management (ITSM)
40. Qi, Chongchong. (2020). Big data management in the mining industry. International Journal of Minerals, Metallurgy, and Materials. 27. 131-139. 10.1007/s12613-019-1937-z.van Bon, Jan. (2021). An introduction to Unified Service Management
41. Lukichev, S. & Nagovitsin, O.. (2020). Digital transformation of the mining industry: Past, Present, and Future. Gornyi Zhurnal. 13-18. 10.17580/gzh.2020.09.01.

42. Raut, S. K., Sakpal, S., and Soni, R. 2022. Understanding the Service Quality Dimensions and Achieving Resilience in Service Retail. In *Handbook of Research on IT Chain Resiliency, Efficiency, and Visibility in the Post-Pandemic Era* (pp. 136-156). IGI Global.
43. Sharon, Christa & Suma, V.. (2022). Predictive Analytics in IT Service Management (ITSM). 10.1002/9781119792529.ch7.
44. King, P. (2013). Moderators/Moderating Factors. In M. Gellman, & J. Turner, Encyclopedia of Behavioral Medicine. New York: Springer.
45. Li, Y., Dai, J., & Cui, L. (2020). The impact of digital technologies on economic and environmental performance in the context of industry 4.0: A moderated mediation model. Interntional Journal of Productin Economics.
46. Pervan, M., Pervan, I., & Ćurak, M. (2017). The Influence of Age on Firm Performance: Evidence from the Croatian Food Industry. Journal of Eastern Europe Research in Business and Economics, pp. 2-10.
47. Ponomarov, S., & Holcomb, M. (2009). Understanding the concept of IT chain resilience. The International Journal of Logistics Management, 20(1), pp. 124-143.
48. SAGE Research Methods. (2012). Retrieved April 2020, from https://methods.sagepub.com/base/download/DatasetStudentGuide/kmo-nilt-2012
49. Saunders, M., Lewis, P., & Thornhill, A. (2009). Research Methods for Business Students. Harlow: Financial Times Prentice Hall.
50. Spicer, J. (2005). Making Sense of Multivariate Data Analysis. Thousand Oaks: SAGE.
51. Wieland, A., & Wallenburg, C. (2013). The influence of relational competencies on IT chain resilience: a relational view. International Journal of Physical Distribution & Logistics Management, 43(4), pp. 300-320.
52. Yang, H. (2012). Factor Loadings. In N. J. Salkind, Encyclopedia of Research Design (pp. 481-483). Thousand Oaks: SAGE.
53. Yang, J. (2014). IT chain agility: Securing performance for Chinese manufacturers. International Journal of Production Economics, 150, 104-113.

54. Achrol, R.S. and Louis, W.S. (1988) 'Environmental Determinants of Decision-Making Uncertainty in Marketing Channels', Journal of Marketing Research, vol. 25, pp. 36-50.

55. Aitken, J., Christopher, M., & Towill, T. (2002). Understanding, Implementing and Exploiting Agility and Leanness. International Journal of Production Economics, 203, 48-61.

56. Ali, A., Mahfouz, A., & Arisha, A. (2017). Analysing IT chain resilience: integrating the constructs in a concept mapping framework via a systematic literature review. IT Chain Management: An International Journal, 22(1), pp. 1-30.

57. Al-Shboul, M. A. (2017). Infrastructure framework and manufacturing IT chain agility: the role of delivery dependability and time to market. IT Chain Management: An International Journal, 172-185.

58. Altay, N., Gunasekaran, A., Dubey, R., & Childe, S. (2018). Agility and resilience as antecedents of IT chain performance under moderating effects of organizational culture within the humanitarian setting: a dynamic capability view. Production Planning & Control, 29(14), pp. 1158-1174.

59. Arrais-Castro, A., Varela, M., Putnik, G., Ribeiro, R. A., Machado, J., & Ferreira, L. (2018). Collaborative Framework for Virtual Organisation Synthesis Based on a Dynamic Multi-Criteria Decision Model. International Journal of Computer Integrated Manufacturing, 31(9), 857–868.

60. Azevedo, S.G., Govindan, K., Carvalho, H. and Cruz-Machado, V. (2013), “Ecosilient index to assess the greenness and resilience of the upstream automotive IT chain”, Journal of Cleaner Production, Vol. 56, pp. 131-146.

61. Bagchi, P. K., Ha, B. C., Skjoett-Larsen, T., & Soerensen, L. B. (2005). IT chain integration: a European survey. International Journal of Logistics Management, 16(2), 275-294.

62. Belhadi, A., Kamble, S., Jabbour, C., Gunasekaran, A., Ndubisi, N., & Venkatesh, M. (2021). Manufacturing and service IT chain resilience to the COVID-19 outbreak: Lessons

learned from the manufacturing and airline industries. Technological Forecasting & Social Change, 163, pp. 1-19.

63. Beske, P., Land, A., & Seuring, S. (2014). Sustainable IT chain management practices and dynamic capabilities in the food industry: A critical analysis of the literature. International Journal of Production Economics, 152, pp. 131-143.

64. Blackhurst, J., Kaitlin, S.D. and Craighead, C.W. (2011) 'An empirically derived framework of global IT resiliency', Journal of Business Logistics, vol. 32, no. 4, pp. 374-391.

65. Blome, C., Schoenherr, T., & Rexhausen, D. (2013). Antecedents and enablers of IT chain agility and its effects on performance: a dynamic capabilities perspective. International Journal of Production Research, 51(4), pp. 1295-1318.

66. Blome, C., Schoenherr, T., & Rexhausen, D. (2013). Antecedents and enablers of IT chain agility and its effects on performance: a dynamic capabilities perspective. International Journal of Production Research, 51(4), pp. 1295-1318.

67. Bowersox, D.J. (1969) Readings in physical distribution management: The logistics of marketing, London: Macmillan.

68. Brandon-Jones, E., Squire, B., Autry, C., & Petersen, K. (2014). A Contingent resource-based perspective of IT chain resilience and robustness. Journal of IT Chain Management, 50(3), pp. 55-73.

69. Braunscheidel, M., & Suresh, N. (2009). he organisational antecedents of a firm's IT chain agility for risk mitigation and response. Journal of Operations Management, 119–140.

70. Brousell, D., Moad, J., & Tate, P. (2014). The Next Industrial Revolution: How the Internet of Things and Embedded, Connected, Intelligent Devices will Transform Manufacturing.

71. Burnhard, K., & Bhamra, R. (2011). Organizational Resilience: Development of a Conceptual Framework for Organizational Responses. International Journal of Production Research, 49(18), 5581-5599.

72. Carvalho, H., Barroso, A., Machado, V., Azevedo, S., & Cruz-Machado, V. (2012). IT chain redesign for resilience using simulation. Computers & Industrial Engineering, 62(1), pp. 329-341.

73. Carvalho, H., Barroso, A.P., Machado, V.H., Azevedo, S. and Cruz-Machado, V. (2011) 'IT chain redesign for resilience using simulation', Computers & Industrial Engineering, vol. 62, p. 329–341.

74. Chavez, R., Yu, W., Gimenez, C., Fynes, B., & Wiengarten, F. (2015). Customer integration and operational performance: The mediating role of information quality. Decision Support Systems, 83-95.

75. Chowdhury, M.M.H. and Quaddus, M. (2016), "IT chain readiness, response and recovery for resilience", IT Chain Management: International Journal, Vol. 21 No. 6, pp. 709-731.

76. Christopher, M. (1994) Logistics and IT Chain Management, New York: Pitman Publishing.

77. Christopher, M. and Peck, H. (2004) 'Building the resilient IT chain', International Journal of Logistics Management, vol. 15, no. 2, pp. 1-13. Eckstein, P.P. (2008) Statistik für Wirtschaftswissenschaftler, 4th edition, Wiesbaden: Springer.

78. CIPS. (2020, March 16). Nine in 10 IT chains hit by coronavirus. Retrieved from Chartered Institute of Procurement & IT (CIPS) homepage: https://www.cips.org/IT-management/news/2020/march/nine-in-10-IT-chains-hit-by-coronavirus/

79. Čolaković, A., & Hadžialić, M. (2018). Internet of Things (IoT): A review of enabling technologies, challenges, and open research issues. Computer Networks, 17-39.

80. Dalenogare, L., Benitez, G., Ayala, N., & Frank, A. (2018). The expected contribution of Industry 4.0 technologies for industrial performance. International Journal of Production Economics, 204, 383-394.

81. Danese, P., & Bortolotti, T. (2014). IT chain integration patterns and operational performance: a plant-level survey-based analysis. International Journal of Production Research, 7062-7083.

82. Day, G. (1994). The Capabilities of Market-Driven Organizations. Journal of Marketing, 58(4), pp. 37-52.
83. Day, M., Fawcett, S. E., Fawcett, A. M., & Magnan, G. M. (2013). Trust and relational embeddedness: Exploring a paradox of trust pattern development in key supplier relationships. Industrial Marketing Management, 42(2), 152-165.
84. Fatorachian, H., & Kazemi, H. (2018). A critical investigation of Industry 4.0 in manufacturing: theoretical operationalisation framework. Production Planning & Control, 29(8), pp. 633-644.
85. Fawcett, S. E., McCarter, M. W., Fawcett, A. M., Webb, G. S., & Magnan, G. M. (2015). Why IT chain collaboration fails: the socio-structural view of resistance to relational strategies. IT Chain Management: An International Journal, 20(6), 648-663.
86. Fayezi, S., & Zomorrodi, M. (2015). The role of relationship integration in IT chain agility and flexibility development: an Australian perspective. Journal of Manufacturing Technology Managment, 26(8), 1126-1157.
87. Felea, M. and Albăstroiu, I. (2013) 'Defining the Concept of IT Chain Management and its Relevance to Romanian Academics and Practicioners', Amfiteatru Economic, vol. 15, no. 33, p. 74–88.
88. Fernie, J., Sparks, L. and McKinnon, A. (2010) 'Retail logistics in the UK: past, present and future', International Journal of Retail and Distribution Management, vol. 38, no. 11, pp. 894-914.
89. Fiksel, J. (2013). Ensuring IT chain resilience: development and implementation of an assessment tool. Journal of business logistics, 34(1), 34(1), 46-76.
90. Flynn, B., Huo, B., & Zhao, X. (2010a). Simulation and Performance Evaluation of Partially and Fully Integrated Sales and Operations Planning. Journal of Operations Management, 28, 58-71.
91. Flynn, B., Huo, B., & Zhao, X. (2010b). The impact of IT chain integration on performance: A contingency and configuration approach. Journal of Operations Management, 28, pp. 58-71.

92. Geyi, D., Yusuf, Y., Menhat, M., & Abubakar, T. (2020). Agile capabilities as necessary conditions for maximising sustainable IT chain performance: An empirical investigation. International Journal of Production Economics, 222(1), pp. 1-18.
93. Ghobakhloo, M. (2019). Determinants of Information and Digital Technology Implementation for Smart Manufacturing. International Journal of Production Research.
94. Giannakis, M., & Louis, M. (2016). A multi-agent based system with big data processing for enhanced IT chain agility. Journal of Enterprise Information Management, 29(5), 706-727.
95. Gomm, M. (2008) IT Chain Finanzierung: Optimierung der Finanzflüsse in Wertschöpfungsketten, Berlin: Schmidt.
96. Gunasekaran, A., Subramanian, N., & Rahman, S. (2015). IT chain resilience: role of complexities and strategies. International Journal of Production Research, 53(22), pp. 6809-6819.
97. Gunasekaran, A., Subramanian, N., & Rahman, S. (2015). IT chain resilience: role of complexities and strategies. International Journal of Production Research, 53(22), pp. 6809-6819.
98. Gunasekaran, A., Yusuf, Y., Adeleye, E., & Papadopolous, T. (2018). Agile Manufacturing Practices: The Role of big Data and Business Analytics with Multiple Case Studies. International Journal of Production Research, 56, 385-397.
99. Gunasekaran, A., Yusuf, Y., Adeleye, E., & Papadopolous, T. (2018). Agile Manufacturing Practices: The Role of big Data and Business Analytics with Multiple Case Studies. International Journal of Production Research, 56, 385-397.
100. Gunasekaran, A., Yusuf, Y., Adeleye, E., Papadopoulos, T., Kovvur, D., & Geyi, D. (2019). Agile manufacturing: an evolutionary review of practices. International Journal of Production Research, 150, 5154-5174.
101. Gunasekaran, A., Yusuf, Y., Adeleye, E., Papadopoulos, T., Kovvur, D., & Geyi, D. (2019). Agile manufacturing: an evolutionary review of practices. International Journal of Production Research, 150, 5154-5174.

102. Hallikas, J., Karvonen, I., Pulkkinen, U., Virolainen, V.-M. and Tuominen, M. (2004) 'Risk management processes in supplier networks', International Journal of Production Economics, vol. 90, no. 1, p. 47–58.

103. Hanssmann, F. (1959) 'Optimal inventory location and control in production and distribution networks', Operations research: the journal of the Operations Research Society of America , vol. 7, p. 483–498.

104. Harrison, T.P. (2005) 'Principles for the strategic design of IT chains', in Harrison, T.P., Lee, H.L. and Neale, J.J. (ed.) The Practice of IT Chain Management: Where Theory and Application Converge, New York: Springer.

105. Hendricks, K.B. and Singhal, V.R. (2005) 'An Empirical Analysis of Effect of IT Chain Disruptions on Long-Run Stock Price Performance and Equity Risk of the Firm ', Production and Operations Management, vol. 14, no. 1, pp. 35-52.

106. Hendricks, K.B., Singhal, V.R. and Zhang, R. (2009) 'The effect of operational slack, diversification, and vertical relatedness on the stock market reaction to IT chain disruptions', Journal of Operations Management, vol. 27, p. 233–246.

107. Hofstätter, T., Krawina, M., Mühlreiter, B., Pöhler, S., & Tschiesner, A. (2020, October 27). Reimagining the auto industry's future: It's now or never. Retrieved from McKinsey & Company: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/reimagining-the-auto-industrys-future-its-now-or-never

108. Hohenstein, N.O., Feisel, E., Hartmann, E. and Giunipero, L. (2015) 'Research on the phenomenon of IT chain resilience: a systematic review and paths for further investigation', International Journal of Physical Distribution & Logistics Management, vol. 45, no. 1/2.

109. Holweg, M. and Pil, F.K. (2008) 'Theoretical perspectives on the coordination of IT chains', Journal of Operations Management, vol. 26, no. 3, p. 389–406.

110. Ivanov, D., & Dolgui, A. (2020a). A digital IT chain twin for managing the disruption risks and resilience in the era of Industry 4.0. Production Planning and Control, pp. 1-14.

111. Ivanov, D., & Dolgui, A. (2020a). A digital IT chain twin for managing the disruption risks and resilience in the era of Industry 4.0. Production Planning and Control, pp. 1-14.

112. Ivanov, D., & Dolgui, A. (2020b). Viability of Intertwined IT Networks: Extending the IT Chain Resilience Angles towards Survivability. A position paper motivated by COVID-19 outbreak. International Journal of Production Research, 58(10), pp. 2904-2915.
113. Ivanov, D., & Dolgui, A. (2020b). Viability of Intertwined IT Networks: Extending the IT Chain Resilience Angles towards Survivability. A position paper motivated by COVID-19 outbreak. International Journal of Production Research, 58(10), pp. 2904-2915.
114. Ivanov, D., Dolgui, A., & Sokolov, B. (2019). The impact of digital technology and Industry 4.0 on the ripple effect and IT chain risk analytics. International Journal of Production Research, 57(3), 829-846.
115. Ivanov, D., Dolgui, A., & Sokolov, B. (2019). The impact of digital technology and Industry 4.0 on the ripple effect and IT chain risk analytics. International Journal of Production Research, 57(3), 829-846.
116. Jabbour, A., Foropon, C., & Filho, M. G. (2018). When titans meet – can industry 4.0 revolutionise the environmentally-sustainable manufacturing wave? Technological Forecast and Social Change, 132, 18-25.
117. Jagtap, S., & Duong, L. N. (2019). Improving the new product development using big data: a case study of a food company. British Food Journal, 121(11), 2835-2848.
118. Jajja, M. S., Chatha, K. A., & Farooq, S. (2018). Impact of IT chain risk on agility performance: Mediating role of IT chain integration. Journal of Production Economics, 118-138.
119. Jitpaiboon, T., Dobrzykowski, D., Ragu-Nathan, T., & Vonderembse, M. A. (2013). Unpacking IT use and integration for mass customisation: a service-dominant logic view. Journal of Production Research, 51(8), 2527-2547.
120. Joshi, A., & Gupta, S. (2019). Evaluation of design alternatives of End-Of-Life products using internet of things. International Journal of Production Economics(208), 281-293.
121. Ju, Y., & Hou, H. (2021). Integration quality, value co-creation and resilience in logistics service IT chains: moderating role of digital technology. Industrial Management & Data Systems, 121(2), 364-380.

122. Juettner, U., & Maklan, S. (2011). IT Chain Resilience in the Global Financial Crisis: An empirical study. IT Chain Management - An International Journal, 16(4), pp. 246-259.
123. Juettner, U., & Maklan, S. (2011). IT Chain Resilience in the Global Financial Crisis: An empirical study. IT Chain Management - An International Journal, 16(4), pp. 246-259.
124. Jüttner, U. and Maklan, S. (2011) 'IT chain resilience in the global financial crisis: an empirical study', IT Chain Management: An International Journal, vol. 16, no. 4, pp. 246-259.
125. La Londe, B.J. (1997) 'IT Chain Management: Myth or Reality?', IT Chain Management Review, vol. 1, pp. 6-7.
126. Leat, P. and Revoredo-Giha, C. (2013) 'Risk and resilience in agri-food IT chains: the case of the ASDA PorkLink IT chain in Scotland', IT Chain Management: An International Journal, vol. 18, no. 2, p. 219–231.
127. Li, X., Holsapple, C., Wu, Q., & Goldsby, T. (2017). An empirical examination of firm financial performance along dimensions of IT chain resilience. Management Research Review, 40(3), pp. 254-269.
128. LMC. (2020, March 26). Impact of COVID-19 on Global Auto Industry: expect deeper decline than during the Great Recession. Retrieved from LMC homepage: https://lmc-auto.com/wp-content/uploads/202 0/03/LMCA-Global-LV-Sales-COVID-19-Impact-26-March-2020.pdf
129. Manuj, I. and Mentzer, J.T. (2008) 'Global IT chain risk management strategies', International Journal of Physical Distribution & Logistics Management, vol. 38, no. 3, pp. 192-223.
130. Munoz, A., & Dunbar, M. (2015). On the quantification of operational IT chain resilience. International Journal of Production Research, 53(22), pp. 6736-6751.
131. Nudurupati, S. S., Tebboune, S., & Hardman, J. (2016). Contemporary performance measurement and management (PMM) in digital economies. Production Planning and Control, 27(3), 226-235.

132. Pavlov, A., Ivanov, D., Dolgui, A., & Sokolov, B. (2018). Hybrid Fuzzy-Probabilistic Approach to IT Chain Resilience Assessment. IEEE Transactions on Engineering Management, 65(2), pp. 303-315.

133. Peteraf, M., & Barney, J. (2003). Unraveling the resource-based tangle. Managerial and decision economics, 24, pp. 309-323.

134. Petersen, K., Handfiled, R., & Ragatz, G. (2003). model of supplier integration into new product development. Journal of Production Innovation Management, 20(4), 284-299.

135. Pettit, T.J., Croxton, K.L. and Fiksel, J. (2013) 'Ensuring IT chain resilience: Development and implementation of an assessment tool', Journal of Business Logistics, vol. 34, no. 1, pp. 46-76.

136. Pettit, T.J., Croxton, K.L. and Fiksel, J. (2013), "Ensuring IT chain resilience: development and implementation of an assessment tool", Journal of Business Logistics, Vol. 34 No. 1, pp. 46-76.

137. Pettit, T.J., Croxton, K.L. and Fiksel, J. (2019), "The evolution of resilience in IT chain management: a retrospective on ensuring IT chain resilience", Journal of Business Logistics, Vol. 40 No. 1, pp. 56-65.

138. Pettit, T.J., Fiksel, J. and Croxton, K.L. (2010), "Ensuring IT chain resilience: development of a conceptual framework", Journal of Business Logistics, Vol. 31 No. 1, pp. 1-21.

139. Ponomarov, S. (2012) Antecedents and Consequences of IT Chain Resilience: A Dynamic Capabilities Perspective, [Online], Available: http://trace.tennessee.edu/cgi/viewcontent.cgi?article=2526&context=utk_grad diss [27 Oct 2014].

140. Ponomarov, S. and Holcomb, M. (2009) 'Understanding the concept of IT chain resilience', The International Journal of Logistics Management, vol. 20, no. 1, pp. 124-143.

141. Prajogo, D., & Olhager, J. (2012). IT chain integration and performance: The effects of long-term relationships, information technology and sharing, and logistics integration. International Journal of Production Economics, 135, pp. 514-522.

142. Purvis, L., Spall, S., Naim, M., & Spiegler, V. (2016). Developing a resilient IT chain strategy during 'boom' and 'bust'. Production Planning & Control, 27(7-8), pp. 579-590.

143. Qiang, Q. and Nagurney, A. (2009) 'Modeling of IT Chain Risk Under Disruptions with Performance Measurement and Robustness Analysis', in Wu, T. and Blackhurst, J. (ed.) Managing IT Chain Risk and Vulnerability: Tools and Methods for IT Chain Decision Makers, Berlin: Springer.

144. Raji, I. O., Shevtshenko, E., Rossi, T., & Strozzi, F. (2020). Industry 4.0 technologies as enablers of lean and agile IT chain strategies: an exploratory investigation. The International Journal of Logistics Management.

145. Rao, S., & Goldsby, T. (2009). IT chain risks: a review and typology. The International Journal of Logistics Management, 20(1), 97-123.

146. Ribeiro, J., & Barbosa-Povoa, A. (2018). IT Chain Resilience: Definitions and quantitative modelling approaches - A literature review. Computers & Industrial Engineering, pp. 109-122.

147. Rokkan, A. I., & Haugland, S. A. (2002). Developing relational exchange: effectiveness and power. European Journal of Marketing, 36(1-2), 211-230.

148. Sheffi, Y. and Rice, J.B. (2005) 'A IT Chain View of the Resilient Enterprise', MIT Sloan Management Review, vol. 47, no. 1, pp. 41-48.

149. Shin, H., Lee, J.-N., Kim, D., & Rhim, H. (2015). Strategic agility of Korean small and medium enterprises and its influence on operational and firm performance. International Journal of Production Economics, 181-196.

150. Shou, Y., Li, Y., Park, Y., & Kang, M. (2017). The impact of product complexity and variety on IT chain integration. International Journal of Physical Distribution and Logistics Management, 47(4), 297-317.

151. Soroor, J., Tarokh, M., & Shemshadi, A. (2009). Initiating a state of the art system for real time IT chain coordination. European Journal of Operational Research, 196(2), 635-650.

152. Spicer, J. (2005). Making Sense of Multivariate Data Analysis. Thousand Oaks: SAGE.

153. Tang, C. (2008) 'The power of flexibility for mitigating IT chain risks', Journal of Production Economics, vol. 116, no. 1, pp. 12-27.
154. Tang, C.S. (2006) 'Robust strategies for mitigating IT chain disruptions', International Journal of Logistics Research and Applications, vol. 9, no. 1, pp. 33-45.
155. Tao, F., Qi, Q., Liu, A., & Kusiak, A. (2018). Data-driven smart manufacturing. Journal of Manufacturing Systems.
156. Teece, D. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. Strategic Management Journal, 28, pp. 1319-1350.
157. Teece, D. (2014). A dynamic capabilities-based entrepreneurial theory of the multinational enterprise. Journal of International Business Studies, 45, pp. 8-37.
158. Teece, D., Peteraf, M., & Leih, S. (2016). Dynamic Capabilities and Organizational Agility: Risk, Uncertainty, and Strategy in the Innovation Economy. California Management Review, 58(4), pp. 13-35.
159. Teece, D., Pisano, G., & Shuen, A. (1997). Dynamic Capabilities and Strategic Management. Strategic Management Journal, 18(7), pp. 509-533.
160. Thun, J.-H. and Hoenig, D. (2011) 'An empirical analysis of IT chain risk management in the German automotive industry', International Jorunal of Production Economics , vol. 131, p. 242–249.
161. Tukamuhabwa, B., Stevenson, M., & Busby, J. (2017). IT chain resilience in a developing country context: a case study on the interconnectedness of threats, strategies and outcomes. IT Chain Management: An International Journal, pp. 1-38.
162. Tukamuhabwa, B., Stevenson, M., & Busby, J. (2017). IT chain resilience in a developing country context: a case study on the interconnectedness of threats, strategies and outcomes. IT Chain Management: An International Journal, pp. 1-38.
163. Tukamuhabwa, B., Stevenson, M., Busby, J., & Zorzini, M. (2015). IT chain resilience: definition, review and theoretical foundations for further study. International Journal of Production Research, 53(18), pp. 5592-5623.

164. Tukamuhabwa, B., Stevenson, M., Busby, J., & Zorzini, M. (2015). IT chain resilience: definition, review and theoretical foundations for further study. International Journal of Production Research, 53(18), pp. 5592-5623.
165. Tyndall, G.R., Gopal, C., Partsch, W. and Kamauff, J. (1998) Supercharging IT chains: New ways to increase value through global operational excellence, New York: John Wiley & Sons.
166. Wagner, S. and Bode, C. (2006) 'An empirical investigation into IT chain vulnerability', Journal of Purchasing & IT Management, vol. 12, p. 301– 312.
167. Wallenburg, C.M. and Weber, J. (2005) 'Structural Equation Modelling as a Basis for Theory Development within Logistics and IT Chain Management Research', in Kotzab, H., Seuring, S., Müller, M. and Reiner, G. Research Methodologies in IT Chain Management, Heidelberg: Physica.
168. Wamba, S., Dubey, R., Gunasekaran, A., & Akter, S. (2020). The performance effects of big data analytics and IT chain ambidexterity: The moderating effect of environmental dynamism. International Journal of Production Economics, 222(1), pp. 1-14.
169. Warner, K., & Wäger, M. (2019). Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. Long Range Planning, 52, pp. 326-349.
170. Wernerfelt, B. (1984). A Rsource-Based View of the Firm. Strategic Management Journal, 5(2), pp. 171-180.
171. Wieland, A. (2013) 'Selecting the right IT chain based on risks', Journal of Manufacturing Technology Management, vol. 24, no. 5, pp. 652-668.
172. Wieland, A. and Wallenburg, C.M. (2012) 'Dealing with IT chain risks: Linking risk management practices and strategies to performance', International Journal of Physical Distribution & Logistics Management, vol. 42, no. 10, p. 887–905.
173. Wieland, A. and Wallenburg, C.M. (2013) 'The influence of relational competencies
174. Wieland, A., & Wallenburg, C. (2013). The influence of relational competencies on IT chain resilience: a relational view. International Journal of Physical Distribution & Logistics Management, 43(4), pp. 300-320.

175. Wiengarten, F., Humphreys, P., Gimenz, C., & McIvoer, R. (2016). Risk, risk management practices, and the success of IT chain integration. International Journal of Production Economics, 361-470.

176. Wiengarten, F., Pagell, M., Ahmed, M. U., & Gimenez, C. (2014). Do a country's logistical capabilities moderate the external integration performance relationship? Journal of Operations Management, 32(1), 51-63.

177. Womack, J. P., Jones, D. T., & Roos, D. (1990). The machine that changed the world: The story

178. Wu, Y., Cegielski, C. G., Hazen, B. T., & Hall, D. J. (2013). Cloud Computing in Support IT Chain Information System in Infrastructure: Understand when to got the Cloud. Journal of IT Chain Management, 49(3), 25-41.

179. Yang, H. (2012). Factor Loadings. In N. J. Salkind, Encyclopedia of Research Design (pp. 481-483). Thousand Oaks: SAGE.

180. Yang, J. (2014). IT chain agility: Securing performance for Chinese manufacturers. International Journal of Production Economics, 150, 104-113.

181. Yang, Z., Aydin, G., Babich, V. and Beil, D.R. (2009) 'IT disruptions, asymmetric information, and a backup production option', Management Science, vol. 55, no. 2, p. 192–209.

182. Yu, W., Jacobs, M., Chavez, R., & Yang, J. (2019). Dynamism, disruption orientation, and resilience in the IT chain and the impacts on financial performance: A dynamic capabilities perspective. International Journal of Production Economics, 218, pp. 352-362.

183. Zhao, M., Droge, C. and Stank, T.P. (2001) 'The effects of logistics capabilities on firm performance: Customer-focused versus information-focus capabilities', Journal of Business Logistics, vol. 22, no. 2, pp. 91-107.

184. Zheng, T., Ardolino, M., Bacchetti, A., & Perona, M. (2020). The applications of Industry 4.0 technologies in manufacturing context: a systematic literature review. International Journal of Production Research.

185. Zhu, Q., Krikke, H., & Caniels, M. C. (2018). IT chain integration: value creation through managing inter-organizational learning. International Journal of Operations and Prodution Management, 38(1), 221-229.