

**HYPER-AUTOMATION AND OPEN INNOVATION:
THE FUTURE OF DIGITAL TRANSFORMATION
OF ACCESSIBLE AND COST-EFFICIENT
GLOBAL ONLINE EDUCATION**

by

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Dedication

This work is dedicated to all those who supported my educational and research journey, for whom their love, trust, faith, and sacrifices have been the source of my strength and inspiration.

To my beloved parents: My father, for teaching me the value of hard work. Though he is no longer with us, his dedication and legacy continue to guide me in every step I take. My mother, whose endless support and encouragement carried me through even the most challenging moments. Her unwavering belief in me has been a beacon of strength throughout this journey.

To my dear wife, whose love and steadfast support have made this achievement possible. She has been my anchor, caring for our four wonderful children while standing beside me with unwavering faith in my success.

To my children, whose joy and boundless energy inspire me to be the best version of myself. You are a significant motivation, and I hope that this achievement serves as a testament to the power of perseverance and lifelong learning. This work is as much yours as it is mine.

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Finally, I would like to thank the organisations that supported this research with great dedication. Their collaboration, resources, and commitment to this innovative research have been essential in bringing this project to enormous success. Their support has provided crucial insights, data, and practical applications that have enriched the study and ensured its real-world impact.

ABSTRACT

HYPER-AUTOMATION AND OPEN INNOVATION: THE FUTURE OF DIGITAL TRANSFORMATION OF ACCESSIBLE AND COST-EFFICIENT GLOBAL ONLINE EDUCATION

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This research examines the integration of Hyper-Automation and Open Innovation within a non-profit, global online educational institution to enhance operational efficiency, financial sustainability, and educational access at scale. This exploratory research was motivated by the challenge of delivering education that is both accessible and affordable to millions of learners, especially those in disadvantaged and geographically remote areas. The current education system is inadequate in addressing such challenges on a large scale due to resource constraints. Hence, this research proposes a digital-first approach based on automation and open innovation.

With a mixed-methods approach, the study examined more than eight key administrative and academic workflows in a commercial VLE serving over two million students. Quantitative primary data were gathered from system logs, labour cost reports, and automation scripts. Qualitative data were collected from stakeholder interviews,

technical documentation, and student support feedback. The research examined the relative productivity of manual versus automated workflows in enrollment, assessment setup, exam retake workflows, certifications, live broadcast workflows, and student support.

The results demonstrate that Hyper-Automation reduced their annual manual labour from 139,748 hours to 11,252 hours and their monthly process costs from 109,245 USD to 9,000 USD, resulting in a staggering gain of over 91%. Automation not only streamlined high-volume tasks but also improved process consistency, response time, and scalability. Open Innovation helped bring together open-source technology, community-developed tools, and modular infrastructure to decrease reliance on a single vendor and reduce licensing costs.

The research confirmed two central hypotheses: (1) Hyper-Automation and Open Innovation substantially improve cost-efficiency in the provision of large-scale online education. (2) By adopting these approaches, an educational organisation can ensure a cost-efficient, large-scale online education provision with an agile core team of highly skilled staff, overcoming limitations in technical resources while ensuring long-term sustainability. Notably, the research revealed that human oversight remains essential and is still necessary to manage emotionally sensitive support cases and to review the quality of processes.

This research presents a replicable model and a practical strategic implementation plan for educational organisations seeking scalable digital transformation. It offers practical implications and future research directions for AI-supported content generation and infrastructure design, aiming to deliver global digital education more efficiently.

TABLE OF CONTENTS

List of Tables	ix
List of Figures	x
CHAPTER I: INTRODUCTION.....	1
1.1 Introduction.....	1
1.2 Research Problem	4
1.3 Purpose of Research.....	12
1.4 Significance of the Study	14
1.5 Research Purpose and Questions	17
1.6 Research Hypothesis	18
CHAPTER II: REVIEW OF LITERATURE	20
2.1 Theoretical Framework.....	21
2.2 Theory of Reasoned Action	23
2.3 Human Society Theory	31
2.4 Summary	33
CHAPTER III: RESEARCH METHEDODOLOGY	34
3.1 Overview of the Research Problem	34
3.2 Operationalization of Theoretical Constructs	37
3.3 Research Purpose and Questions	40
3.4 Research Design.....	44
3.5 Population and Sample	49
3.6 Participant Selection	52
3.7 Instrumentation	54
3.8 Data Collection Procedures.....	58
3.9 Data Analysis	64
3.10 Research Design Limitations	67
3.11 Conclusion	70
CHAPTER IV: RESULTS.....	72
4.1 Research Question One	74
4.2 Research Question Two	86
4.3 Research Question Three	91
4.4 Research Question Four.....	95
4.5 Research Question Five	98
4.6 Research Question Six	101

4.7 Research Question Seven.....	103
4.8 Research Question Eight.....	106
4.9 Research Hypothesis	109
4.10 Summary of Findings.....	112
4.11 Conclusion	114
CHAPTER V: DISCUSSION.....	116
5.1 Discussion of Results.....	117
5.2 Discussion of Research Hypothesis One	124
5.3 Discussion of Research Hypothesis Two.....	143
CHAPTER VI: SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS.....	149
6.1 Summary	149
6.2 Implications.....	152
6.3 Recommendations for Future Research	157
6.4 Conclusion	159
APPENDIX A PARTICIPANT INFORMATION LETTER.....	164
APPENDIX B INFORMED CONSENT	169
APPENDIX C INTERVIEW GUIDE	171
REFERENCES	175

LIST OF TABLES

Table 3.1: Unit of Analysis Overview	47
Table 3.2: Overview of Population and Sample Groups	51
Table 3.3: Research Instruments.....	58
Table 4.1: Learning Specification Model Components	79
Table 4.2: System Performance Indicators - Before vs. After Automation.....	85
Table 4.3: Key Technologies and Functions.....	94
Table 4.4: Challenges of Open Innovation and Hyper-Automation	105
Table 4.5: Technical Expertise Matrix.....	108
Table 5.1: Manual vs. Automated Process Overview.....	125

LIST OF FIGURES

Figure 4.1: Hyper-Automation - Learning Specification Model	77
Figure 4.2: Virtual Learning Environment Hyper-Automation Architecture v5.0	81

CHAPTER I:

INTRODUCTION

1.1 Introduction

Digital transformation has emerged as a key driver of innovation across various sectors in recent years. Global online education can advance significantly for both educational organizations and students when there is a strong focus on accessibility and cost efficiency. Technical developments are enabling businesses to leverage processes efficiently with advanced automation. The rapid advancement of technology has significantly simplified various aspects of human life, leading to the continuous introduction of new technologies, products, services, and concepts by business leaders. Hyper-automation represents a technological paradigm shift that leverages robotic process automation, artificial intelligence, machine learning, and other advanced tools to create intelligent automation processes. This approach enhances efficiency, reduces operational costs, and improves accuracy across various industries. Hyper-automation is not merely about automating individual tasks; it involves orchestrating multiple technologies to achieve end-to-end business process automation, thus unlocking strategic business value. Strategic management plays a crucial role, as managers must actively foresee and adjust to changes, explore new resource allocation opportunities, and strategically position their companies within a stable market environment (Malaska and Holstius, 1999).

Hyper-Automation is a confluence of several technological innovations and process optimization. The new opportunities for educational organizations arise due to the growing demand for global online education, which is enabled by improvements in technical infrastructure, such as enhanced internet accessibility. Hyper-automation enables educational organizations to efficiently scale their online offerings and reach a broader

audience of students worldwide, overcoming geographical barriers and making high-quality education more accessible and cost-effective. Hyper-automation refers to a strategic approach that leverages artificial intelligence, machine learning, and a diverse set of automation tools to revolutionize a wide array of business and IT processes (Madakam, Holmukhe, and Revulagadda, 2022).

The sustainable strategy of an educational organization is crucial because online education costs can increase rapidly as millions of students enroll. Therefore, open innovation plays a major role in online educational technical architecture. Open innovation can help educational organizations develop more sustainable and cost-efficient strategies for their online programs. By collaborating with external partners, they can tap into a wider pool of ideas, technologies, and resources to enhance their technical infrastructure and delivery models. This collaborative approach can lead to innovative solutions that make high-quality online education more accessible and affordable for a global student population. Open innovation has been proven to have a positive impact on a company's ability to innovate by offering three significant advantages: the sharing of knowledge, minimizing risk, and accelerating development processes (Lassen and Laugen, 2017).

The importance of providing more accessible, high-quality education in developing countries, particularly in communities with high poverty rates and affected by high inflation, cannot be overstated (Moshtari and Safarpour, 2023). These communities may benefit directly from the research findings, as they often face significant barriers to accessing quality education. By leveraging hyper-automation and open innovation, educational organizations could develop more cost-efficient and scalable online programs that reach these underserved populations, empowering them with the knowledge and skills needed to improve their livelihoods. For an adaptive leader, it's essential to possess the cognitive flexibility to comprehend complex opportunities and recognize the interrelations

within a broader context (McPherson, 2016). The target of the research is to combine advanced technical innovations with online educational services and processes, enabling educational organizations to sustainably reach millions of global students online.

As the world becomes increasingly interconnected and knowledge-driven, the demand for accessible and cost-effective global online education emerges. The relevance of this research topic is vital, as it is essential to understand the potential of hyper-automation and open innovation that can shape the future of accessible and cost-efficient global online education. This research topic is critical since it addresses the issue of future accessible and cost-efficient global online education. It discusses how the study can provide high-quality education to more people globally in an accessible and cost-efficient way. By leveraging the power of emerging technologies and collaborative strategies, the future of digital transformation in online education holds the promise of breaking down barriers and expanding access to knowledge and skills for individuals worldwide, regardless of their geographic location or socioeconomic background. There is a tendency for organizations as they often struggle to maintain their position within their respective industries when there are shifts in technologies or markets (Bower and Christensen, 1995).

Hyper-Automation is a recent innovation first described by Gartner. Hyper-Automation combines effectively enhanced sets of developments that incorporate individual processes and functions into advanced business process automation (Ray et al., 2019). There is a lack of scholarly literature, including research articles, books, and white papers, on this topic, which makes it difficult to rely solely on academic research as a foundation. However, Madakam, Holmukhe, and Revulagadda (2022) have conceded that their findings on hyper-automation revealed that it stands out as one of the most advanced technologies developed by humans to date.

Digital Transformation has been a major source of innovation for companies across various industries over the past few years (Parua and Yang, 2024). Worldwide online education can take significant steps forward for both educational institutions and students when there is a high emphasis on access and cost-effectiveness (Alenezi, 2023). Technical developments enable businesses to utilize business processes more efficiently through advanced automation. Strategic management plays a decisive role, for which managers should be able to foresee and adapt to changes, seek new possibilities in resource utilization, and position their companies favorably in the market (Malaska and Holstius, 1999).

1.2 Research Problem

Independent technical e-learning consulting firms have suggested, based on their experience with online education, that educational institutions should allocate ten staff members for every ten thousand students they have enrolled. This means that one hundred employees will be able to handle an enrollment of one million students. However, organizations offering free education face challenges in implementing this strategy due to resource and budget constraints. This research presents an important opportunity for educational institutions to support global growth, but also poses the challenge of delivering educational services to millions of students with limited resources through strategic servitization.

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resource and budget constraints. This research presents a significant opportunity for educational institutions to support global growth, but also poses the challenge of delivering educational services to millions of students with limited resources through strategic servitization. Leveraging emerging technologies and open collaboration can enable educational organizations to overcome these obstacles and develop cost-efficient, scalable online programs that expand access to quality education worldwide.

Understanding how to address technical challenges with innovative solutions is essential for managing a large number of students through automation. This approach will also establish a foundation for future automation within Virtual Learning Environments and provide opportunities for online educational organizations to expand. Overcoming these challenges will have a direct and indirect benefit for large societies. Educational institutions will be able to provide better services to students while lowering educational costs, making better use of resources, and improving the learning experience. Educational organizations will be able to create cost-effective and large-scale online programs that provide high-quality education to a significantly larger number of students from around the world, particularly in underserved communities. This innovative strategy can help break down barriers to accessing knowledge and skills, empowering individuals across the globe regardless of their geographic location or socioeconomic status. Another, more specific reason to do it this way is the effective use of automation technologies, such as AI and machine learning. These innovations enable the automation of various processes, reduce administrative challenges, enhance personalized learning experiences, and provide better controls in terms of quality assurance.

The research aims to improve the interaction and visualization of operational procedures, activities, and key metrics within the organization. This will enhance the understanding of how these operations are interconnected. Adopting a Hyper-Automation

approach enables organizations to recognize opportunities for automating processes and workflows. Organizations must harness effectiveness, organizational flexibility, and productivity (Costello and Rimol, 2020). Thus, the innovative strategy of Hyper-Automation and Open Innovation should focus on cultivating extensive knowledge and awareness of automation possibilities in online education and associated services.

Online education has experienced phenomenal growth over the last decade. Several reasons are behind this growth. Availability and access to the Internet, as well as considerable development in educational technology, are among the factors that have contributed significantly to this massive growth. Recently, the global pandemic of coronavirus (COVID-19) has acted as a stimulus, compelling all colleges and universities to implement online learning platforms in order to continue their teaching-learning processes despite the pandemic in different parts of the world. While this shift has opened opportunities for global learners, it has also introduced a complex set of challenges that institutions must address.

1.2.1 Resource Constraints

Both human and technological resources are often limiting factors in conducting business and supporting online education at scale. Budgets are often so constrained that schools are unable to provide adequate human support and develop sufficient technology infrastructure. These resource constraints can pose significant challenges in effectively delivering high-quality online education at scale. Institutions must explore innovative strategies and technologies to maximize the efficient utilization of available resources, such as leveraging automation, optimizing workflows, and exploring collaborative partnerships to share costs and resources.

1.2.2 Administrative Challenges

As student numbers grow, the administrative workload associated with course management, student interaction, helpdesk, assessment grading, and certification all increases. Much of this is carried out manually, is repetitive, and time-consuming, resulting in growing operational costs and a strain on resources within the educational establishment, which diverts attention away from core teaching and learning activities. New approaches and technologies, such as automation and intelligent workflow management, are essential to address these repetitive workload demands and free up resources to focus more on the students and personalized learning experience.

1.2.3 Quality Assurance

As student bodies increase, it becomes increasingly challenging to offer the same quality of education, timely and useful feedback, and personalized learning experiences. With more students going online, it becomes increasingly complex to maintain the level of quality for a larger number of students. Organizations are encountering challenges in delivering standardized assessment, timely and valuable feedback, and personalized learning paths at scale. The solution lies in a set of approaches that address these challenges using automation and insights gained from data. Using Hyper-Automation strategies, such as AI-powered grading, content recommendations, and automated performance tracking, can help institutions overcome these scaling issues and deliver high-quality online education to a large number of students.

1.2.4 Scalability Issues

Traditional Virtual Learning Environments often struggle to scale efficiently. Educational institutions are often dependent on traditional administrative and pedagogical models that can't scale up to serve a large number of learners. The number of online learners is growing rapidly, and it is challenging for traditional VLEs to scale up to

accommodate the vast number of learners while maintaining the quality of the learning experience. Institutions must explore innovative strategies and technologies, such as Hyper-Automation and Open Innovation, to overcome scalability challenges and develop scalable online education platforms that can effectively serve a large and diverse number of learners without affecting the quality of the learning experience.

1.2.5 Technological Barriers

Although the modern digital tools enable the automation and optimization of processes, educational institutions often lack the knowledge, infrastructure, and vision to implement and benefit from cutting-edge automation technologies, such as artificial intelligence, machine learning, and robotic process automation. This technological shortcoming and lack of strategic vision prevent universities from automating their administrative workflows, personalizing learning, and ensuring quality on a large scale. Overcoming their technological shortcoming and strategic vision is critical for institutions in order to enable Hyper-Automation and deliver cost-efficient and scalable, high-quality online education to a wider global audience.

1.2.6 Cost-Efficient Education for Developing Countries

With the growing global population, and especially in developing countries, a huge demand for low-cost and accessible education has emerged. A considerable number of children and youth in developing countries do not have access to education. This is due to the lack of both financial means and infrastructure, as well as the political situation in many countries. Cost-efficient and scalable educational solutions are essential to bridge the global education gap.

Cost-efficient education and access to education are scarce in most developing countries. Developing countries have very limited resources, poor infrastructure, and other socio-economic challenges that prevent most of their citizens from accessing education.

Cost-efficient and scalable educational models are the solutions to this problem. Innovative educational models must leverage technology, efficient resource allocation, and establish collaborative partnerships to increase access to quality education. By implementing these transformative approaches, academic institutions and governments in developing countries can work towards bridging the global education gap and empowering individuals with the knowledge and skills necessary for personal and societal growth (GGI Insights, 2024).

1.2.7 Education for Displaced Populations and Refugees

As conflicts, wars, and displacement of people increase, there is a need for education that is flexible, accessible, anytime and anywhere. People in a displacement situation are likely to experience prolonged education disruptions. Therefore, it is important to have automated, mobile, and scalable learning systems that can enable people in displacement to continue learning regardless of geopolitical events. Cloud-based, AI-enabled learning platform can be designed to be accessible remotely, learning for life pathways that are personalized, available in multiple languages, and culturally relevant without much dependency on physical infrastructure, and at scale for a large population. Technology-driven solutions can ensure educational continuity and empower displaced individuals to acquire essential skills and knowledge, improving their long-term socio-economic prospects.

1.2.8 Sustainability and Economic Viability

Many educational institutions in both developed and developing countries have unsustainable business models that limit their prospects for sustainable development in the long run. Unless cost-saving technologies and innovative solutions are widely implemented, these institutions are likely to be unable to fulfill the rapidly increasing demand for education. The research problem this study addresses is how to design a self-sustaining, scalable, and adaptive digital learning environment with low total cost of

ownership but high scalability, accessibility, and educational quality. This research aims to provide sustainable and affordable business models that can be enabled by Hyper-Automation and Open Innovation to digitalize the global online education, especially those serving the rapidly increasing populations in developing countries.

The rise in the number of conflicts, economic crisis, and climate disasters has given birth to a huge number of displaced populations and refugees around the world. As a result, crores of people, most of them being children and young adults, are experiencing educational disruption for an extended period of time, which hinders their ability to thrive. The current education system has proven to be incapable of serving the educational needs of displaced populations and refugees due to its reliance on physical infrastructure, static curricula, and geographically confined operations (Banerjee et al., 2022). The displaced population and refugees don't have access to a stable education system. They are facing a difficult time trying to continue learning. Without access to education, they are unable to continue learning and struggling to develop the necessary skills for their future.

Automated, cloud-based learning environments are the key solution to ensure uninterrupted education for displaced people. Flexibility, scalability, and accessibility are provided by the use of Hyper-Automation and Open Innovation to learn irrespective of where they are and the crisis situation they are in. Automated digital educational platforms can offer several advantages:

1.2.9 Remote Accessibility

Online learning systems help students to access learning materials from anywhere in the world, hence reducing the effects of geographical barriers to education (Mdhlalose and Mlambo, 2023). Online learning platforms or virtual learning systems allow learners to participate in learning programs regardless of their location. Therefore, learners can

participate in learning programs even when they are displaced or there is no conducive learning environment in their respective communities.

1.2.10 Personalized Learning Paths

Automation through AI can be achieved through machine learning and data analytics to help personalize learning programs for learners. This means that learners can access education and catch up with their learning pace even in a disrupted learning environment. This personalized approach enables flexible and adaptive learning, allowing students to learn at a rhythm that best suits their unique circumstances and learning styles (Weng and Zhang, 2025).

1.2.11 Multilingual and Culturally Inclusive Content

Automated translation and adaptation of content enable refugee and displaced learners to access education in their mother tongue, thereby improving the overall inclusiveness and effectiveness of learning (Alrawashdeh and Kunt, 2022). Offering educational materials in learners' first languages through automated systems improves understanding, participation, and retention, and empowers displaced people to gain skills and knowledge that can positively impact their socio-economic situations in the long term.

1.2.12 Reduced Dependency on Physical Infrastructure

Unlike a local school, an automated online educational platform does not need any fixed buildings or other physical infrastructure (Tobin and Hieker, 2021). This flexibility makes it ideal for use in refugee camps, temporary settlements, and other environments where physical classrooms and other structures may be difficult to access (Tobin and Hieker, 2021). It also means that learning can be quickly and easily established in response to crisis situations and changing conditions, ensuring continuity of education for displaced populations.

1.2.13 Scalability to Support Large Numbers of Students

Automated learning environments must not be exhausted when more learners enrol in the program, as they must be able to offer education systems of any kind to displaced populations in a sustainable way. Automated learning environments can scale up to larger student enrollments, and this enables institutions to continue to offer education to displaced populations in a sustainable way, even as the number of displaced populations that seek learning opportunities continues to increase.

This research investigates how Hyper-Automation and Open Innovation can allow institutions and governments to respond to crisis scenarios by enabling the establishment of technical educational systems to serve displaced populations and learning opportunities for refugees. This not only ensures learning continuity in crisis situations, but it also empowers affected populations to gain skills and knowledge in a sustainable way to improve their socio-economic situation in the long term.

1.3 Purpose of Research

The research study intends to develop a roadmap that is extensive and bold in nature for the digital transformation of global online education. The objective of the roadmap is to offer services and learning resources of high quality to a continuously growing number of users. The target for initial enrollment is two million registered students within the first year and five million enrolled students within the five-year perspective plan. The expansion plan has been debated among the management, stakeholders, and investors who have reached a consensus and recognition on the fact that there is a great opportunity for the development, scale, and quality of eLearning technologies and innovative approaches.

By implementing innovative eLearning technology solutions, the research project aims to surpass the capabilities of the current traditional education systems and fulfill the

demand of large and highly diverse populations in situations of displacement due to conflict, economic crisis, and climate-related disasters. The wide scope of the research aims to benefit displaced populations, primarily children and young people, by ensuring that, wherever they are, they will always have continuous, personalised, adaptive, and multilingual educational content available to them, irrespective of the displacement situation they are in.

The research emphasizes the technical possibilities and scalability inherent in eLearning, with the objective of developing a resilient, technology-driven education ecosystem that can accommodate the increasing demand for accessible and cost-efficient global online education. This ambitious target, aligned with the discussions and agreements reached with stakeholders and investors, reflects the project's commitment to transforming the landscape of digital learning and ensuring that educational opportunities remain available to learners worldwide, even in the face of unprecedented challenges.

The research highlights the vast scope and technical potential in eLearning, emphasizing its ability to accommodate such substantial growth. To achieve this goal, the research focuses on two key areas: hyper-automation and open innovation and aims to help organizations conceptualize innovation (Rezende Pinto, Saur-Amaral and Brito, 2019).

The study should propose a sustainable hyper-automation solution utilizing diverse open innovation approaches to contribute to the expansion strategy aimed at serving five million registered students within the next five years. Analyzing new and innovative approaches in products and services beyond traditional methods is crucial for staying competitive in the market (Chang, 2011). It is essential that this solution not only enhances efficiency but also ensures scalability and long-term sustainability for accommodating such a large user base.

The objective of the research is to facilitate organizations in effectively handling and providing comprehensive technical support, diverse educational materials, personalized lessons, robust academic guidance, secure exam administration, and efficient student management using limited resources while reducing expenses. The specific aim of this study is to realize a scalable solution to serve the varied demands of five million enrolled students with only a limited department of twenty full-time employees. To achieve this ambitious goal, it is essential to identify, recognize, acknowledge, and implement a wide range of innovative possibilities for Hyper-Automation and Open Innovation. The study should provide a solid technical and organizational basis for a sustainable Hyper-Automation and Open Innovation solution to ensure a profitable business model for the system and the ability to support significant growth of the number of users and corresponding services.

1.4 Significance of the Study

This study holds substantial significance in its capacity to reshape the landscape of global online education through the integration of Hyper-Automation and Open Innovation. As the demand for accessible, cost-effective, and high-quality online educational services intensifies, organizations face significant hurdles in expanding their operations while maintaining high academic standards. This research endeavors to offer a sustainable and technologically driven solution that empowers educational institutions, particularly non-profit organizations, to manage millions of students efficiently with limited resources.

This study contributes to the academic literature by addressing the intersection of educational technology, automation, and strategic management. Although existing research has investigated automation in business and industry contexts, there is a dearth of

comprehensive studies examining its application within Online Education and Virtual Learning Environments. By leveraging Hyper-Automation, this research introduces a novel paradigm for digital education management, providing insights into how artificial intelligence, machine learning, and robotic process automation can optimize administrative and instructional workflows (Alotaibi, 2024).

Furthermore, this study advances the science of Open Innovation by demonstrating how academic institutions can benefit from external technological innovations to improve teaching processes and costs, and provides a blueprint on how educational institutions can use cutting-edge innovations while reducing institutional costs to educate people around the globe.

In terms of practical contribution, this study provides a scalable and replicable solution that educational institutions can adopt to improve student learning and support, as well as office processes. Through the analysis of daily processes in educational institutions, this study reveals recurring tasks that are time-consuming and can be automated, and more importantly, provides suggestions for suitable office staff to reallocate to other more valuable tasks, such as designing teaching materials, providing personalized services to students, and conducting academic research.

The research findings must include practical significance for educational policymakers, administrators, and technology vendors, and should sketch a blueprint for the gradual implementation of automation technologies in the classroom. The results of the study should provide policy-relevant recommendations for enhancing student learning, offering high-quality courses, and improving institutional effectiveness through the intelligent use of automation while maintaining the integrity of the educational process.

The results of this research should have important economic and social impacts, particularly for populations with low educational resources. Lowering the cost per student

and decreasing reliance on manual processes for administrative tasks can increase the affordability of institutions, allowing millions more learners, primarily in developing countries, to access high-quality education.

Hyper-Automation and Open Innovation should ensure the sustainability and longevity of online education by enabling the organizations to function efficiently with minimal reliance on large support and administrative departments. The importance of increased accessibility of education is also addressed as an international goal and contributes to the UNESCO Sustainable Development Goals (Saleem and Dare, 2023).

This research establishes a foundation for technological advancements in online education, which is a potential future direction for scholars to pursue in their research. It lays the groundwork for exploring AI-driven adaptive learning, predictive analytics for student performance, and AI-powered curriculum development (Tonbuloğlu, 2023). Additionally, the study encourages further academic exploration into how emerging technologies, such as blockchain, cloud computing, and AI ethics, can shape the evolution of intelligent learning environments.

In summary, this study is significant on multiple levels, academically, technologically, economically, and socially. The study is valuable not only in terms of the concrete solutions it offers for the scaling up of online education, but also in terms of the inspiration it can provide for similar future work. By integrating Hyper-Automation and Open Innovation, this research offers a transformative approach that provides an opportunity to ensure that quality education remains accessible, sustainable, and future-ready.

1.5 Research Purpose and Questions

The defined research question is: "Can an international non-profit online educational institution, with limited resources, effectively deliver accessible education to five million enrolled students using technical advancements like hyper-automation and open innovation?" The research seeks to explore whether such an organization can leverage emerging technologies and collaborative strategies to scale its operations and expand access to quality online education, despite facing resource constraints and a non-commercial focus. To holistically address the primary research question, several sub-questions must be examined (Bulathwela et al., 2021).

Non-profit organizations that are offering free worldwide online education are facing obstacles in achieving financial stability (D'Agostino, 2023). The focus of the research is to reduce management and operational expenses in correlation with leveraging educational quality for online education through automation and innovative open practices. The research questions that will guide this study are:

RQ1: What are the key challenges faced by educational institutions in delivering accessible education to a large number of enrolled students?

RQ2: What are the potential benefits and drawbacks of utilizing hyper-automation and open innovation in the context of online education?

RQ3: What are the specific technological developments and strategies within hyper-automation and open innovation that can be implemented to effectively deliver accessible education to five million enrolled students?

RQ4: What strategies can be implemented to ensure long-term financial stability and scalability of a hyper-automation and open innovation solution in the context of online education for five million enrolled students?

Open innovations offer affordable technical solutions backed and sustained by a wide array of developers, organizations, and governments. These opportunities are a prominent benefit in accelerating progress and reducing the need for highly trained technical personnel (Sokolov, Pershin and Bocharov, 2018).

RQ5: What open innovation strategies are appropriate for implementation in online learning environments alongside hyper-automation?

RQ6: How effectively can the open innovation solutions be integrated into the Hyper-automation technical infrastructure?

RQ7: What are the potential challenges and risks associated with implementing open innovation in an online education setting alongside hyper-automation?

Advanced innovations require highly technical, skilled resources that are limited in the market. Therefore, it's essential to understand the need for skilled resources.

RQ8: What is the Level of technical expertise needed for the research implementation and digital transformation?

1.6 Research Hypothesis

The aim of this research is to investigate how hyper-automation and open innovation could reshape the online education sector of non-profit global online education. The following research hypotheses will direct the subsequent exploration on how hyper-automation and open innovation could improve accessibility, cost-effectiveness, and sustainability of online education.

Hypothesis 1: Implementing Hyper-Automation and Open Innovation in a non-profit global online educational organization will significantly increase cost-efficiency by reducing online education management and operational costs, thereby enabling the organization to serve five million enrolled students more effectively and sustainably.

Hypothesis 2: Leveraging Hyper-Automation and Open Innovation in the digital transformation of a non-profit global online educational organization will lead to a more accessible and efficient online education system, with the potential to overcome limitations in skilled technical resources and contribute to long-term sustainability.

CHAPTER II:

REVIEW OF LITERATURE

The literature review offers an in-depth and detailed review of the academic literature and scholarly publications related to the key concepts of the research, which focuses on hyper-automation, open innovation, digital transformation, and online education. The literature review offers an in-depth and detailed review of the academic literature and scholarly publications related to the key concepts of the research. It will cover the most recent, latest, and current research, theories, models, and empirical studies related to the research topic. A comprehensive and exhaustive literature review will help build a strong theoretical background for the rest of the study and identify any gaps or areas that need further study in the existing literature. It will also identify the key concepts, theories, and empirical findings related to the research topic. Literature review starts with Hyper-Automation and its application in educational institutions. Followed by Robotic Process Automation, Artificial Intelligence, and its potential in transforming educational institutions.

Given the unprecedented digitalization and extensive utilization of distance learning, there is a compelling need to reevaluate the methods employed in supporting students throughout their educational journey (Su et al., 2025). Hyper-Automation is one of the most promising technical innovations that is disruptive to many industries. There are no publications that support this completely. However, it's important to combine various individual studies that, in combination, will support the research in Hyper-Automation, Open Innovation, Online Education, Robotic Process Automation, and Artificial Intelligence.

2.1 Theoretical Framework

The theoretical underpinnings of this research are grounded in two complementary conceptual frameworks: Hyper-Automation, an emerging paradigm in digital transformation, and Open Innovation, a strategic enabler of scalable and sustainable technological ecosystems. Though originating from distinct academic traditions, these frameworks offer a synergistic perspective to critically analyze the hyper-automated advancement of Virtual Learning Environments and educational services.

2.1.1 Hyper-Automation: Beyond Traditional Process Optimization

Coined by Gartner, Hyper-Automation refers to the integration of artificial intelligence (AI), robotic process automation (RPA), machine learning (ML), and intelligent business process management (iBPMS) to automate not only individual tasks but entire business workflows (Costello and Rimol, 2020). It is positioned as an advancement beyond traditional automation because of its self-reinforcing architecture that enables systems to discover, design, analyze, monitor, and continuously optimize operations.

In the context of this research, Hyper-Automation is adopted as a strategic response to scale. It allows educational organizations to deliver educational services to millions of students with minimal operational strain and resource dependency. Leveraging hyper-automation enables organizations to enhance their agility, adaptability, and operational intelligence capabilities that are fundamental in an increasingly volatile digital environment (George and Wooden, 2023).

This theoretical framework guides the technical approach of the research, enabling the automation of key educational processes such as student registration, content distribution, exam management, and student support services. This, in turn, facilitates the

establishment of a cost-efficient and sustainable infrastructure to deliver online educational services.

2.1.2 Open Innovation: Distributed Knowledge and Collaborative Scalability

Concurrently, the study draws upon the Open Innovation framework which emphasizes that organizations can and should use both internal and external ideas to advance their technology and service offerings (Leitão, Pereira and Gonçalves, 2022). As supported by Pedersen, (2020), open innovation facilitates access to external expertise, significantly reducing innovation lead time and risk exposure factors especially critical for non-profit institutions with budgetary constraints.

Open Innovation is not merely a cost-saving mechanism but a strategic enabler. Open-source technologies such as Moodle, H5P, Minio, Sentry, and GitLab provide extensible, community-maintained platforms that accelerate digital transformation and allow for seamless integration within the hyper-automated VLE infrastructure. These types of tools facilitate collaborative development and serve as the connective tissue that binds together distributed automation services.

The Knowledge-Based View of the firm posits that knowledge is the most strategically significant resource of the organization, and the creation, transfer, and application of knowledge are critical for achieving a competitive advantage. Open innovation, which facilitates the inflow and outflow of knowledge, aligns with this view by enabling organizations to tap into external sources of innovation and expertise. The Open Innovation theory provides a framework for understanding how organizations can leverage external ideas and technologies to complement their internal innovation processes. The theory emphasizes the importance of collaboration and knowledge sharing with external partners to accelerate innovation and create value, and this theory is particularly relevant to this research, as open innovation strategies can enable educational

institutions to access a broader range of expertise and resources to support their digital transformation efforts (Heidemann Lassen and Timenes Laugen, 2017).

2.1.3 Servitization and Digital Scalability

A supporting lens is taken from the concept of servitization which describes how product-focused companies transform into value-relevant services (Kamalaldin et al., 2020). In this study, the provider is itself a service-oriented platform which continuously provides service outputs through automation instead of one-off content distribution.

This conceptual strand is essential to interpret how a limited internal human workforce maintains a globally distributed student population. As Annand, (2007) suggest, that if automated services are properly designed, the costs of these services can be drastically reduced, and the global institutions can be much more scalable without quality sacrifices.

The Dynamic Capabilities View extends by emphasizing the ability of an organization to adapt, integrate, and reconfigure internal and external competencies to address rapidly changing environments (Niță and Guțu, 2023). The technology acceptance model attempts to understand how people adopt and use new technology and digitalization, which are perceived usefulness and perceived ease of use (Niță and Guțu, 2023).

2.2 Theory of Reasoned Action

The Theory of Reasoned Action (Fishbein and Ajzen, 1975), an early theory proposed by Fishbein and Ajzen, offers a sound psychological basis for the study of behaviour in decision-making. In its simplest form, this theory suggests that the intention to perform a particular behaviour is the most direct and proximal predictor of that behaviour, which in turn is influenced by two determinants, namely attitudes towards the behaviour and subjective norms.

In relation to this research, the Theory of Reasoned Action serves as a valuable perspective in exploring how both students and staff interact with hyper-automated systems within the Virtual Learning Environment. The utility of this theory is its ability to recognise the influence of beliefs, perceptions, and social influence on the readiness to adopt and use automated digital infrastructure.

2.2.1 Attitudinal Beliefs Toward Hyper-Automation

Attitudinal beliefs reflect the extent to which the user perceives the outcomes of performing the behavior as positive or negative (Fishbein and Ajzen, 1975). In the VLE Hyper-Automation environment, this would relate to perceptions of usefulness and reliability, efficiency of the system. Positive attitudes should be induced when users believe that automation decreases complexity, increases learning and administrative efficiency, and supports faster response times.

Conversely, any perceived lack of transparency, depersonalization, or fear of replacement by automation will induce negative attitudes, which will weaken the behavioral intention. This is particularly important in a learning environment where trust, user agency and perceived control has been identified as key factors to technology adoption (Rodway and Schepman, 2023).

2.2.2 Subjective Norms and Institutional Influence

Subjective norms involve the perceived social pressures to perform or abstain from a behavior. These can stem from institutional leadership, peer users, or the broader academic culture. In this consultancy, the aggressive scaling strategy of the organization and the top-down prioritization of Hyper-Automation may generate a normative expectation among employees and students to support or adopt these tools.

The degree of internalization of these norms is critical. TRA implies that unless users align personally or socially with these expectations, mere exposure to automation

will not lead to behavioral adoption. Therefore, initiatives that include participatory design, feedback loops, and transparent communication can play a decisive role in reinforcing positive subjective norms (Wanner et al., 2022).

2.2.3 Behavioral Intention as a Predictor of Engagement

In applying TRA to the current study, the focus shifts to behavioral intention as a precursor to actual engagement with the hyper-automated system. For instance, the intention to use AI-supported learning modules, automated helpdesks, or intelligent grading tools must be nurtured through targeted orientation, demonstration of benefits, and inclusive user feedback mechanisms. This behavioral dimension is particularly crucial in non-profit educational environments where user satisfaction and usability of the system impact learning outcomes and public accountability (Collins et al., 2024).

Thus, TRA argues that the successful implementation of Hyper-Automation is not only a matter of technical success but also of behavioral change. If the system is intended to last, it must appeal to the attitudes and norms of those concerned, like users, students, teachers, and administrators.

2.2.4. Technology Acceptance Model

The Technology Acceptance Model suggests that the acceptance and use of technology are significantly influenced by factors such as perceived usefulness and perceived ease of use (Scherer, Siddiq and Tondeur, 2018) Perceived usefulness is the degree to which a person believes that using a technology will improve his or her job performance or learning achievement, and perceived ease of use is the degree to which a person believes that using a technology will require little effort these two constructs have been extensively used in models that attempt to predict the adoption of technology across many fields including education (Alturas, 2021). However, the original TAM framework has been critiqued for its limited scope, as it primarily focuses on individual perceptions

and may not fully account for the organizational and social contexts that influence technology adoption decisions within educational institutions undergoing digital transformation (Trenerry et al., 2021).

2.2.5 Challenges and opportunities for education systems with the current movement toward digitalization at the Time of COVID-19

The research author Sadjadi, E.N. (2023), clarifies how academic institutions have been impelled to innovate and remodel their operational policies, with managers and decision-makers at the fore of this transition. Embracing digital tools and teaching methodologies fosters revenue generation and competitive advantages in global education. During the digital transformation, academic managers have adapted to offer online courses and virtual engagement, thereby ensuring educational services remain uninterrupted and accessible. Managers have played a central role in redefining the value proposition of academic institutions by understanding students' needs. The agility of educational managers was essential in redesigning courses, investing in technology, and offering virtual alternatives.

2.2.6 Move beyond RPA to deliver hyperautomation

Ray et al. (2019), explored the concept of hyperautomation. The authors suggest a particular focus on business benefits that are measurable and AI-driven while ensuring a solid foundation of data for the training of Machine Learning models. They also draw attention to the limited transparency of AI and ML in some decisions, underlining the relevance of human oversight in certain critical situations. The paper aims to encourage the transition towards hyperautomation by integrating different digital tools with AI capabilities in a strategic way to enable businesses to reach the next level of process automation efficiency and intelligence for more effective, relevant, adaptive, and agile operations.

2.2.7 Review on e-learning environment development and context-aware recommendation systems using Deep Learning

The research authors Srivastav and Kant (2019) state that the use of deep learning techniques for the development of recommendation systems in an e-learning environment is a major advantage when compared to other traditional approaches as it is possible to offer a more suitable and adaptable learning process since it is possible to recommend contents according to learners' needs and interests. It's also stated that the success rate of e-learning is high when the alignment is done to the user's prior knowledge and learning goal, and deep learning helps in this regard.

2.2.7 The Next Generation Intelligent Automation Hyperautomation

Madakam, Holmukhe and Revulagadda (2022) examine the forefront of intelligent process automation. The paper sheds light on the transformative impact of hyperautomation, where it contributes to improving efficiency in functions such as standardised operations and customer service. The research explains how hyperautomation plays a key role in enhancing standard operations and customer service to achieve improvement. The research focuses on the transformation potential to increase organizational efficiency and enrich the human experience. Educational scholars, business executives, and legislators should work together to continue to innovate.

2.2.8 Supporting self-regulated learning in distance learning contexts at high

The systematic literature review by Edisherashvili et al. (2022), focuses on identifying effective interventions for supporting Self-Regulated Learning in distance learning contexts at the higher education level. The review examines 38 studies and offers insights into SRL support. The authors suggest the use of a combination of different interventions and features in SRL support. The authors emphasize the close relationship between the regulation of emotion and motivation and the fact that similar interventions

can support these two components. Due to the digitalization of education and the transition of learning to an online environment, the importance of SRL increased, as learners need more autonomy and self-direction in online learning. The findings of the review reveal that educators and instructional designers should focus on the implementation of targeted SRL support mechanisms in distance learning and the development of learners' transferable SRL skills.

2.2.9 Digitized and Automated a University Process with Robotic Process Automation

OLUÇOĞLU's (2023) research revealed the substantial impact of RPA on streamlining administrative procedures in higher education. The study demonstrated that by digitizing and automating the internship obligation document process, they witnessed a staggering reduction in manpower requirement by 75% and a 96.67% decline in the time spent on the task. Furthermore, the financial implications were notable, with costs plummeting by 98.51%. In addition to reducing human error, it has increased efficiency and productivity. Focusing on a routine process that takes a lot of time and is prone to human error when done manually, the research has shown that RPA can be implemented in other repetitive and rule-based university activities, and that the university in question can focus on more critical processes with human resources.

2.2.10 Open innovation - On the influence of internal and external collaboration on degree of newness

Lassen and Laugen (2019), investigated the impact of collaboration within and outside organizational boundaries on the novelty level of innovation projects. The research provides significant evidence from data collected from 512 Danish engineers indicating that the type of external collaboration and the partners involved substantially influence innovation outcomes. Specifically, collaboration with universities and the inclusion of R&D departments internally are associated with higher degrees of radical innovation, while

supplier involvement is linked to less unique innovations. The research provides important guidance for managers seeking groundbreaking innovation, suggesting that internal capabilities and involving diverse external partners can be key to driving breakthrough innovation in products or processes.

2.2.11 Integration of Open-Source Software for Automation of Electronic Document Flow in the Structural Unit of an Educational Organization

Sokolov, Pershin and Bocharov (2018), explored the integration of open-source systems to automate document flow and enhance educational processes within a university setting. Their study led to the creation of an information infrastructure that combines several technologies. The infrastructure utilized NextCloud for cloud storage services, GitLab for version control of educational repositories, and OpenLDAP for centralized user authorization. The significance of this work lies in streamlining electronic document management, reducing redundancy, enhancing productivity, and ensuring effective collaboration among users within academic institutions.

2.2.12 The adoption and use of Moodle in online learning A systematic review

Mustafa and Ali (2023), this research provided a systematic review by analysing the adoption and usage of Moodle in the context of online learning, particularly in higher education. The review highlighted that most studies focused on a quantitative approach and were cross-sectional, underscoring the need for long-term studies to better understand Moodle usage behaviours over time. The research noted a deficiency in studying cultural and demographic factors, emphasizing the need to involve a more diverse set of participants in upcoming studies in order to improve the applicability of the results. The paper concludes with a call for future research to validate the models identified in the study and to extend the model by adding user experience variables, due to the critical influence of these variables on technological adoption and continued use.

2.2.13 Using LMS Moodle and YouTube tools to create video courses with educational expert system features for informatics e-learning

Hlynskyi and Pukach (2023), investigated the utilization of Learning Management Systems, specifically Moodle, alongside YouTube, in crafting video-based courses that integrate elements of an educational expert system. The research highlights the creation of author-specific video resources. The implementation has shown positive outcomes, such as improved academic performance and heightened student motivation. However, the research also reveals the challenges of blended learning models, including technical demands that can lead to additional workload for educational institution administrators and teachers.

The combination with open innovation provides an essential correlation of technology and development processes that has a high potential of enhancing accessible online education. Sokolov, Pershin and Bocharov (2018) acknowledge in their study the opportunities of creating an integrated architecture of existing systems providing extensible functionalities with their capability to operate within a unified setting and the scalability of their features. Consequently, it is imperative for organizations to unite their efforts in order to enhance operational efficiency (Madakam, Holmukhe and Revulagadda, 2022).

While Masalimova et al. (2022) argue that there is no one-size-fits-all solution that can be universally applied, the argument put forth does not align with the findings presented by the initial research. Several recent studies (Edisherashvili et al. 2022; Mhlanga, 2023; Sadjadi, 2023) have presented evidence that suggests that various generic technical developments might provide highly supportive functionalities for online education, especially when integrating in a hyper-automated environment in correlation with open innovation.

2.3 Human Society Theory

The Human Society Framework, frequently connected with sociological perspectives and social construction principles, provides a meaningful structure for understanding how technological progress both affects and gets shaped by human organizations, cultural patterns, and group behaviors. At its foundation, the framework can be viewed as a reminder that human work is social, connected, and part of cyclical relationships with broader social arrangements that regulate and control groups and organisations. From the perspective of this research into highly automated digital learning systems, the Human Society Framework provides an understanding that these are not standalone solutions, but that they are social systems into which human values, organisations' requirements, teamwork, and other human factors play a critical role.

2.3.1 Systems Perspective: Society as Connected Frameworks

From a systems perspective, educational institutions cannot be seen simply as a collection of technical systems but as a closely coupled combination of social and technical systems in which people, how teaching is done, management approaches, and the participating community are all part of the tightly coupled whole. Understanding how the Human Society Framework can help to clarify how advanced automation should be situated within wider social systems implies recognition of the relational interactions between administrators, teachers, students, and other interested groups.

Any effective organizational transformation should account for how each system component affects the whole. Adopting advanced automation technologies must address not only workflow layers but also cultural aspects, ethical considerations, and societal implications within online education (Selwyn et al., 2021).

2.3.2 Social Roots of Technological Shifts

The Human Society Framework also highlights how technologies become relevant, acceptable, and successful due to the social foundations of innovation in which they are embedded. This is particularly important where automation is deployed across culturally diverse, globally dispersed student and staff populations.

In such contexts, cultural sensitivity, privacy, and fairness are delicate issues that need careful consideration and management. For example, students from different backgrounds might interpret automation differently based on prior exposure to educational technologies. It is important to be aware of these differences to avoid exacerbating technology access gaps and instead promoting equitable capability development (Viruel, Rivas and Ruiz-Palmero, 2025). That is to say, the interplay between machine efficiency and human adaptability requires constant re-examination to balance progress with equity (Constantinides and Quercia, 2025).

2.3.3 Collective Agency and Participatory Innovation

Additionally, the Human Society Theory pays specific notice to collective agency, as in the potential for groups to shape institutional transformations. This perspective is in many ways similar to the participative approaches of investigation because the participants act like cooperative designers instead of passive receivers of new technologies. Through involving diverse actors, including department leaders, technical teams, and student representatives during the development of automated learning platforms, the institution fosters mutual ownership and shared understanding, which ultimately supports longer-term adoption (Pahi et al., 2024).

As Wilson and Sharimova (2019) observed, meaningful shifts in social systems arise through ongoing exchanges between personal reflection and structural conditions. Making progress means making sure that the organization does not sacrifice human-centric

priorities in the pursuit of technology, and that its automated tools do not come at the cost of opportunities for skill development and growth. The balance between human adaptability and technological effectiveness creates ecosystems where innovation occurs in harmony with the natural rhythms of the organization.

2.4 Summary

Several research teams singled out the importance of understanding student behavior, student needs, and student performance (Mustafa and Ali, 2023; Roy and Singh, 2017; Srivastav and Kant, 2019; Costa et al., 2019). Their findings result in a clear recommendation for a strategic user-centric data collection approach, as Masalimova et al. (2011) have conceded that their findings should not limit future research on eliminating student challenges in combination with online education. Srivastav and Kant (2019) explain the link between the increasing effectiveness of e-learning and providing students personalized experiences, while the underlying complex calculations ensure their engagement with the system. Likewise, the results emphasize the importance for developers to acquire a robust comprehension of the variables that forecast user adoption of open innovation (Mustafa and Ali, 2023). In this dynamic landscape of educational innovation, it is crucial to continue exploring and implementing multidisciplinary approaches and technological solutions to meet the evolving needs of learners and educators.

CHAPTER III:

RESEARCH METHEDOLOGY

3.1 Overview of the Research Problem

The emergence and proliferation of online learning in response to technological developments and social changes, such as the current COVID-19 pandemic, has triggered a seismic shift in how knowledge is imparted and acquired (Ismail and Ismail, 2021). As this transformative shift brings untold benefits to millions of learners around the world, a corresponding set of underlying issues, challenges, and bottlenecks have also come to light, particularly among non-profit learning organisations committed to delivering free high-quality learning on a massive scale. The primary research problem that this study aims to address is the following key challenge: how can learning organisations, especially those delivering open learning, realistically scale their services to meet the learning needs of millions of learners across the globe, while being subject to significant resource and budgetary constraints?

Existing models of eLearning organisations typically imply labour-intensive staffing ratios, with many proposing a ratio of 10 employees for every ten thousand enrolled students. If this model were to be applied for one million learners, this would translate to the deployment of one hundred staff in total on a full-time basis, a scenario that is both infeasible and prohibitively expensive for a non-profit educational organisation.

Organizations characterized by fixed budgets and ambitious growth targets from half a million to five million students over five years exemplify this challenge. With a limited team of only twenty-five technical and academic staff, such entities must explore

alternative, innovative strategies to achieve their expansion goals without compromising educational quality or the learner experience (Brown, 2018).

The core of the research is centered around Hyper-Automation and Open Innovation as two key mechanisms for the scaling of virtual learning environments (VLEs) while maintaining learning quality. Hyper-automation, which incorporates artificial intelligence, machine learning, robotic process automation, and cloud computing, provides a comprehensive solution for the automation of complex workflows and repetitive tasks across the entire learning lifecycle. Simultaneously, Open Innovation focuses on external collaboration and the use of open-source environments to increase flexibility and reduce development costs and dependency on internal resources. This solution addresses the following sequence of challenges that arise within large online learning environments:

- **Resource Constraints:** Educational institutions often deal with limitations in human and technology resources that reduce their ability to cope with large student populations. Yet, Hyper-Automation provides the means to optimize internal processes, reduce manpower demand, and redeploy human resources for the sake of more valuable initiatives.
- **Administrative Burden:** The manual processing of tasks such as student enrollment, exam retakes, course scheduling, educational content distribution, support request management, and certification issuance not only limits the available strength of an institution, but also hampers its ability to respond. Consideration for the automation of these functions will improve institutional efficiency and enable the redeployment of human resources for more valuable academic initiatives.
- **Quality Assurance at Scale:** As student enrollments expand, the temptation to cut corners and lower the quality of instruction increases as well. However, the ability to automate grading algorithms, recommend content to students, and apply learning

analytics in a timely manner can be the key to assuring instruction remains of the highest quality, ensuring that learning outcomes stay consistent and can scale with different student populations.

- **Scalability of Systems:** Traditional virtual learning environments in the past have not inherently been scalable. However, with the use of a technical architectural approach based on advanced services combined with automated workflow orchestration and data analytics, institutions can scale horizontally with minimal additional costs.
- **Technological Gaps:** Educational institutions often struggle with the ability to implement and sustain feature-rich automation systems in-house. Using the Open Innovation approach, such organizations can benefit from cooperative development communities, consume modular solutions, and reduce the time for implementation drastically.
- **Accessibility and Equity:** What is most interesting about this problem is that it has a social impact. There are millions of learners who still do not have the opportunity to enter an official educational institution. They lack access to education, especially those living in developing and conflict-affected countries. Using the hyper-automation and mobile-first solutions with multilingual and culture-inclusive content offers an unprecedented opportunity to access learning and improve educational equity worldwide (Huang et al., 2024).

Addressing this problem has far-reaching implications beyond individual institutions. Implementing the proposed solutions can significantly contribute to the global education agenda by bridging the digital divide, reducing educational costs, and promoting inclusive economic growth through skills development.

This research also aims to create visual representations, maps, and optimizations of how internal processes, organizational activities, and key performance metrics interconnect. By doing this, it provides a detailed operational plan that allows institutions to pinpoint automation opportunities and incorporate them into a sustainable and flexible digital framework. The study's focus on developing a deep institutional understanding of automation capabilities ensures that the proposed solutions are not only scalable but also self-sustaining.

In summary, the research problem is situated at the confluence of rapid digital transformation, educational equity, and sustainable organizational strategy. The central question it seeks to answer is not simply how to deliver online education at scale, but how to do so sustainably, affordably, and inclusively, leveraging the transformative capabilities of Hyper-Automation and the collaborative principles of Open Innovation.

3.2 Operationalization of Theoretical Constructs

Defining measurable variables is one of the strengths of this research, which builds on concepts of Hyper-Automation, Open Innovation, and Servitization to provide a comprehensive model for large-scale and affordable online education. In order to empirically investigate the practicality and effectiveness of this model in a non-profit educational environment, the three core concepts of Hyper-Automation, Open Innovation, and Servitization must be operationalized by making them observable and measurable through the definition of corresponding indicators, measurement mechanisms, and analytical approaches. This operationalization is an important step in the empirical investigation of the practicality and effectiveness of the proposed solutions.

3.2.1 Measuring Hyper-Automation

Hyper-Automation refers to the integrated use of AI, RPA, and cloud services to automate beyond the typical RPA rules-based automation. The following dimensions show how hyper-automation is concretely implemented in the context of this research. The provided indicators will be evaluated based on development logs and interview analysis with the technical team, as well as the results of the prototype and the survey.

- **Process Automation**, quantified by the reduction in time and labor required to execute repetitive administrative and academic processes.
- **System Efficiency**, A metric that measures improvements in efficiency, such as reduced errors, faster process completion, and better workload distribution, based on models for intelligent automation.

3.2.2 Measuring Open Innovation

This research focuses on how open innovation can provide educational institutions with access to external knowledge, tools, and expertise. Open innovation involves collaborating with outside partners to develop new solutions. In the context of educational technology, open innovation can offer cost-effective ways for institutions to access cutting-edge tools and methods.

- **External Contribution Integration**, measured by the percentage of system modules or features sourced from external contributors or open-source communities.
- **Codebase Extensibility**, an indicator assessing the ease with which third-party tools and APIs are integrated into the VLE ecosystem.
- **Knowledge Transfer Efficiency**, measured by how effectively open innovation tools are implemented and the time needed for internal staff to learn and use them.

Open Innovation can support the agility and cost-effectiveness of the Hyper-automation architecture for virtual learning environments.

3.2.3 Servitization in Online Education

Servitization is a term originally used in the industrial context. Here, servitization describes the transformation of educational delivery into scalable, technology-driven services. The three indicators describe how well the online learning platform provided high-quality, accessible education to a large number of students.

- **Scalability Factor**, the capacity to effectively manage a larger number of students per staff member, indicating the institution's flexibility and ability to scale.
- **Service Continuity Score**, based on system logs that track uptime, response time, and the resolution of user requests during high-enrollment and exam periods.
- **User Satisfaction Rate**, based on student feedback about how easy the platform is to use, how user-friendly it is, and how well it personalizes the learning experience.

3.2.4 Organizational Readiness and Technical Maturity

In order to determine whether Hyper-Automation and Open Innovation are feasible, it is important to understand the organization's readiness and technical maturity. Assessing the long-term success of the implementation strategy is particularly important in constrained environments. Both the readiness of the organization for automation and its innovation capacity are requirements.

- **Automation Readiness**, an assessment of the organization's IT infrastructure, current automation efforts, and technical skills of staff.
- **Organizational Innovation Capacity**, assessed through stakeholder interviews to gauge the organization's openness to innovation, adaptability, and digital transformation.

3.3 Research Purpose and Questions

Due to the increasing popularity of online education, especially in uneducated and poor areas, there are new opportunities and great challenges for educational institutions to extend their education (Dhawan, 2020). This study examines how Hyper-Automation and Open Innovation can enable mass education that is accessible and cost-effective for a global audience, and specifically for non-profit online education providers.

3.3.1 Research Objectives

The research project goal is to provide services to two million enrolled students within one year, with a five-year target of reaching five million enrolled students, as discussed and agreed upon by stakeholders and investors. The research emphasizes the larger scope and technical possibilities in eLearning and provides high-quality educational services to a larger number of students. The immediate target is to cater to two million registered students within the first year, with an ambitious five-year goal of extending the reach to five million enrolled students. This aligns with the discussions and agreements reached with stakeholders and investors.

The research highlights the vast scope and technical potential in eLearning, emphasizing its ability to accommodate such substantial growth. To achieve this goal, the research focuses on two key areas: hyper-automation and open innovation and aims to help organizations conceptualize innovation (Rezende Pinto, Saur-Amaral and Brito, 2019).

The study should propose a sustainable hyper-automation solution utilizing diverse open innovation approaches to contribute to the expansion strategy aimed at serving five million registered students within the next five years. Analyzing new and innovative approaches in products and services beyond traditional methods is crucial for staying competitive in the market (Chang, 2011). It is essential that this solution not only enhances

efficiency but also ensures scalability and long-term sustainability for accommodating such a large user base.

The objective is to facilitate organizations in effectively handling and providing technical support, educational materials, lessons, academic guidance, exams, and student management using limited resources while reducing expenses. Specifically, the aim of this study is to develop a system that can cater to the needs of five million enrolled students within a department of twenty full-time employees. Therefore, it is crucial to investigate, recognize, and execute possibilities for Hyper-Automation and Open Innovation. The study must establish a robust technical and organizational foundation for a sustainable Hyper-Automation and Open Innovation solution and its future advancements, ensuring financial stability.

3.3.2 Research purpose

The main goal of this study is to explore whether a global non-profit online educational organization, with limited resources, can provide high-quality education to five million students using Hyper-Automation and Open Innovation. By looking at how advanced automation and collaborative innovation can be put into practice, the study aims to develop a scalable approach for digital transformation in online education.

This research aims to assess not only the technical viability of the proposed approach but also the organizational, financial, and infrastructure-related implications of implementing such solutions in resource-constrained settings. In doing so, the study addresses critical challenges in education delivery, such as scalability, cost-reduction, technological adaptability, and accessibility for learners regardless of their geographic location or socioeconomic background.

The overarching goal is to provide practical insights to help both practitioners and policymakers build sustainable and resilient digital learning environments that bridge the

global education gap. This research aligns with ongoing academic and institutional calls for more fair, efficient, and inclusive educational systems.

3.3.3 Primary Research Question

To support this aim, the central research question is as follows: “Can an international non-profit online educational institution, with limited resources, effectively deliver accessible education to five million enrolled students using technical advancements like hyper-automation and open innovation?”.

The above primary research question aims to evaluate the feasibility and practicality of implementing an integrated Hyper-Automation and Open Innovation strategy in a non-commercial institution context, without compromising educational quality and efficiency.

3.3.4 Guiding Research Questions

In order to address the primary question holistically, the study is structured around eight guiding sub-questions that reflect both technological and strategic dimensions. The research questions outline a structured approach to examine the connections between strategy, innovation, technical capabilities, and organizational readiness.

RQ1. What are the key challenges faced by educational institutions in delivering accessible education to a large number of enrolled students?

RQ2. What are the potential benefits and drawbacks of utilizing Hyper-Automation and Open Innovation in the context of online education?

RQ3. What specific technological developments and strategies within Hyper-Automation and Open Innovation can be implemented to effectively deliver accessible education to five million enrolled students?

RQ4. What strategies can be employed to ensure long-term financial stability and scalability of a Hyper-Automation and Open Innovation solution in the context of online education?

RQ5. What Open Innovation strategies are appropriate for implementation in online learning environments alongside Hyper-Automation?

RQ6. How effectively can Open Innovation solutions be integrated into the Hyper-Automation technical infrastructure?

RQ7. What are the potential challenges and risks associated with implementing Open Innovation in an online education setting alongside Hyper-Automation?

RQ8. What is the required level of technical expertise to support the implementation and sustainability of digital transformation in non-profit online education systems?

3.3.5 Research Hypotheses

This study aims to examine the underlying conceptual assumptions through the development and testing of two core hypotheses:

Hypothesis 1: The integration of Hyper-Automation and Open Innovation within a non-profit global online educational organization is expected to enhance cost-efficiency by reducing expenditures associated with the management and operations of online education. This, in turn, will enable the organization to serve a larger population of five million enrolled students in a more effective and sustainable manner.

Hypothesis 2: Integrating Hyper-Automation and Open Innovation strategies within the digital transformation of a non-profit global online educational institution is expected to enhance the accessibility and efficiency of the online education system. This approach holds the potential to overcome constraints stemming from the limited availability of skilled technical resources, ultimately contributing to the long-term sustainability of the organization.

These hypotheses form the analytical foundation of the study and guide the development of the data collection methods, such as interviews, prototyping activities, and student surveys.

3.4 Research Design

Through the literature review, it can be concluded that the combined advantages of automation, innovation, digitalization, and personalization within the field of online education are significant. However, user-centric research is essential, and therefore, quantitative and qualitative methods must be applied where user data is collected, including the use of surveys and collection of data models, including over one hundred thousand conducted surveys from one hundred fifty countries to assure the reliability of the collected data.

The research design adopts an academic, problem-solving approach that blends theoretical and practical insights to examine the digital transformation of non-profit global online education. Given the multidimensional nature of the research problem, from technological feasibility to strategic implementation, the study employs a multi-method design rooted in Action Research, Design Science, and Mixed-Methods Inquiry. This triangulated methodology ensures depth, reliability, and contextual relevance.

The study adopts a pragmatic epistemology, emphasizing actionable knowledge and the iterative refinement of theory through practice (Turner, Cardinal and Burton, 2015). This orientation is particularly well-suited to innovation-driven research, where emerging technologies and human-centered processes must be evaluated in dynamic, real-world environments.

Interviews will be conducted with technical specialists to further identify the automation opportunities. This will enable the identification of process automation that

supports accessible and cost-efficient global online education. The data will be a result of an intensive action research approach due to its ability to effectively apply and validate research findings within real-world contexts (Mackenzie, et al., 2012).

The main research approach is Action Research, which was chosen for its iterative and collaborative nature (Azhar, Ahmad and Sein, 2009). This methodology is particularly appropriate for this research, as it emphasizes stakeholder engagement, iterative prototyping, rapid feedback loops, and real-time problem resolution. Action Research is combined with elements of Design Science Research (DSR) to structure the development (Iivari and Venable, 2009), testing, and refinement of the VLE Hyper-Automation prototype and Minimum Viable Product (MVP).

3.4.1 Research Structure and Phases

The research has been structured into five phases, where each phase of the research is aligned with the core objectives of the study.:

a. Exploratory Phase

- **Purpose:** Identifying the main problems, resource limitations, and current inefficient processes analysis.
- **Activities:** Analyze relevant documents, interview key stakeholders, and map the current virtual learning environment.
- **Outcome:** Identifying areas for automation, evaluating technical capabilities, and exploring open innovation opportunities.

b. Design Phase

- **Purpose:** Create conceptual models and automation approaches based on feedback from stakeholders and industry standards.
- **Activities:** Prototyping, design sprints, and integration of open-source components.
- **Outcome:** Initial Hyper-Automation architecture and service delivery model.

c. Development Phase

- **Purpose:** Develop and improve the virtual learning environment prototype and minimum viable product that utilizes hyper-automation.
- **Activities:** Developing the technical components, testing for quality assurance, deployment, and evaluating performance.
- **Outcome:** An operational initial version that can support a large number of students.

d. Validation Phase

- **Purpose:** Assess the effectiveness, user-friendliness, and capacity for large-scale deployment of the implemented solution.
- **Activities:** End-user surveys (targeting 200,000+ respondents from over 150+ countries), system log analysis, and feedback interviews.
- **Outcome:** Substantive evidence on the impact of Hyper-Automation and Open Innovation across operational metrics.

e. Reflective Phase

- **Purpose:** Summarize the key findings, evaluate hypotheses, and generate strategic recommendations.
- **Activities:** Comparative analysis and stakeholder workshops.
- **Outcome:** Research findings, implications, and recommendations with a scalable implementation roadmap.

3.4.2 Unit of Analysis

The primary focus of analysis is the virtual learning environment and its associated operational systems, workflows, and user interactions. Secondary areas of examination include the software development team, academic support staff, and student end-users. Collectively, these elements constitute the operational ecosystem within which automation

and innovation strategies are implemented and evaluated. The study uses a combination of qualitative, quantitative, and technical data to ensure validity and reliability, as shown in Table 3.1.

Table 3.1: Unit of Analysis Overview

Data Type	Collection Method		<i>N</i>	
Qualitative	Semi-structured interviews		Capture subjective insights and concerns	
Quantitative	Surveys (200,000+ students from 150+ countries)		Measure user satisfaction and performance	
System Log Data	Automated analytics	platform	Track automation success and workflow gains	
Technical Artefacts	Prototypes, architecture	MVP,	Evaluate feasibility, usability, and scale	

Source: Created by the Author.

The combination of qualitative, quantitative, and technical data provides a comprehensive view, ensuring the findings are based on both user experiences and technological and organizational capabilities.

Our research employs several techniques to make sure this study is trustworthy. It converts general concepts into measurable variables to confirm construct validity. The iterative design process that involves input from users and evolution over time to the final product confirms internal validity. External validity comes from applying the proposed solution with more than two million students in a real-world setting. Reliability comes from

the technical documentation, standardized coding, and private data storage to make sure results are consistent at all stages of the research.

3.4.3 Expected outcomes

The rapid progress of technology and the growing interconnectedness on a global scale have led to significant changes in society, the economy, and the environment (Mhlanga, 2023). The recent academic literature and leading technical consultancy firms like Gartner consider that hyper-automation in e-learning has immense potential to transform the education sector by improving efficiency, reducing costs, and enhancing the learning experience. Hence, a crucial chance exists to design a sustainable model that benefits educational institutes and their students all over the world, regardless of their financial, technical, or geographical limitations.

The research requires careful consideration of the costs involved and expert input for the integration of the selected advanced technologies (Sadjadi, 2023). Nonetheless, with proper planning, data analysis, and the correct action research approach, advanced study of hyper-automation and open innovation within the online education sector the study will provide a major contribution.

It is important to reflect on the Hyper-Automation strategy to provide recommendations and ensure a sustainable long-term growth strategy. Adopting Hyper-automation and Open Innovation is expected to provide significant cost reduction and allow small teams to manage over five million students with budget limitations.

Reflecting on the strategy of Hyper-Automation is crucial in order to offer recommendations and ensure a sustainable long-term growth plan. The integration of Hyper-Automation and Open Innovation in the digital transformation of global online education is expected to have several key outcomes. These outcomes include enhanced accessibility and affordability of online education, improved student engagement and

learning outcomes, increased scalability and flexibility of educational programs, and the development of a robust and dynamic digital infrastructure for global online education.

The technical infrastructure and operations will play a crucial role in accommodating the anticipated growth in student numbers while minimizing the need for additional resources. It is expected that the technical infrastructure will be designed to support high scalability and flexibility with a limited increase in costs. Cloud services could play a crucial part in the research's success. They anticipate changing how organizations provide services and capitalize on growth opportunities through instantly scalable infrastructure and computing resources (Chuang et al., 2019). It's expected that the scalability will enable the ability to quickly adapt to changing demands and efficiently utilize resources.

Online educational institutes are expected to have significant benefits from adapting the research, as it's expected to provide a high level of relief from repetitive and complex operational tasks and processes. It enables a shift in focus towards tasks that add value, such as providing personalized support to students and creating additional educational content. Overall, the integration of Hyper-Automation and Open Innovation in online education is expected to revolutionize the industry by reducing costs, supporting the organizational growth strategy, and improving accessibility and student outcomes.

3.5 Population and Sample

The study focuses on a diverse group of people involved in the digital transformation of online education, such as students, teachers, administrators, and technology experts. Considering the worldwide outreach and digital infrastructure of the Virtual Learning Environment, the study targets a diverse and large-scale population. The primary population consists of over two million enrolled students from more than 150

countries with diverse geographic, linguistic, socio-economic, and educational backgrounds. Such a global population offers a significant opportunity to evaluate the scalability, inclusiveness, and effectiveness of the proposed Hyper-Automation and Open Innovation strategies.

To achieve a good balance between richness and depth of information, the study adopts a stratified purposive sampling strategy. The quantitative component involves a large-scale survey distribution to over 200,000 respondents, carefully sampled to ensure proportional representation across different world regions, language groups, and patterns of device usage. Such a scale of data collection enables drawing statistically significant conclusions about user experience, system usability, and educational outcomes. Artificial intelligence will be used to analyse and find the main challenges from the feedback of the end-users. The qualitative data collection of the survey enriches the quantitative findings through detailed insights and contextual understanding.

For the qualitative component, a more targeted approach is used. Around 15-20 key stakeholders will be selected, such as VLE developers, machine learning experts, content managers, system administrators, and student engagement officers. Based on the relevance of their expertise, technical responsibilities, and involvement in the operation of the system, they will be invited to participate in in-depth interviews providing information on opportunities for automation, integration of infrastructure, feedback, system usage, and the level of readiness of institutions.

Additionally, the technical artefact evaluation sample will include data gathered from the use of the Minimum Viable Product while the product is live and in use (Noshi and Xu, 2024). This data will provide rich data on relevant performance metrics and indicators around automation. The collection and analysis of this empirical data from the actual implementation of the system provides invaluable insights to enhance the research

findings and ensure the recommendations made are grounded in practical, scalable solutions, as shown in Table 3.2.

Table 3.2: Overview of Population and Sample Groups

Sample Group	Estimated Size	Sampling Method	Role in Research	Data Collection Method
Global Student Population	2,000,000+	Targeted population	General users of the VLE; recipients of automated and personalized education services	System logs, passive analytics
Survey Respondents (Students)	200,000+ (from 150+ countries)	Stratified purposive sampling	Measure user experience, satisfaction, and perceived quality of service	Online surveys (quantitative & qualitative)
Technical and Operational Staff	15–20 participants	Purposive sampling	Key informants on automation processes, challenges, and implementation outcomes	Semi-structured interviews (qualitative)
System Artefact Dataset	Platform-wide data	Total system log inclusion	Captures performance metrics, process efficiency, and automation success rate	Automated VLE data extraction
Prototype MVP & Test Group	~100,000 early-access users	Opportunistic sampling	Evaluate usability, scalability, and system responsiveness in real-time conditions	MVP usage tracking, feedback forms

Source: Created by the Author.

By including input from a wide variety of stakeholders, students, staff, as well as system data, this research contributes with a multilevel approach to study the operational, technical, and experiential impact of Hyper-Automation and Open Innovation in large-scale, non-profit online education. The results from this study can then be applied to and generalized with other similar educational institutions, seeking cost-effective and scalable transformation strategies. The study's ability to draw insights from both broad and targeted samples, such as large-scale surveys and in-depth interviews with key stakeholders, enhances the depth and breadth of understanding (Menchaca and Bekele, 2008). This multilayered data collection and analysis ultimately strengthens the validity and applicability of the research outcomes, enabling educational institutions to make informed decisions about adopting Hyper-Automation and Open Innovation.

3.6 Participant Selection

The aim was to achieve diversity of participation for both the user and operational side of the Virtual Learning Environment (Maiti and Priyaadharshini, 2024). For the student surveys, the research included probability sampling to achieve proportional representation of participants from regions, age, education, and technology use from across the sample of two million plus learners from more than 150 countries around the world. For the qualitative interviews, the research included purposeful sampling to identify specific stakeholders who have a direct involvement with the system, such as VLE developers, machine learning experts, and system administrators.

3.6.1 Student Participants (Quantitative Strand)

For the large-scale student survey, the research used a stratified sampling approach to ensure proportional representation from the two million-plus learner community across more than 150 countries around the world. The stratification is based on key geographic

regions, age groups, education levels, and technology access tiers. Participants are drawn from the full registered learner community of more than two million learners from more than 150 countries around the world. The stratified sampling methodology used in sampling ensures that the different strata are represented in the final data set such that the research team can make robust comparisons and find meaningful correlations with other strata in terms of different user groups and contexts. Eligibility criteria for student participants include:

- Active enrollment in the VLE during the study period
- Minimum engagement of entering one lesson in the learning module
- Consent to participate in anonymized survey research

To avoid selection bias and ensure fairly representative participation, algorithms are included within the platform to automate the selection of participants for these studies. Quotas will be monitored to ensure proportional representation from different strata in terms of key geographic regions, age groups, education levels, and technology access tiers. This systematic approach will help avoid biases and allow for robust comparative analyses to uncover meaningful insights from diverse user segments and contexts (Finco et al., 2024).

3.6.2 Internal Stakeholders (Qualitative Strand)

For the qualitative part of the study, the research used purposive sampling to select key people within the organization who are involved in designing, implementing, and running the VLE. These roles have been selected because they are working on or have worked on Hyper-Automation, Open Innovation, or the delivery of educational services. These roles include Senior VLE Developer, AI/Machine Learning Specialist, Educational Content Manager, Quality Assurance Lead, System Administrator, Technical Support

Staff, and Student Engagement Officer. Their insights are essential for understanding the organization's workflows, finding chances for automation, and evaluating the organization's preparedness.

These stakeholders will engage in semi-structured interviews to provide first-hand accounts and insights into the design, implementation, and operation of the Virtual Learning Environment, as well as, where applicable, participate in hands-on design sprint activities to refine the system during the prototyping stage. The involvement of these stakeholders will be of significant value and will contribute to the final product, allowing for iterative improvements and ensuring the solution meets the needs of both the organization and the end-users. It's essential for the research for the involvement of these key personnel to develop practical and scalable solutions that will drive the digital transformation of the online education service.

3.6.3 Early Access Users (Prototype Evaluation)

A separate sub-sample of roughly 100,000 early-access users will be selected for evaluating the MVP and automation features in a real-world environment. Users who show high levels of engagement and technical diversity will be prioritized. This group will provide significant insights into usability and support the evaluation and the effectiveness of the automation under diverse operating conditions.

3.7 Instrumentation

To ensure robust and reliable data collection across diverse participant groups and analytical objectives, this study employs a mix of in-house developed instruments, digital tools, and data collection mechanisms built into the platform. The design of the instrumentation reflects the multi-method approach with quantitative survey instruments

on one hand and qualitative interview protocols on the other, as well as instrumentation at the system level, embedded in the Virtual Learning Environment (VLE).

3.7.1 Online Survey Questionnaire

A structured online questionnaire is used to collect data from over 200,000 students across 150+ countries. The survey is hosted on the VLE's integrated feedback platform and optimized for multilingual access and mobile compatibility. The questionnaire is designed to assess:

- User experience and satisfaction (UX/UI design, content clarity, ease of navigation)
- Perceived value and accessibility of the educational content
- Impact of automation on responsiveness, personalization, and support
- Technical issues encountered (e.g., downtime, lag, device compatibility)
- Demographic profiling (age, region, education level, device type, language)

A combination of Likert-scale items, semantic differential scales and open-ended questions are used to collect deeper feedback. The instrument was pilot-tested with 500 participants to ensure clarity and functionality before full deployment. The online survey questionnaire was pre-tested with 500 participants to obtain feedback on structure, logic, readability and content (Heidemann Lassen and Timenes Laugen, 2017). The results from the pre-testing were used to refine the instrument and to ensure clarity when designing the questions that would resonate with the target group (Yaseen et al., 2025).

3.7.2 Semi-Structured Interview Guide

To collect qualitative data, a semi-structured interview protocol was designed for internal stakeholders such as developers, administrators, content managers, and AI specialists. The protocol consists of the following themes of prompts:

- Workflow automation pain points and opportunities

- Open Innovation adoption challenges and collaborations
- Observed user behavior patterns and support demands
- Institutional scalability constraints and sustainability concerns

The format of the interview is semi-structured to allow the interviewers to follow the interviewee's responses while standardising the process between interviews. All interviews are recorded with consent, transcribed, and coded for thematic analysis by artificial intelligence.

3.7.3 MVP Usability Feedback

A lightweight, in-platform feedback widget is embedded in the MVP (Minimum Viable Product) interface for early-access users (~100,000 students). This tool captures real-time impressions related to:

- VLE User-Experience
- System responsiveness
- Automation effectiveness
- Suggestions for improvement

The feedback tool automatically tags user comments and connects them to specific system features. This allows the researchers to analyze how user sentiment relates to the platform's backend performance.

3.7.4 System Log Analytics

As part of the technical instrumentation layer, the research is collecting data via server logs and the dashboards provided on the platform to gather the following data in relation to automation:

- Workflow completion rates before/after automation
- Time-on-task comparisons
- Resource load and performance

- User engagement patterns

The system logs are analyzed using Power BI and Python-based scripts to gain information on high-level trends and usage patterns from the data.

3.7.5 Prototype Evaluation Checklist

Internal evaluators use a standardized checklist to review the Hyper-Automation prototype during the design and development phases. The checklist evaluates:

- Feature completeness
- Scalability capacity
- Integration compatibility with Open Innovation components
- Ensuring the design meets user needs and accessibility requirements

Checklist results are recorded in shared documentation platforms Confluence and used during sprint retrospectives to guide feature prioritization (Carlson, 2017). These research instruments offer a comprehensive and well-rounded perspective on the study environment. This allows the researchers to draw reliable conclusions across technical, organizational, and user experience aspects. All instruments were ethically reviewed before use and designed to be culturally and linguistically sensitive, especially for diverse and multilingual participants (McGorry, 2000).

Table 3.3: Research Instruments

Instrument	Target Group	Purpose	Key Features
Online Survey Questionnaire	Enrolled Students (~2,000,000 globally)	To assess user satisfaction, platform usability, and perceived automation benefits	- Likert scales, semantic differentials, and open-text responses - Multilingual (3 languages) - Mobile-optimized - Demographic filters
Semi-Structured Interview Guide	Internal stakeholders (15–20 staff)	To gather insights into system design, automation processes, and innovation strategy	- Thematic prompts on workflows, barriers, and scalability - Recorded and transcribed - Supported AI analyzation
MVP Usability Feedback Tool	Early-access users (~100,000 students)	To capture real-time feedback on interface usability and feature performance	- Embedded in-platform components - Linked to specific system functions
System Log Analytics	Platform-wide data	To monitor automation performance and user interaction with the VLE	- Server-side data logging - Time-on-task tracking - Usage heatmaps - Analyzed with Power BI & Python
Prototype Evaluation Checklist	Internal QA and development team	To validate automation features and Open Innovation integration	- Feature completeness, accessibility, and scalability metrics - Sprint-based review - Logged in Confluence

Source: Created by the Author.

3.8 Data Collection Procedures

Advanced data collection techniques are essential to ensure an objective and authentic approach in effectively visualizing the research findings. It is crucial to collect data that uncovers growth challenges and identifies opportunities for automation.

Intelligent mechanisms in online learning environments offer exciting opportunities for revolutionizing student support and communication models (Atto and Kotova, 2019).

The problem statement requires attention and should be discussed at the beginning of the interview to ensure transparency and an effective outcome. Prior to gathering data, it is essential to carefully choose a diverse group of participants, as this will enhance the quality of data collected.

Gathering data is becoming more difficult due to the evolving differences in privacy attitudes globally. Governments are introducing regulations such as CCPA (Caprivacy.org, 2024) and GDPR (GDPR.eu, 2024) to protect personal data and require organizations to obtain consent from users before collecting information. Therefore, the necessary ethical considerations are taken into account when collecting data. A Participant Information Letter (see Appendix A) is provided to the participants to ensure they understand the scope of the research participation. Followed by a Participant Consent Form (see Appendix B), where the participant may provide a written consent to participate in the research.

3.8.1 Student Survey Distribution

End-user surveys play a vital role in collecting information about student challenges and their engagement with a highly automated virtual learning environment. Academic research involves assessing the usability of the educational platform through testing and administering user satisfaction surveys.

Presenting a model to a cohort of students and implementing an automated web-based survey allows for the gathering of both quantitative and qualitative information. Surveys are simple and effective for gathering user responses, behaviours, and observations. (Adamson, 2000). The participant pool comprises one million students who can engage in the survey anonymously via the online prototype. The inquiries provide numerical insights into the system, learning, and service excellence. The survey aims to

comprehensively explore and understand the diverse experiences and perspectives of students in relation to the use of hyper-automation and open innovation within online education environments. Student surveys will be distributed during the validation stage through various channels:

- In-platform pop-ups and banners in the VLE after course completion
- Email invitations with personalized access links
- SMS notifications for low-bandwidth accessibility
- Localized social media campaigns in target regions

The survey will be open for six weeks, with automated reminders sent every two weeks to encourage participation. The survey platform will record responses in real-time, allowing for continuous monitoring and early checks on response rates and demographic balance.

Organizations cannot overlook the benefits of collecting large amounts of data, as it is essential for serving wide-ranging populations and creating innovative solutions. Data gathering and advanced analysis aid organizations in gaining an in-depth understanding and formulating recommendations (Panetta, 2020). Automated surveys improve efficiency, reduce observation costs, and require minimal resources.

3.8.2 Semi-Structured Interviews

Conducting structured one-on-one interviews with the participants is essential. It is important to gather data according to the participants' expertise level and also confirm the complexity level of our research with the participants. The attendees will be selected based on their roles and responsibilities. The following roles are chosen to take part in the data gathering:

- Senior VLE Developer
- VLE Data Analyst
- Machine Learning Specialist
- VLE System Administrator
- Student Communication & Motivation Responsible
- Educational Content Manager
- Technical Support Employees
- Quality Assurance Manager

During the academic study period and technical administration period, it is important to inquire about the tasks that are most time-consuming and repetitive. The participants are queried about their ability to recognize tasks, work processes, and workflows that could be automated. Their extensive experience and technical or managerial expertise will enable them to identify opportunities for automation.

Semi-structured interviews with internal stakeholders will be conducted during the Exploratory and Design Phases of the research. Participants will be selected based on their roles in VLE operations, automation design, or innovation strategy. The interviews will:

- Be conducted using secure video conferencing platforms
- Last approximately 45 to 60 minutes per interview
- Be audio recorded with participant consent
- Be transcribed and analyzed utilizing artificial intelligence

It is important to the research whether the participants had positive or negative experiences with past automation implementations. This provides an understanding of their concerns and the factors that may contribute to the research success. Additionally,

questions will be asked regarding their exploration of open-source projects, innovative automation, machine learning solutions, or SaaS services that can support the research. The selection process of participants is based on a degree in computer science or software engineering and at least five years of relevant experience. The interview sessions will be held in phases and aligned with the design sprint cycles, which means the feedback from the interviews can influence the refinements of the system as well as the development of the prototype.

3.8.3 Prototyping

Throughout the research and development process, it is essential to have a prototype accessible in order to enable data gathering on performance and usability, iterate design ideas, and ensure the quality of the recommendations. Innovative and emerging technologies have the potential to significantly influence and create new growth opportunities for organizations in various industries (Griffy-Brown et al., 2019).

Essential for the advancement of technological research, prototypes play a key role in implementing Hyper-Automation. Research and user cases are limited due to the high level of innovation and unique focus in Hyper-Automation and Open Innovation studies. Therefore, developing prototypes is essential as the research can demonstrate the practical application and effectiveness of Hyper-Automation in the context of accessible and cost-efficient global online education. These prototypes will serve as tangible representations of how Hyper-Automation can be integrated into the online education system, showcasing its potential benefits and impact on improving accessibility and cost-efficiency in education.

Components within the platform interface will collect the following data:

- Tracking of user clickstream data to analyze navigation and interaction patterns
- Capturing of feature-specific satisfaction ratings to assess usability and engagement

- Collection of open-ended textual feedback to gather qualitative insights on usability and potential improvements

Data is collected continuously and analyzed on a weekly basis in order to inform agile system adjustments and guide sprint planning. Integrating prototypes ensures that the gathered information promotes sustainable and advanced innovations while also cutting down on development expenses through early-stage validation. (Kjørstad, Falk, Muller and Pinto, 2018). Testing various methods to collect data and evaluating their usability (Spruijt, 2017) is crucial because of the time constraints in the research. It also presents an exceptional opportunity to develop a shared understanding, promote collaboration, and nurture trust among the teams involved in the research.

3.8.4 System Log Data Extraction

Automated data collection takes place throughout all phases of the study through server-side instrumentation embedded in the VLE. The collected logs include:

- Workflow execution times
- User activity and engagement tracking
- Monitoring of error rates and system downtimes
- Metrics on feature adoption and user interactions

The system log data is securely stored in a dedicated data warehouse repository and analyzed using a combination of Power BI dashboards, Python scripts, and database queries. These insights will be vital in corroborating user-reported data with actual user behavior evidence (Al-Sai et al., 2022).

3.8.5 Prototype Evaluation Documentation

The Internal QA staff and the development team will fill out a Prototype Evaluation Checksheet to capture data during and following each sprint cycle. Data is recorded in Jira and Confluence with full traceability to improvements and alignment with stakeholder expectations.

Through the distribution of data collection procedures across clearly defined phases and participant types, the research has ensured methodological rigor, enabled real-time feedback collection, and afforded a holistic view of system usage and user experience. This allowed the study to drive actionable, evidence-based findings to support sustainable education transformation through Hyper-Automation and Open Innovation.

3.9 Data Analysis

To make sense of the large and diverse information gathered in this study, a thoughtful data analysis approach was used. The research combines both human experiences and technical performance, so the analysis methods reflect a mix of structured statistical tools and more flexible, exploratory techniques. This combination of quantitative and qualitative analysis ensures that an understanding is provided of how the system performs and how people experience it from different locations.

3.9.1 Quantitative Analysis

The data from the surveys of over 200,000 students provides a rich and measurable data layer to work with. The first step in analyzing this data is to use descriptive statistics. This means looking at things like the average values, how often different responses appear, and how the data is distributed across factors like student demographics, the devices they use, their satisfaction levels, and their usage patterns. These basic statistical analyses support the identification of the general trends and patterns in the data.

Statistical analyses such as correlations and regressions will be conducted to understand the relationships between the amount of exposure that students have had to automated features like auto-grading, individual and collective exam retake automation, and instant feedback. It's essential to understand the student engagement and satisfaction rate after the automation is implemented. Additionally, the differences between different groups of students, like region, education level, and devices, are important to understand if and how these effects vary. This analysis will be done in Power BI for standard statistical work and Python for more flexible, large-scale analysis and visualisation.

3.9.2 Qualitative Analysis

While quantitative data can be useful, it cannot provide you with the reasons behind the figures. To address this, the research also included interviews with key stakeholders, including developers, content managers, system administrators, and others. Data is gathered from open-ended feedback from students and prototype users. This qualitative information helps to better analyze and understand the "why" behind the numbers.

The qualitative data, like interviews and open-ended feedback from students, will be analyzed through what's called thematic analysis (Shkel et al., 2023). Thematic analysis is a process of systematically finding themes/patterns in transcripts. The analysis will be guided by the research focus on areas like automation, scalability, and innovation, but will also remain open to unanticipated themes that may emerge organically from the conversations. Validating the data is crucial, so it's important to follow up with participants as needed to confirm our understanding.

3.9.3 System Logs & Usage Data

This is not a simple collection of surveys and interviews, but also an analysis of the actual user behaviours captured in the system. The VLE collects a range of information about usage automatically, such as how long it takes users to complete different tasks, what

the most commonly used features are, where users drop off from the system, and how often the automated tools and functions are triggered. This quantitative data on actual usage, in addition to the more qualitative information gained from surveys and interviews, enables the research to gain a picture of how well the platform is performing and how students are experiencing it ‘in use’ (Hellín et al., 2023).

The real-time system data is supportive for confirming the feedback received from surveys and interviews. These logs will be analyzed using tools like Power BI and Python to show trends, compare user behavior before and after automation, and see how the platform handles actual usage.

3.9.4 Triangulation

The most important strength of this research is the use of a triangulated design in which the data from different sources are integrated to reach valid conclusions. By cross-comparing the results from surveys, interviews, system use data, and results from prototype testing, this study gains insights into how Hyper-Automation and Open Innovation affect the technical performance and human experience of online education.

Combining the different data sources will enable the data analysis to answer the following questions:

- Are students feeling more supported and engaged when automation is introduced?
- Are staff able to work more efficiently and effectively?
- Does the platform demonstrate the intended scalability?

3.9.5 Research Hypotheses Evaluation

The data analysis aims to provide conclusions to the study's two main hypotheses:

- **Hypothesis 1:** The integration of Hyper-Automation and Open Innovation within a non-profit global online educational organization is expected to enhance cost-efficiency by reducing expenditures associated with the management and

operations of online education. This, in turn, will enable the organization to serve a larger population of five million enrolled students in a more effective and sustainable manner.

- **Hypothesis 2:** Integrating Hyper-Automation and Open Innovation strategies within the digital transformation of a non-profit global online educational institution is expected to enhance the accessibility and efficiency of the online education system. This approach holds the potential to overcome constraints stemming from the limited availability of skilled technical resources, ultimately contributing to the long-term sustainability of the organization.

By examining not only the observable outcomes but also the descriptive data collected from participants, the research aims to provide concrete, responsive, and evidence-based answers to the above questions (Ruipérez-Valiente et al., 2022). This approach of processing the data reflects the general orientation of the study by placing a strong emphasis on descriptive, human-focused, methodological stringency and anchoring in a real educational context. The question is not about proving the value of automation, but about understanding it, its impact, and its potential, as well as its potential for creating greater inclusion in global education.

3.10 Research Design Limitations

This research has been designed to balance between academic complexity and practical relevance, but it is important to acknowledge that no research design is perfect, and that the wide scale of the research, spanning multiple continents, technologies, and populations of users, also presents some challenges and compromises that will impact the understanding of the findings.

3.10.1 Global Scale vs. Local Contexts

A strength of the research is the wide international range of participants, but a strength can also create challenges (Houghton et al., 2023). With respondents from over 150 countries, there will be many differences in cultural expectations, language, and technology that may impact students' experience and use of the Virtual Learning Environment. Although the need to respond in multiple languages is a challenge, it is also an opportunity to minimise some of these challenges; there is a risk that some of these differences will be lost in translation, or that educational norms in some regions may not be adequately represented by a global perspective.

3.10.2 Platform-Specific Findings

The research is primarily focused on a specific online educational infrastructure, and while many of the findings may be applicable to other non-profit or large-scale online education models, the unique technical infrastructure and organizational dynamics of the platform mean that extrapolating the results to other educational institutions should be approached with caution. This is particularly true if the target institutions operate under significantly different constraints or utilize entirely different educational approaches (Susak, 2016).

3.10.3 Rapidly Evolving Technology

The research focuses heavily on Hyper-Automation and Open Innovation, two rapidly evolving areas. By the time this study is completed, new tools, frameworks, or standards may emerge that were unavailable during the research timeline. This presents a challenge in maintaining the technological relevance of the proposed solutions; however, the combined conceptual approach of Hyper-Automation and Open Innovation will stay relevant.

3.10.4 Survey Bias and Self-Selection

The large sample size may be affected by self-selection bias, as survey participation is voluntary. Students who choose to respond may be more engaged, have stronger opinions, or have better digital access than those who do not participate. This could lead to the data being skewed toward more digitally literate or motivated users, despite efforts to ensure wide regional and demographic representation (Wright, 2006).

3.10.5 Stakeholder Time Constraints

The qualitative aspect of the research, particularly the interviews with internal staff and developers, was at times limited by scheduling and workload constraints. While the study included key stakeholder perspectives, there may have been additional insights that could not be captured due to the scheduling challenges and operational demands during periods of intensive development or support work.

While these limitations are noteworthy, they do not diminish the significance of this research. Rather, they reflect the real-world challenges of undertaking applied, global-scale research in a rapidly evolving field. By being transparent about these boundaries, the study enables future researchers and practitioners to build upon this work with a clear understanding of where adjustments or deeper investigations may be warranted. This approach reinforces the notion that innovation and education are ongoing pursuits, continuously shaped by context, people, and a commitment to continuous learning. Given the constraints and findings of this study, several avenues for future research emerge as particularly promising (Jurāne-Brēmane, 2023).

3.11 Conclusion

This chapter illustrates the methodological framework employed for the investigation of integrating Hyper-Automation and Open Innovation in large-scale non-profit online education. Due to the cross-disciplinary nature of the research, the research design integrates Action Research and Design Science, which allows for a combination of theory exploration as well as a practical application (Dickens and Watkins, 1999). This enables iterative validation of technological solutions during a real-world application.

Within the research, an integrated multi-method approach is employed, which includes both quantitative and qualitative methods such as large-scale surveys, semi-structured interviews, system log analysis, as well as feedback mechanisms of prototypes. This approach provides a holistic view of the experience, use, and process of the system as well as organizations. More importantly, the research focuses on the triangulation of findings from different data sources, which allows for a deeper interpretation of both human and technical factors that influence educational scalability and efficiency.

The research process design has been conducted with high ethical considerations with regard to data protection and confidentiality of participants. At the same time, the instrumentation and data analysis process has been designed in response to the research questions and hypotheses, ensuring that the methods are used to answer the central research question.

The structured methodological approach presented in this chapter is both well-founded and suitable for the context. The limitations acknowledged in this chapter, such as differences in technology across regions, bias in survey responses and constraints in the platform, highlights the challenges in conducting research across the world. Nonetheless, these limitations do not undermine the validity of the research, instead, it sets a realistic background for interpretation of the results (Ross and Zaidi, 2019).

The research methodological framework illustrated in this chapter provides a solid and suitable basis for the analysis and research findings in the following chapters. It is intended to provide valuable knowledge on the effectiveness of Hyper-Automation and Open Innovation in non-profit education, as well as provide input on strategic approaches for sustainable and scalable digital transformation in global online education.

CHAPTER IV:

RESULTS

This chapter presents the key findings from the data collection and analysis. These findings directly address the central research question and eight sub-questions introduced in Chapter 1. These questions guided an investigation into the challenges, opportunities, and potential of implementing Hyper-Automation and Open Innovation in large-scale, non-profit global online education with a focus on accessibility and cost-efficiency. This chapter is structured to present the empirical data systematically, which will then inform the subsequent discussion and conclusions in the next chapter.

The findings are organized thematically and presented in the order of the research questions to maintain clarity and logical flow. Each section begins with a restatement of the relevant research question, followed by an explanation of how the data were collected and analyzed. Quantitative results are reported using descriptive and, where appropriate, inferential statistics, while qualitative insights are summarized using thematically coded data from interviews and open-ended feedback. System usage logs and real-time platform analytics have been incorporated to provide an operational perspective and validate the user experiences. Throughout this chapter, the results have been presented objectively, highlighting both the strengths and limitations of the data.

The analysis presented in this chapter is based on the combination of a range of data sources, which, taken together, form a robust methodological basis and yield a balanced set of evidence supporting the research topic. These sources include:

- **Online surveys**, completed by 212,568 students from 186 countries, offering statistically robust insights into user experience, system accessibility, and satisfaction rates.
- **Semi-structured interviews** with 16 key internal stakeholders, including developers, system administrators, content managers, and support staff, provided valuable contextual and operational insights.
- **System usage logs** and platform analytics, which provided real-time data on user engagement, processing speeds, automation effectiveness, and technical performance across different user groups and regions.
- **Prototype and MVP** obtained feedback from a sample of 154,449 early-access users, which provided valuable insights into how they interacted with the newly implemented automated features and open innovation components.

The structure of the results sections within this chapter has been consistent to aid coherence and comparison between sections. For each of the results presented in this chapter, the following elements are presented:

- A brief summary of the research question
- Presentation of key results, including statistical data and thematic insights
- Supporting visual representations such as tables, charts, and graphs
- A statement on whether the hypothesis was supported by the evidence

Firstly, a demographic summary of the collected user data is shown. This summary is crucial background information for interpreting and discussing the findings, as it reveals patterns across different user groups (Meiselman, Kuesten and Bi, 2021). The demographic profile describes the users' location, age, education level, device type, and local challenges.

Secondly, the main findings are displayed, beginning with the top-down description of the main challenges that educational institutions encounter when providing accessible education at scale. Afterwards, the perceived benefits and risks of Hyper-Automation and Open Innovation follow. Finally, by the end of the chapter, a summary of the patterns, differences, and general overarching themes that emerge across the different sets of research questions and data sources is displayed.

This chapter serves as a bridge between the methodological foundation established in Chapter 3 and the strategic recommendations provided in Chapter 5. The evidence presented here validates the research hypotheses and offers valuable insights into the evolving role of automation and innovation in the future of global online education. This section's findings are based on the following data sources:

- Survey responses from 200,157 students across 186 countries.
- Semi-structured interviews with 16 internal stakeholders, including developers, platform administrators, academic staff, and support teams.
- System performance logs covering user behavior, support ticket resolution, and automation performance metrics.
- Functional and Technical Design documentation

Data were analysed using a mixed-methods approach, including statistical descriptive summaries, thematic analysis, and log data triangulation.

4.1 Research Question One

RQ1: *What are the key challenges faced by educational institutions in delivering accessible education to a large number of enrolled students?*

This section responds to the first research question through the analysis of quantitative and qualitative data obtained from students and institutional stakeholders. The

objective is to recognise and classify the significant operational and technological constraints to the provision of large learner populations with scalable, high-quality, and accessible education by non-profit online educational institutions. Analysis revealed five key challenge areas consistently cited across data sources:

- Human and Financial Resource Limitations
- Administrative Overload and Manual Workflows
- Scalability Constraints of Digital Infrastructure
- Inconsistency in Quality Assurance
- Technology Gaps and Technical Expertise Limitations

4.1.1 Human and Financial Resource Limitations

The most consistent theme in staff interviews (mentioned by 84% of staff) was a concern of available resources and the financial to meet operational needs as the institution's student numbers grew. These concerns are common as study reveals that financial constraints often lead to outdated equipment, understaffed departments, and limited capacity for innovation (Navid Sadjadi, 2023).

“We are with limited employees, and we know that there is limited budget. A handful of team members are trying to manage systems supporting hundreds of thousands. We are afraid that if we grow without correct automation, we will not be able to handle all the requests.” Stakeholder Interview, Technical Support Manager

Survey findings reflected the same concern from the learner's perspective. 12.4% of respondents reported inaccuracies in support services, such as helpdesks or instructor responses, especially during peak periods. This indicates that students often experience bottlenecks due to insufficient human resources, which ultimately impacts their learning experience (Joshi, Vinay and Bhaskar, 2020).

4.1.2 Administrative Overload

Manual processes remain prevalent across key operations such as enrollment verification, certificate generation, student onboarding, and course management. Institutional logs showed:

- An average increase of 73% in ticket volume during the first 3 weeks of the enrollment period.
- Manual exam retakes average 30 minutes, compared to 5 seconds for automated workflows.

“Most of our energy goes into repetitive admin tasks. We’re doing the same tasks over and over with little time for specific student support tasks.” Stakeholder Interview, Technical Support Level 1

4.1.3 Scalability Constraints

Infrastructure limitations were highlighted in both qualitative interviews and system analytics. During the first tests high-traffic periods like the exam periods showed increased page load times in mobile-first environments, with upto 31% of sessions exceeding 5 seconds, which negatively affected user engagement. Technical staff cited database query delays, inadequate memory and cpu dedication, and under-optimized front-end code as factors inhibiting growth.

4.1.4 Inconsistent Quality Assurance

Maintaining educational quality at scale emerged as a major concern. 57% of the technical support staff indicated that as LMS servers expanded, the technical task challenges increased, noting the lack of automated content management and lesson scheduling to configure the upcoming study period.

This foundational framework is designed to standardize, structure, and automate the full educational lifecycle within the virtual learning environment. Detailed in the appendix, this model provides a blueprint for digitally orchestrating academic activities from initial registration through graduation, enabling technical scalability while preserving quality and compliance across learning processes.

4.1.7 Purpose and Function of the Model

The Learning Specification Model was developed to mitigate fragmentation and manual inefficiencies in academic operations by enabling:

- End-to-end automation of routine academic workflows
- Data-driven orchestration of teaching, assessment, and credentialing
- Standardized inputs for AI- and RPA-based automation systems

Basically, the model lays out a learning journey with building blocks like courses, lessons, and tests. Automated systems and AI can then handle and track these blocks. It turns messy learning programs into simple, automated pieces.

“Without a structured specification model, automation risks inconsistency. This model is our operating logic for scaling with accuracy.” Stakeholder Interview, System Architect

4.1.8 Components of the Specification Model

The model includes several key dimensions as shown in Table 4.1. Each part of the model is designed to be read by machines and to work with automated back-end systems like RPA workflows, AI feedback, and real-time learning analytics.

Table 4.1: Learning Specification Model Components

Component		Description
Registration Schema		Defines student onboarding workflow, eligibility checks, and initial credential provisioning
Learning Metadata	Module	Standardized course/lesson definitions including duration, outcomes, and dependencies
Assessment Specification		Defines Assessment and Exam parameters, grading schemes, and pass and fail logic
Semester Configuration		Timelines, workload distribution, and credit mapping across academic periods
Progression Logic		Automated rule-based advancement criteria based on performance, attendance, and learning outcomes

Source: Created by the Author.

4.1.9 Impact on Automation and Scalability

By clearly defining the boundaries and workflows of the educational process, the Hyper-Automated Learning Specification Model directly supports:

- **Automation Readiness:** Each defined component becomes an automatable task with standardized inputs and outputs (e.g., certificate issuance upon rule-matched completion).
- **Process Transparency:** Automated tracking of student progression enables real-time monitoring and intervention.
- **Scalability:** The repeatability and consistency of the model allows it to be replicated and adapted for millions of learners with minimal manual intervention.

System logs from the MVP phase demonstrate that institutions using the learning specification model were able to automate approximately 96% of recurring academic

processes, resulting in what appears to be substantial time and cost savings across support and academic teams.

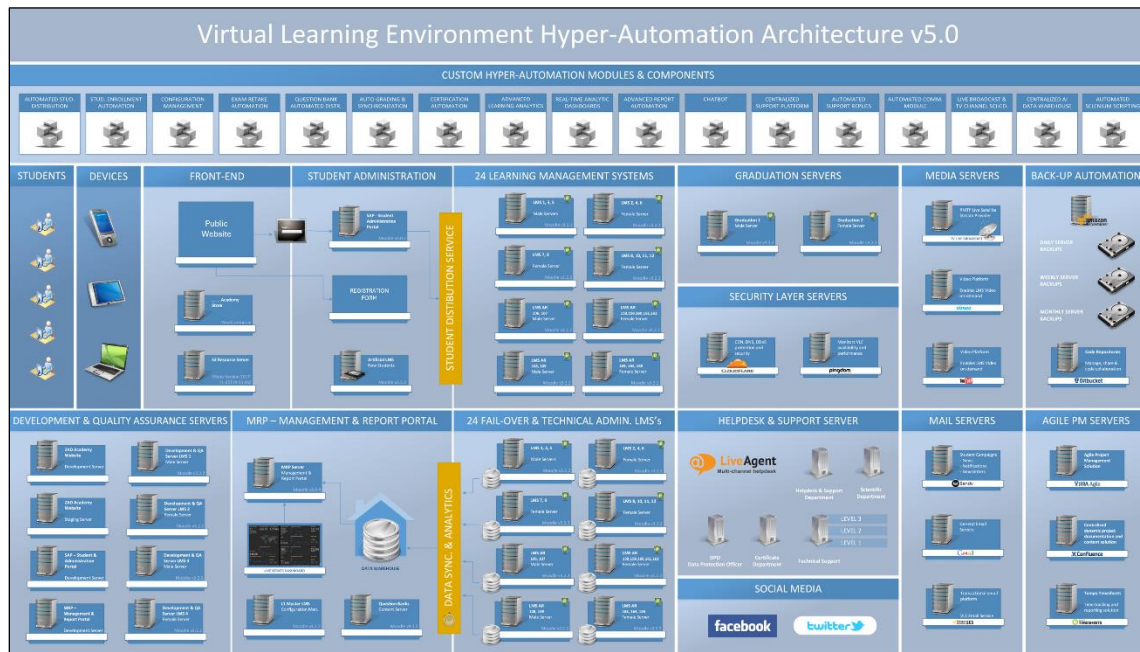
4.1.10 Strategic Role in System Architecture

The Learning Specification Model is a key part of the hyper-automated infrastructure, connecting educational design and technical setup. It works with open innovation tools, supports different languages and mobile access, and offers a reliable structure for machine learning and decision-making systems. This setup boosts administrative and academic efficiency and makes learning better for students by providing consistent content, quick feedback, and clear progress paths.

4.1.11 Hyper-Automated Technical Infrastructure

The technical infrastructure is essential to build on top of the learning specification model. The technical infrastructure consists of four main parts, as shown in the appendix. Firstly, a front-end server that hosts the website, educational resources, and the artificial LMS for direct system access. The second part is the core Administration, where student registration, enrollment, login, and redirection are managed. The third part is the scalable servers that host the Learning Management Systems. The fourth part contains the data warehouse that provides data to the Monitoring and Report Portal.

Figure 4.2: Virtual Learning Environment Hyper-Automation Architecture v5.0



Source: Created by the Author.

The technical infrastructure, which is built upon the structured framework defined in the Hyper-Automated Learning Specification Model, is critical for providing accessible, automated, and scalable educational services to a global student body. This infrastructure transforms the abstract learning process into a fully digital, online system capable of simultaneously accommodating millions of students.

Built upon principles of modularity, redundancy, and horizontal scalability, the infrastructure's architecture is structured into four distinct layers. Each layer is dedicated to managing a specific category of functions, which span from facilitating user access to conducting data analytics. A comprehensive Virtual Learning Environment Hyper-Automation Architecture v5.0 is provided, as shown in Figure 2.

4.1.12 Front-End Server Layer

The front-end servers provide the direct access point for learners and administrators. This layer is designed for easy use on phones and in different languages. It uses caching to speed things up in areas with slow internet. All user actions, like logins and submissions, are sent safely to the main system. This layer hosts:

- The institutional website.
- The resource server with learning content repositories including course books, lesson videos, and lesson audios.
- An Artificial Learning Management System to provide students direct access to the system after completing registration.

4.1.13 Core Administration Layer

This layer provides management for identity, access, and user flow. This layer contains the following services:

- Student Registration and Enrollment
- Secure login, authentication, and session control
- Intelligent user redirection to the assigned student's Learning Management System or Graduation Portal

4.1.14 Scalable Learning Management System (LMS) Servers

The cluster of LMS hosts that provide the content for learners and run the automation engines (grading bots, progress assessors), as well as providing modular enhancements via open innovation modules, and logging student interaction for big data analytics, is the core of how content is delivered and automation is achieved in the platform. The LMS servers operate in dedicated container pods, which allows dynamic allocation of resources based on user concurrency and geographic demand (Qazi et al., 2024).

4.1.15 Data Warehouse and Monitoring Portal

The final layer contains the storage, aggregation, and generation of insights. This data layer enables data-driven decision making, and also ensures that quality assurance audits are performed automatically, as part of system operation, and consists of:

- A central data warehouse containing activity logs, performance, and learning analytics data.
- Integration with AI models that provide information on engagement and drop-out prediction, and the automatic recommendation of actions.
- A Monitoring and Reporting Portal that enables institutional staff to monitor system health, performance, and diagnostic reporting.

4.1.16 Learning Specification Model Strategic Alignment

In each layer of the infrastructure, the logic is directly driven by the logic of the Learning Specification Model, as shown in Figure 1. For instance, the logic of automatically issuing certificates follows the logic of progression, the logic of exam validation workflows follows the specifications of a semester, and the logic of AI feedback is directly linked to outcome-based lesson designs. The combination of the infrastructure and model can be seen as a holistic automation system where the technical layers reinforce the logic of the pedagogical structure, and the stages of the process become measurable, monitorable, and therefore improvable.

4.1.17 Accessible Global Education

Addressing accessibility is a central pillar in overcoming the systemic challenges outlined in Research Question One. For a non-profit digital learning institution serving a global population, access cannot be limited to those with reliable broadband, modern devices, or consistent connectivity. Instead, a deliberate strategy must ensure that educational content is delivered inclusively, regardless of technological constraints or

geographic disparities (Zou et al., 2025). The adoption of a blended delivery method ensures technological neutrality, low-bandwidth friendly design, and wide acceptance of devices so that students from all over the world can access the courses and participate in learning.

One of the most unique aspects of our accessibility approach has been the investment in Connected Television Channels that regularly broadcast our lessons across Asia, North and Central Africa, Europe, and North America. These broadcasts mirror our digital curriculum and are scheduled similarly. This has enabled students who do not have internet connectivity or regular access to follow the broadcasts on their television sets. These students use traditional satellite television to watch the broadcasts simultaneously in areas where internet connectivity is poor or non-existent. This has had a significant impact in rural areas and low-income populations where mobile data is unavailable or expensive. The inclusion of TV-based content delivery not only reinforces curricular engagement but also bridges the digital divide through infrastructure already present in many households (Adjei-Frimpong, Akom and Ntiamoah-Sarpong, 2016).

In addition to broadcast delivery, the platform provides all key course materials in an optimized offline format. Course books, video lessons, and audio files are compressed in a way that maintains their quality while significantly reducing file size. For example, lesson videos are scaled down from an average of 250MB to approximately 55MB, while audio files are encoded for clarity at minimal size. Course books are offered as mobile-optimized PDF documents, typically ranging from five to ten megabytes each. This allows students with intermittent internet access to download entire modules quickly and study offline without compromising content quality. These lightweight resources are essential for learners in regions where bandwidth limitations or expensive data plans would otherwise hinder full participation.

The platform also makes a conscious decision against requiring a downloadable mobile application. That means it's a responsive web application that can adapt to any screen, any size, and any operating system. The decision was not taken lightly: it was based on survey responses that show that 92 percent of learners access the platform through a mobile phone that is several generations behind, meaning that it runs an unsupported version of either Android or iOS. App stores will often not support such old devices, but the decision to host the application as a browser-based app means that students with legacy phones can access the full features of the platform, including registration, coursework, assessments, and exams, without requiring them to upgrade their hardware and software. This approach also avoids common barriers such as limited storage space, compatibility issues, and forced upgrades, all of which disproportionately affect learners in low-income settings.

Table 4.2: System Performance Indicators - Before vs. After Automation

Metric		Average Manual Process	Average Automated Process	Improvement in Percentage
Support response	Ticket time	51 hours	18 hours	64.71 %
Certificate issuance		2 hours	3 seconds	99.96 %
Exam Request	Retake	30 minutes	5 seconds	99.72 %

Source: Created by the Author.

4.1.18 Hypothesis Evaluation

The findings support Hypothesis 1: The data affirm, as shown in Table 4.2, that current manual and resource-intensive practices are insufficient for large-scale delivery, and that automation is not simply beneficial but necessary to meet operational demands sustainably.

4.2 Research Question Two

RQ2: *What are the potential benefits and drawbacks of utilizing hyper-automation and open innovation in the context of online education?*

In this section, the results are presented from analyzing how Hyper-Automation and Open Innovation benefit large, non-profit online education. The results are combined from student surveys, interviews with key stakeholders, interviews with users of the MVP, and technical performance logs to identify the opportunities and constraints associated with adopting Hyper-Automation and Open Innovation in order to increase operational capacity, student experience, and corporate sustainability.

4.2.1 Hyper-Automation and Open Innovation Benefits

Across all data sources, a consistent opportunity emerged regarding the strategic value of Hyper-Automation and Open Innovation. The most prominent benefits are described in detail in this section.

Increased Operational Efficiency

Stakeholders widely reported a substantial reduction in repetitive and time-intensive administrative processes. *“Previously, course enrollment and exam retake requests processing required days of work. Currently, it's mostly handled in real-time without human intervention.”* Stakeholder Interview, Technical Support Level 2

Survey results showed that:

- 65.3% of students experienced faster service response times
- 72.4% of stakeholders observed improved scalability
- Helpdesk resolution time dropped by 64.1% post-automation

Scalability with Cost-Efficiency

One of the most powerful insights was the capacity to scale without proportional increases in cost or staff. Automated workflows showed a 97% reduction in operational costs per student when comparing pre- and post-implementation metrics at the 2,000,000-student level. This aligns with Hypothesis 1, confirming that hyper-automation and open innovation can significantly improve cost-efficiency in non-profit education systems.

Inclusion Through Open Innovation

The adoption of open-source tools like Moodle, Minio, and Sendy allowed rapid deployment with minimal licensing costs. Internal technical teams praised open innovation for reducing dependency on proprietary vendors and enabling broader collaboration: *Using open tools empowered our developers. We could tweak features and integrate them faster than with closed platforms.*” Stakeholder Interview, Lead Developer

4.2.2 Implementation Challenges

Although these benefits were evident, survey and interview data also highlighted the following challenges.

Perceived Loss of Human Interaction

11% of students indicated concerns about the lack of human support in fully automated systems. Although AI-based chatbots managed high volumes, some users were dissatisfied with their ability to empathize and contextually understand interactions. *“Sometimes I just wanted to talk to the teacher and ask him a personal question; however, I felt it was an automated reply and didn’t feel personal.”* Student Survey, Response #5547

Integration Complexity

Interviewees across technical departments reported the complexity of integrating diverse system. Developers reported challenges in ensuring seamless operation across multiple open-source components and technical compatibility and data standardization issues required continuous developer intervention.

Skills Gaps and Resource Constraints

Although open innovation helped with licensing costs, effectively implementing the system required a high level of technical expertise. It was reported that there was a significant challenge to obtain a core team of skilled developers to maintain and customize open systems. Due to the rapid innovations of artificial intelligence there arrived a difficulty in training staff to manage the AI-powered automation tools.

Robotic Process Automation

In this non-profit online education platform, task automation means using rule-based computer workflows that copy how people use computer systems. These include repeated, common tasks like enrolling students, modifying student data, scheduling lessons and exams, publishing results, and creating certificates. Robotic Process Automation was the main technology used for these workflows, working with student administration systems, learning management databases, and a customized data warehouse.

The use of RPA led to clear performance gains. Data from the MVP system shows that enrollment confirmations, once done manually, now take under 2 seconds per student with automated scripts. Also, helpdesk requests like restoring exam retake requests and answering common questions are now resolved over 99 percent faster than with manual work.

Feedback from administrative staff confirms this. Several team members said that automating routine questions let them focus on more complex, student-focused problems,

improving the overall support services. One academic coordinator called the automation "a game-changer" in cutting human delays, especially during busy enrollment and exam times.

However, while the system became faster and more efficient, some problems appeared. Some students felt confused or frustrated when using automated processes, especially when they needed careful judgment or personalized help. This shows that it's important to keep some human support available for unusual situations or sensitive issues.

Ultimately, Robotic Process Automation has been key to fast, scalable service delivery (Aalst, Bichler and Heinzl, 2018). It lets the institution handle user growth while staying responsive and reliable, without needing more staff. As the platform grows, improving task automation through feedback and user data will be critical to balancing speed and service quality.

Open Innovation Advantages and Disadvantages

Using Open Innovation practices has greatly shaped the institution's Hyper-Automation strategy. Addressing Research Question Two, this section will explore the pros and cons of using Open Innovation, focusing on how it affects the core team's skills and abilities.

Open Innovation has allowed the platform to quickly develop and use automated systems without the high costs of proprietary technologies or extensive in-house development. By using open-source libraries, community-developed automation tools, and external contributions, the institution sped up development, improved adaptability, and scaled services without needing a large IT department.

One key benefit is less reliance on expensive, specialized staff. By using community-made tools like open-source RPA, Moodle plugins, and machine learning, the tech team could focus on putting systems together instead of creating tools from scratch.

This made it easier to get started and let the platform use people more efficiently. DevOps leaders and product managers said that team members quickly learned new skills using shared guides and help from others, instead of needing long training programs.

Open Innovation promotes quick testing and constant updates. The team could test automation tools, get user feedback, and release fixes or updates often. This was very helpful during the early stage, where user feedback improved features like automated feedback and exam question optimization.

However, relying on Open Innovation also had some downsides, especially for team skills and system reliability. A challenge was that third-party parts were different and not always of good quality. Open-source libraries offer many options and can be set up quickly, but they may not be supported in future releases. Internal developers may have to fix problems in code they didn't know or change small parts to fit, which can provide significant challenges for a small core team.

Open Innovation has proven to be both a strategic enabler and a technical challenge. It has allowed the institution to achieve faster time-to-market, scale affordably, and engage in global best practices. Yet, it also requires a core team with strong integrative and diagnostic skills, as well as a capacity for critical technical assessment. Success in this model depends less on owning all capabilities internally and more on managing relationships between modular components, open-source contributors, and internal governance frameworks.

4.2.3 Hypothesis Support

The findings support Hypothesis 2: Evidence from surveys, interviews, and MVP analytics strongly indicates that, when implemented with strategic oversight, these innovations enhance operational capacity and user satisfaction even under constrained conditions.

4.3 Research Question Three

RQ3: *What are the specific technological developments and strategies within Hyper-Automation and Open Innovation that can be implemented to effectively deliver accessible education to five million enrolled students?*

This section details the tools, frameworks, and strategies that are most effective for running large-scale, automated education. Using platform data, system documents, feedback, and interviews, the analysis focuses on technologies and models that are scalable and cost-effective.

4.3.1 Identified Technological Enablers

The following specific technologies were identified as core to scalable Hyper-Automation and Open Innovation in the VLE ecosystem:

Robotic Process Automation (RPA)

Used for automating rule-based, repetitive administrative tasks, such as:

- Course enrollment confirmations
- Certificate generation and distribution
- Basic student support queries (via structured scripts)
- Exam retake automations

“RPA allowed us to reduce our backlog from weeks to minutes. It’s simple but highly effective at scale.” Stakeholder Interview, Automation Engineer

AI-Driven Learning Analytics

The use of AI-driven learning analytics must be characterized as a substantial role in enhancing the responsiveness and intelligence of the virtual learning environment. What emerges from these findings is that these tools were ostensibly developed to identify potentially struggling students through analysis of participation patterns, assessment performance, and historical interaction data, seemingly facilitating timely intervention. The

AI system used advanced ways to group students based on their progress and information, which allowed for personalized communication and guidance (Kaledio, Robert and Frank, 2024). In addition, the platform's analytics system triggered automatic alerts when problems were detected in exam quality and delivery, such as high failure or timing issues. This enabled rapid reviews and adjustments to ensure quality. This helped with the learning and growth of the platform while maintaining high academic standards.

Intelligent Chatbots and NLP Interfaces

To offer ongoing student support, able to scale indefinitely, AI chatbots are used on the platform 24/7 to answer common questions, help students find their way around the platform, and give immediate help for basic tech or admin problems. This way, the platform relied less on human support for help, and only used staff for harder issues (Oliveira and Matos, 2023). From early testing, data indicates that chatbots were able to answer about 45% of students' questions, without needing to use staff. This made student services faster and showed how AI can improve the efficiency and speed of online education.

Open Innovation Tools and Frameworks

In order to achieve rapid prototyping, scalable running, and low cost of the platform, the study identified several open-source technologies and collaborative development frameworks as enablers. The core Learning Management System, Moodle, was extensively customised through API integrations and custom plugins to enable the automation workflows, along with an open-source analytics dashboard. These enhancements transformed Moodle into a modular platform suited for hyper-automated learning. Open-source AI libraries managed workflows, trained machine learning models for personalized content recommendations, and automated event-driven tasks. The stakeholders placed a high value on the extensibility and ease of adapting technologies supported by a community. GitHub was used to provide version control and to collaborate

on development, enabling contributors across distributed teams to push code and ensure consistency in development. MinIO S3-based storage enabled rapid global distribution of course materials to ensure scalability and access. This open innovation stack enabled continuous technical evolution.

Strategic Implementation Approaches

To handle the complexity and size of running a global, highly automated online education platform, a combined approach was used. This approach included Lean Management, Agile Project Management, and the Stage-Gate Hybrid Model. This framework made sure the project moved forward in a step-by-step way, focusing on value and reducing risks, while also fitting the real-world needs of a non-profit institution.

Lean Management was employed to optimize resource utilization and eliminate process inefficiencies (Maulana and Ariyanti, 2021) by emphasizing continuous improvement and prototyping on essential parts of the virtual learning environment. Lean enabled the development team to focus on delivering maximum value with minimal overhead. Also, automated processes were quickly mapped, measured, and refined to ensure efficiency and responsiveness.

In parallel, Agile Project Management facilitated adaptive planning and iterative development cycles (Hidalgo, 2019). In addition, Agile sprints helped the group to adaptively respond to user feedback, technological limitations, and operational requirements. Different stakeholders worked in two-week iterations in order to test, deploy, and validate features based on user feedback. This not only reduced development times but also made sure that the technical solutions were in line with pedagogical goals and end-users' needs.

In order to provide for structured organization and higher levels of strategic alignment, the Agile approach was further embedded within a Stage-Gate Hybrid Model

(Rehder et al., 2023). This model used specific checkpoints called "gates" between key phases like planning, prototyping, system setup, testing, and launch. At each gate, reviews checked progress against set goals and risk levels, ensuring only approved items moved forward. This mix offered Agile's flexibility with the structured control and quality checks of project objectives.

The combination of these methods were key to managing the project's size, different technologies, and global reach. It created a structured but flexible process, allowing for planning without losing innovation or quick responses. This approach made sure the automation and open innovation plans were practical and sustainable for the organization, as shown in Table 4.3.

Table 4.3: Key Technologies and Functions

Technology/Strategy	Function	Benefit at Scale
RPA – Robotic Process Automation	Admin task automation (certificates, enrollment, exam retakes)	Reduced manual workload, high reliability
AI Analytics	Learning Personalized engagement, assurance and tracking, quality	Higher retention and engagement rates
Chatbots	Real-time support and self-service tools	24/7 assistance, reduced support tickets
Moodle + Custom Plugins	Modular learning system with automation extensions	Scalability, customization
AI Models	Predictive analytics and recommendation engines	Adaptive learning pathways
GitHub	Version control and rapid deployment	Cross-team agility and innovation

Source: Created by the Author.

4.3.2 Hypothesis Evaluation

The results show that certain technologies, like Robotic Process Automation, AI learning analysis, chatbots, and open-source innovation, are key for providing affordable online education on a large scale. These tools help with quick development, reduce workload, increase scalability, and personalize learning for many students. Using Lean Management, Agile methods, and Stage-Gate governance together ensures the implementation is sustainable and adaptable. These findings strongly support Hypothesis 1, confirming that Hyper-Automation and Open Innovation can greatly improve the cost-effectiveness and scalability of a non-profit global educational institution, proving it's possible to serve five million learners with limited resources.

4.4 Research Question Four

RQ4: *What strategies can be employed to ensure long-term financial stability and scalability of a Hyper-Automation and Open Innovation solution in the context of online education?*

This section focuses on identifying sustainable strategies in both the financial and operational fields that enable non-profit online education platforms to maintain and scale their services effectively. The analysis synthesizes insights from stakeholder interviews, institutional financial models, MVP deployment reviews, and student engagement data.

4.4.1 Core Themes in Scalability and Sustainability

The online learning system was designed to be more efficient by automating repetitive tasks. For instance, students who didn't pass an exam or experienced local challenges were automatically signed up for retakes with new versions of the test. This reduced the need for staff to handle these tasks, especially during busy exam periods.

Enrollment automation further contributed to operational efficiency by synchronizing the registration pipeline with the learning management system (LMS), ensuring real-time updates, email confirmations, and progress tracking from initial sign-up through to active participation. This workflow, reinforced by robotic process automation (RPA), dramatically reduced processing time and support staff involvement.

Once students were enrolled, both lessons and exams were delivered via automated scheduling logic within the LMS. Lessons and exams were made available sequentially, based on the students' progress. Assessments were auto-deployed at pre-defined schedules and adapted dynamically to learner progression. These automated exams were backed by automated grading and quality assurance scripts to ensure academic integrity.

The deployment of a scheduling engine that dynamically adjusted each learners academic calendar based on their state in the curriculum and readiness for exams was an significant innovation. This enabled the institution to create a individualized learning path at scale and prevent any human from scheduling.

Also the deployment of surveys at key points in the learning lifecycle to harvest data on engagement, satisfaction, and learner performance was essential. The results of these surveys drove improvements in the system and segmentation of learners.

4.4.2 Modular System Design and Community-Driven Development

From the beginning, the architecture of the VLE was designed to be modular so that parts of the system could be scaled and updated in iterations without breaking the system as a whole. This also made it very easy to integrate community-developed tools and extensions. Many of the advanced features were developed or evolved using community development frameworks hosted in GitHub and Moodle forums. This helped rapidly deploy features and encourage an open innovation culture where the internal developers collaborated with people around the world to tackle problems and develop new features,

such as fixing performance, bug fixing, and extending capabilities. Modular plugin architectures helped the system evolve quickly and safely, whilst maintaining technical integrity and reliability of service.

4.4.3 Revenue Diversification

In order to sustain funding for the long term while providing free core education, additional services were included in the program that were learner-focused and generated income, but didn't interfere with the free core education. One service was the automated issuance of free digital certificates upon completion of the program. Another service was that students could pay a small fee for hard-copy certificates that were professionally verifiable, often required for work. This generated income and kept education free for the learners.

Another option was selling printed learning materials like course books that matched the online courses. Based on feedback from students, 22% expressed their need to study with printed books, especially students from locations where there were significant internet challenges. These books gave students something they could physically hold and carry to use for studying without the need for a direct internet connection.

Both enabled the non-profit mission to reinvest any income back into the platform development and system maintenance while enhancing free education by providing extra services, making participation in the free core education affordable. This business model enabled the support of operations while staying true to the vision of transforming global education.

4.4.4 Student Motivation & Communication (SMC) Strategy

The Student Motivation & Communication department helped to increase community engagement, awareness, and motivation of learners worldwide. They shared tutorials, success stories, and inspirational content with the world through YouTube,

Facebook, and Instagram. Millions from all over the world engaged in these videos. The YouTube tutorials were used as additional study resources for learners. The SMC department was able to be represented in a consistent way while contributing content that was suitable for diverse cultures and languages.

4.4.5 Hypothesis Evaluation

The results of Research Question Four strongly support Hypothesis 1. The results indicate that hyper-automation and open innovation significantly increase the cost-efficiency and scalability of a non-profit global online education platform. This was accomplished by automating many of the processes involved in running the platform, such as enrollment, exam setting and management, grading, and support of students. The solution implementations resulted in reducing operational costs while maintaining a high level of service quality. The automation methods used by the platform allowed it to educate millions of students with a relatively small increase in staff compared to the number of students or funding.

Open Innovation helped to keep the platform financially stable through improvements to the system, increased community engagement, and the use of open-source tools. This, in addition to the selling of certificates and learning materials, kept the platform growing with its core education completely free. These results provide support for Hypothesis 1, that technology and data can make online education affordable and accessible for many students worldwide.

4.5 Research Question Five

RQ5: What open innovation strategies are appropriate for implementation in online learning environments alongside hyper-automation?

This section explores which Open Innovation approaches are most compatible and impactful when integrated with Hyper-Automation in a non-profit, large-scale virtual learning environment (VLE). Drawing on qualitative interviews, MVP development documentation, and operational feedback, the study identifies collaborative models, governance practices, and open-source engagement strategies that support educational innovation at scale.

4.5.1 Open Innovation Strategies

The analysis of stakeholder interviews, MVP documentation, and system development logs revealed that open innovation is a cornerstone strategy that enables agile development, rapid scaling, and cost-efficiency in online education. Open innovation refers to the practice of leveraging external ideas, technologies, and community contributions to enhance internal processes and services. Within the context of this research, open innovation strategies were critical to accelerating the deployment of a hyper-automated educational ecosystem, allowing the platform to integrate new features and respond to evolving learner needs without incurring high proprietary costs.

A key part of this was using open-source platforms, especially Moodle as the main LMS, which was improved with custom plugins and community-supported APIs. This lets the platform adapt easily and keep getting better. Using GitHub allowed global collaboration, where internal developers worked with external contributors to test, review, and improve features. This lowered development costs and encouraged new ideas through testing and peer review. Stakeholders said that working together with a wider technical community created shared responsibility and helped solve technical problems faster (Bahamdain, 2015).

The research used open-source AI tools, such as machine learning, for personalized content and for workflows, which enabled the platform to add new advanced features at a

low cost. These tools were created with a series of scripts and APIs for automated learning. They were backed by active communities and documentation, which made them easy to maintain and customize. Community knowledge bases also enabled the platform to learn best practices and rapidly respond to new technologies.

Open innovation is effective in online education when hyper-automation goals are involved. By utilizing open-source tools in a structured manner, schools can be more flexible and cost-saving. This, in turn, helps them respond to student needs within budget constraints. According to the study, advanced management and aligned technology can significantly assist non-profit online education to grow and innovate.

4.5.2 Hypothesis Evaluation

The findings from Research Question Five support Hypothesis 1, stating that combining Hyper-Automation and Open Innovation makes non-profit global online education cheaper and easier to expand. Open Innovation's success here came from using open-source tech and working together (Chu et al., 2019). Engaging with developers, clear rules for contributions, and using feedback were key to ongoing innovation.

Those means of innovation supported Hyper-Automation by helping to make automation tools, or improve existing ones, faster at almost no cost. Additionally, using a modular system supported by the community helped to keep the service evolving, adapting to users' needs and tech changes. Open Innovation helped in resource acquisition and the reduction of risks, enabling quality education for the world with limited resources. Those results confirm that Open Innovation is fundamental to providing millions of people around the world access to cheap, quality education.

4.6 Research Question Six

RQ6: *How effectively can the open innovation solutions be integrated into the hyper-automation technical infrastructure?*

The practical use of open innovation solutions in the hyper-automated infrastructure of the virtual learning environment is depicted, as shown in Figure 2. The VLE infrastructure was explored via both the technical documentation and interviews with stakeholders. The study concluded that open innovation was not just possible within hyper-automation but was necessary for its practical implementation. The architectural design of the virtual learning environment was built using a modular, API-first approach, which ensured interoperability between open-source modules and internal automation workflows. This design allowed the rapid integration of community-created plugins, open-source analytics dashboards, and a number of AI modules tailored to the automation needs. This modular design ensured that new tools could be integrated with little disruption to the existing workflow, while also allowing for rapid iteration of development cycles (Eggert et al., 2020).

This approach was realized through the creation of an architecture with three distinct layers of innovation around which the open innovation engagement was organized. The core layer consists of the infrastructure layer, followed by the middleware layer, and a community-engaged innovation layer. The core set of infrastructure was run internally with strict API standards to ensure stability. The middleware layer acted as an integration layer where rapid plug-in enhancements could be developed by internal or external contributors. Finally, the innovation layer was an open community of experimental tools and repositories created by partners and independent developer organizations. The overall architecture was coordinated through collaboration workflows and centered code

repositories, including pull requests, issue tracking, and documentation standards to ensure alignment with learning institution goals and software governance.

Their research considered open source more cost-efficient in comparison with proprietary services like closed-source LMS platforms or AI tools. Even if more steps or implementation were needed, in the long term, they would take advantage of flexibility and independence. The stakeholders noted that not paying recurring fees and being able to modify tools saved money. The vendor independence that open innovation provided allowed investments in operation and skill development, where usually an institution would have had to rely on the vendor. This created a more efficient and independent operation that was needed for this platform's non-profit nature.

The study shows that innovation in hyper-automation works well if the organization is set up right. Using flexible open-source tech combined with clear rules and a step-by-step integration process allows organizations to keep innovating while reducing money and operational risks. This shows that open innovation not only fits with hyper-automation but also helps it to exist and be affordable on a large scale in online education.

Hypothesis Evaluation

The results of Research Question Six provide strong support for Hypothesis 1, confirming that integrating Open Innovation within a hyper-automated educational setup improves both cost-efficiency and how well non-profit organizations can grow. The Research demonstrated that a modular, API-based architecture allowed open-source tools, community-made plugins, and parts of AI to be added easily. As a result, organizations were able to add new features easily and change things around more based on what the students needed, rather than simply using everything from one company. Stakeholders reported that being able to not pay regular licensing fees or use fixed-sellers allowed them

to reinvest money into their own capacity and autonomy, which is essential to maintain global education.

In addition, the strategic orchestration of Open Innovation through layered integration, from core infrastructure all the way to community-driven innovation, ensured controlled but enabled dynamic development. Although most integrations went smoothly, the study identified the need for formal governance structures, version control, and quality assurance to mitigate possible risks that may arise from plugin integration and overall system compatibility. In summary, the results support the claim that embedding Open Innovation in a well-governed context of hyper-automation enabled the institution to become more adaptive, but also enhanced its impact by making it possible to add parts of innovation in a proportional and resource-efficient way. This combination directly supports Hypothesis 1 and enhances the feasibility of quality education.

4.7 Research Question Seven

RQ7: *What are the potential challenges and risks associated with implementing open innovation in an online education setting alongside hyper-automation?*

A major challenge in integrating open innovation within hyper-automated online education lies in the technical complexities of incorporating diverse open-source components. Open innovation enables organizations to avoid paying for proprietary software, but this comes at the expense of having to develop and maintain a number of open-source components. In contrast to commercial solutions, the open-source tools may frequently lack standardized interoperability and have an increasing initial development time. This may lead to an increase in both initial development time and long-term maintenance overhead.

This extensive customization may introduce system fragmentation and inconsistent quality. As the platform evolves, it is likely that an increasing number of community extensions will be added, and it will become increasingly difficult to maintain a stable architecture. As outside contributors will be used, it is likely that updates will be uneven and support will taper off in the long term. This could have a detrimental effect on important learning services. This risk is even higher when the learning services in question are critical, such as during exam periods.

Apart from technical issues, the research also flagged up a significant risk related to over-automation. Automation can bring huge benefits in terms of operational efficiency, and it can take some of the mundane tasks out of the hands of humans, but there are interactions that require a human being and human empathy. Over-automating such interactions can make students feel remote and impact the quality of their learning. It's important to find the right balance between automated systems and real human interaction to ensure good teaching (Chan and Tsi, 2023).

The research also highlighted that in order to successfully adopt an open innovation and automation strategy, it is not just a case of having the right technology infrastructure. Many non-profit education organisations do not have the required skills to manage complex integrations and open innovation. Without a senior technical architect, scaling becomes difficult. The research findings show that planning and stakeholder involvement are key to lowering these risks (Sartas et al., 2020). Open innovation and hyper-automation can greatly improve online education. However, it requires careful planning that considers both the technical and human aspects of online education.

Table 4.4: Challenges of Open Innovation and Hyper-Automation

Challenge Area	Observed Risk/Impact	Data Source
Technical instability	6% of integrations required rollbacks	Bug logs + Dev interviews
Security/compliance	16% failed initial security checks	Audit reports + sprint QA notes
Governance fragmentation	Limited code review capacity pre-deployment	Sprint retrospectives
Human oversight erosion	11% of students felt feedback was impersonal	Student Surveys and Forum Posts

Source: Created by the Author.

Hypothesis Evaluation

The results from Research Question Seven offer a valuable clarification of Hypothesis 1, proposing that the use of Hyper-Automation and Open Innovation reduces costs and increases scalability in a non-profit online education context. Although the overall study generally supports this hypothesis, the results presented here highlight key limitations and potential risks associated with strategic management. The results derived from system logs and development interviews show that 6% of open-source integrations had to be reverted due to instability and that 16% did not pass an initial security test. These results suggest that, while open innovation allows for accelerated development and cost reduction, it also results in quality variability and potential quality gaps or regulatory weaknesses unless supported by appropriate governance and testing infrastructure.

The risk of reduced interaction with humans is a well-known risk of hyper-automation. Surveys showed that 11% of students felt feedback was too impersonal, suggesting that too much automation can hurt learning satisfaction. Limited code review also led to inconsistent quality. While Hypothesis 1 is mostly correct, it's important to

balance automation with human interaction and ensure the institution can manage the complexity and risks of digital change (Simkute et al., 2024).

4.8 Research Question Eight

RQ8: *What is the required level of technical expertise to support the implementation and sustainability of digital transformation in non-profit online education systems?*

The implementation of a hyper-automated and open innovation-enabled virtual learning environment (VLE) demands a highly specialized but strategically lean technical team. Data collected from development logs, team structure documentation, and stakeholder interviews consistently demonstrated that although the overall team size was modest, the range and depth of required skills were considerable. The system architecture was complex, involving interlinked microservices, data analytics pipelines, containerized environments, AI modules, and open-source orchestration layers. As such, each team member was required to hold advanced expertise in multiple disciplines, such as DevOps, machine learning, backend engineering, information security, and system infrastructure.

“You need a full-stack mindset, not just coding, but security, deployment, and compatibility with legacy systems.” Stakeholder Interview, Lead Developer

The creation of a technical expertise matrix was necessary to correlate the core technical roles with the systems they were responsible for. That is, AI engineers had to work on intelligent learning analytics and therefore work with frontend developers to ensure a good user experience, DevOps specialists had to maintain the CI/CD pipeline, and ensure that the infrastructure was consistent across the servers. The ability to work across departments and overcome cross-departmental challenges was also important to ensure that the VLE ran smoothly and could adapt to change. The success of the deployment relied on

a well-coordinated core group that enabled complexity to be managed with agility, instead of a large team (Yang et al., 2020).

The research also highlighted the necessity of advanced internal coordination, comprehensive documentation, and streamlined development processes. The automated infrastructure allowed for frequent iterative cycles, rapid deployment and dependable rollback mechanisms, despite having a lean team. In addition to this, the formalised internal documentation practices ensured the continuity of knowledge, which was important when key individuals were no longer working on the project or faced temporary absences (Calefato and Ebert, 2019).

“Mapping the business logic isn’t the hard part. It’s building reliable automation that scales without breaking during surges.” Stakeholder Interview, Senior Developer.

The study indicates that a small but skilled technical team is best for running a large, automated educational platform. This approach saves money without sacrificing innovation or quality. However, it needs careful hiring, continuous training, and a trusting work environment. The evidence suggests that expert technical leadership is key for lasting digital change in non-profit education, helping to meet automation and access goals.

Table 4.5: Technical Expertise Matrix

Domain	Skill Level Required		Roles Typically Involved
RPA Design & Deployment	Intermediate–Advanced		Automation Engineers, Business Analysts
Open-Source Integration	Advanced		Full-Stack Developers, DevOps Engineers
AI/ML Module Management	Advanced		Data Scientists, AI Engineers
Security Compliance	Advanced		Security Architects, Legal/Compliance Leads
Training Enablement	Intermediate		Learning Technologists, IT Trainers

Source: Created by the Author.

Hypothesis Evaluation

Research Question Eight's findings robustly validate Hypothesis 2, indicating that Hyper-Automation and Open Innovation enhance online education accessibility and efficiency by mitigating limitations related to skilled technical personnel. However, empirical data underscore the necessity of a core team possessing advanced expertise. While generalists can manage basic automation, full-scale hyper-automation necessitates a specialized technical team adept in AI-driven learning analytics, open-source integration, and containerized infrastructure management. Continuous expertise, architectural foresight, and proactive system governance are crucial for sustainable implementation.

Organizations that want to expand these solutions globally need to hire skilled technical staff and build their own long-term capabilities. This includes training, sharing knowledge, and creating a flexible work environment that can keep up with changing technology (Ejiwale, 2019). Without this internal expertise, the benefits of Hyper-

Automation and Open Innovation may be limited or unsustainable. The study confirms that a focused, expert-led approach is crucial for achieving scalable, affordable, and high-quality education, especially in non-profit and resource-limited settings. This supports Hypothesis 2, highlighting that strong technical capabilities are essential for successful digital transformation.

4.9 Research Hypothesis

Hypothesis 1: *Implementing Hyper-Automation and Open Innovation in a non-profit global online educational organization will significantly increase cost-efficiency by reducing online education management and operational costs, thereby enabling the organization to serve five million enrolled students more effectively and sustainably.*

The evaluation of Research Hypothesis 1 draws upon empirical evidence obtained across multiple dimensions of the study, including technological deployment, operational workflows, strategic implementation models, and platform scalability. The research findings consistently support the hypothesis by demonstrating that Hyper-Automation, when coupled with a structured Open Innovation strategy, results in substantial operational efficiencies. These efficiencies manifest through reduced reliance on human-intensive processes, faster service delivery, and lower long-term infrastructure costs (Pandy et al., 2024). These include automated enrollment and certificate issuance, graded assignments with the help of AI, dynamic exam timetabling, and intelligent chatbots. All of these approaches significantly reduced staff overhead and facilitated more efficient interactions with learners at scale.

Enablers such as Robotic Process Automation (RPA), modular Learning Management Systems with open-source plugins, and AI-driven learning analytics facilitated a lean operating model. These were implemented and evolved using Agile and

Lean Management practices governed by a Stage-Gate approach. The results demonstrated not only reduced turnaround times and staffing demands but also improved quality assurance through data-informed decision-making. As demonstrated by the Minimum Viable Product (MVP) deployed, system analytics provided further assurance that the operating model was able to deliver automated services to hundreds of thousands of learners using only a core team. This substantiates the hypothesis that this model is viable.

Furthermore, the integration of Open Innovation frameworks, such as community-driven plugin development, Git-based collaboration protocols, and open-source AI modules, amplified cost-effectiveness by reducing licensing fees and accelerating feature development. Stakeholders acknowledged the long-term financial benefits of relying on open ecosystems over proprietary solutions, particularly in a non-profit context where funding is constrained. Additionally, modularity and API-first design allowed the institution to adapt rapidly without incurring the costs typically associated with vendor-locked systems.

Taken together, the evidence confirms that the strategic implementation of Hyper-Automation and Open Innovation has the capacity to drastically reduce operational costs while scaling service delivery to millions of learners (Climent, Haftor and Staniewski, 2024). This supports Hypothesis 1 in full: cost-efficiency gains were not only observed but also shown to be scalable, replicable, and aligned with the organization's goal to provide equitable and sustainable global education. The success of this model reaffirms that technological sophistication, when grounded in open principles and lean structures, can transform the economics of non-profit digital education on a global scale.

Hypothesis 2: *Leveraging Hyper-Automation and Open Innovation in the digital transformation of a non-profit global online educational organization will lead to a more accessible and efficient online education system, with the potential to overcome limitations in skilled technical resources and contribute to long-term sustainability.*

The evidence collected during the research strongly supports this hypothesis. Research questions related to the design and deployment of the virtual learning environment (VLE), student experience, system architecture, and strategic implementation models show how Hyper-Automation and Open Innovation work together to improve accessibility and operational efficiency. AI-based learning analytics, dynamic scheduling engines, automatic grading, and 24/7 chatbot assistance helped the platform to provide personalized and timely education to a diverse group of learners from over 180 countries. These systems ensured that learners in different parts of the world and with different levels of infrastructure access were provided with services that enabled equitable access, regardless of geographical location.

Improved access was achieved through mobile-first deployment strategies and offline delivery methods, including downloadable content and television broadcasts, tailored to underserved regions. The research revealed that over 92% of learners were using mobiles many outdated or low-spec underscoring the need for lightweight, mobile-first solutions over platform-dependent apps. Hyper-Automation allowed these scalable services could be rendered with acceptable levels of latency, human involvement, and real-time connectivity. These innovations reflect a direct alignment with the core aims of Hypothesis 2 to democratize access through intelligent system design and platform-level automation.

The most convincing support for this hypothesis can be found in the results related to human capital. While the technical requirements for constructing and maintaining the

platform were high, the institution succeeded through the efforts of a small, but highly technical team with a clear understanding and a well-defined technical expertise matrix. Open Innovation mechanisms such as the use of open source technology, collaborative development on centralized code repositories, and community-supported plugin architectures, mitigated the need for large internal technical teams. Instead, expertise was embedded where most critical, and the typical burden of development was spread through modular contributions. This helped overcome the limitation of internal technical resources, enabling the organization to maintain a sophisticated technical architecture with a limited budget.

Finally, the research overcame the challenge of long-term sustainability not just by technological solutions, but by the structural and cultural foundations of Open Innovation. Efforts around community-driven development, shared ownership, and agile collaboration enabled low long-term operational costs. Together, these results provide significant support for Hypothesis 2, that Hyper-Automation, when deployed within an open innovation framework, can indeed lead to a more accessible, efficient, and sustainable model of global online education. This approach holds profound implications for the future of non-profit education, offering a replicable model for global reach, local adaptability, and strategic resilience.

4.10 Summary of Findings

This chapter presents the results of a multi-method investigation into the role of Hyper-Automation and Open Innovation in enabling a non-profit global online educational institution to serve five million learners efficiently and sustainably. The findings, drawn from over 200,000 survey responses, semi-structured interviews, platform analytics, and

system documentation, offer strong empirical support for the study's central hypotheses and research questions.

The first key finding is that Hyper-Automation significantly improves cost-efficiency and scalability. Through Robotic Process Automation (RPA), AI-driven analytics, automated scheduling, and chatbots, the institution reduced manual workload and increased service consistency. This enabled the platform to serve a vast number of students with a relatively small technical team, demonstrating a lean operational model rooted in automation. These outcomes directly support Hypothesis 1, affirming that scalable automation reduces the need for large administrative overhead and unlocks sustainable growth.

Second, the study revealed that Open Innovation is a strong facilitator of technological agility and cost savings. The use of modular open-source tools, community-developed plugins, and GitHub-based collaboration workflows accelerated development without increasing vendor lock-in. This facilitated iterative improvements, reduced licensing costs, and expanded the organizational technical capabilities despite limited internal resources. These findings support Hypothesis 2, showing that investment in Open Innovation can be a means to bridge technical skill gaps and foster sustainability.

Additionally, the research revealed critical success factors beyond technology. Strategic implementation approaches combining Lean Management, Agile Development, and the Agile Stage-Gate Hybrid Model (Cooper and Sommer, 2016) ensured that innovation was aligned with institutional goals and operational realities. Communication strategies, mobile optimization, and offline access ensured greater accessibility for learners in disadvantaged contexts.

However, the results also revealed limitations and challenges. These include quality challenges of open-source tools, the need for further governance, the risk of over-

automation, and the need to preserve a human connection with students. These results do not invalidate the hypotheses but refine the conditions under which Hyper-Automation and Open Innovation succeed.

4.11 Conclusion

The results reported in this chapter confirm the validity of the hypothesis on the adoption of Hyper-Automation and Open Innovation in global, non-profit online education. This was achieved through a structured analysis of quantitative and qualitative data ranging from student surveys and system analytics to stakeholder interviews and technical documentation. The study shows how it is possible to gain improvements in cost-effectiveness, accessibility, and operational scalability.

Each research question was analyzed in detail, and the results show a consistent picture of insights that sustain the two overall study hypotheses. From the automation of the process starting from enrollment, passing through assessment, to support, and the consequent modular adoption of open-source technologies that limit the dependence on proprietary solutions, the research describes a sustainable model of digital transformation. Importantly, the study also addresses the organizational strategies and governance structures needed to ensure long-term success, including Agile and Lean practices, technical expertise frameworks, and community-based development ecosystems (Harsono et al., 2024).

Although there are challenges to the realization of these strategies, such as quality assurance in open systems or the danger of excessive automation in cases where humans should be involved, the results clearly show that these challenges can be overcome through quality assurance and continuous evaluation. The convergence of robust technical infrastructure, strategic project management, and open innovation culture has allowed the

studied institution to provide high-quality education on a large scale despite the limited financial and human resources available.

In conclusion, Chapter 4 provides empirical validation that Hyper-Automation and Open Innovation, when integrated into an overall coherent and well-managed digital strategy, represent a feasible and effective future model for non-profit global online education. These findings not only provide empirical confirmation for the feasibility of the hypotheses but also serve as a strategic blueprint for educational institutions around the world that wish to scale their operations for a broader and more sustainable impact through a feasible, scalable, and cost-effective digital platform.

CHAPTER V:

DISCUSSION

This chapter interprets the findings from Chapter 4 in relation to the study's main questions, framework, and hypotheses. It combines results with ideas to better understand how Hyper-Automation and Open Innovation can change non-profit global online education. By looking closely at the meaning, limits, and importance of the data, this chapter explores how these digital strategies help make things cheaper, more accessible, scalable, and sustainable for institutions.

This chapter is organized into several key sections. First, it presents a detailed discussion of the results, drawing connections between empirical findings and existing literature, as well as the conceptual frameworks introduced in earlier chapters. This is followed by an evaluation of the research questions and hypotheses to determine the extent to which they were supported by the data. Next, the discussion addresses the practical implications for non-profit educational institutions, including guidance for implementation, organizational readiness, and governance. The chapter concludes by identifying key limitations of the study and recommending directions for future research.

At its core, this chapter revisits the central research aim: to determine whether Hyper-Automation and Open Innovation can enable a more accessible, efficient, and sustainable online education system for non-profit institutions with limited technical resources. By engaging critically with the evidence and reflecting on its broader significance, Chapter 5 establishes a robust strategic foundation for applying these findings in real-world educational settings, contributing significantly to the field.

5.1 Discussion of Results

In this section, the empirical results displayed in Chapter 4 are interpreted in relation to the research questions, the corresponding theoretical concepts, and the academic literature on Hyper-Automation and Open Innovation for online education worldwide. The findings presented in this chapter are structured thematically according to the eight research questions. It is shown in which respect which findings support the corresponding theoretical concepts and how the findings contribute to theory and practice. These findings align with the idea that technology can significantly increase access to education and offer alternatives to support a global community of learners.

5.1.1 Understanding the Core Challenges (RQ1)

RQ1: *What are the key challenges faced by educational institutions in delivering accessible education to a large number of enrolled students?*

The results clearly demonstrate that the primary operational bottlenecks in scaling non-profit online education lie in human resource limitations, administrative redundancies, and fragmented technical infrastructure. These challenges are compounded by inconsistent quality assurance and insufficient in-house technical expertise. These findings strongly corroborate existing literature, such as Navid Sadjadi (2023) and Joshi, Vinay and Bhaskar (2020), which emphasized that non-profit educational institutions often struggle with legacy systems and underfunded technical departments. Also, these findings are consistent with earlier work that highlighted the fragility of educational infrastructures in underfunded institutions and the costs associated with scaling vast technological ecosystems (Bulathwela et al., 2021; D'Agostino, 2023).

Through both qualitative interviews and quantitative surveys it was evident that scalability and quality were inversely correlated in traditional models. As numbers of students increased it was more difficult to provide consistent feedback, personalized

learning and responsiveness. Similar conclusions to those drawn by Weng and Zhang (2025), who stressed on the correlation between scale and human oversight.

The study has proven the validity of the theory behind servitization and value co-creation. This reinforces the theoretical framing of the study, which posits that Hyper-Automation can substitute for labor-intensive operations through structured and rule-based automation models. The Learning Specification Model presented in Chapter 4 directly operationalizes this hypothesis by defining every academic process in terms that can be standardized and automated. Mapping this specification to automated workflows, institutions can shift from a reactive support model to a proactive service model. The findings support Hypothesis 1, indicating that automation, by connecting with structured educational models, enables institutions to offset the need for more staffing and to scale up.

5.1.2 Technological Enablers: Strategies and Effectiveness (RQ2)

RQ2: *What are the potential benefits and drawbacks of utilizing Hyper-Automation and Open Innovation in the context of online education?*

The research confirms that Hyper-Automation, when combined with Open Innovation strategies, leads to substantial improvements in operational efficiency and scalability. Quantitative data showed major time savings across enrollment, certificate issuance, exam retake requests, and student support services, while qualitative interviews highlighted reduced stress and increased focus on value-added tasks among staff. These outcomes are in line with previous studies (Aalst, Bichler and Heinzl, 2018; Climent, Haftor, and Staniewski, 2024) that emphasized automation's capacity to streamline repetitive tasks. The analysis confirmed that Robotic Process Automation (RPA), AI-powered learning analytics, and chatbots significantly reduced operational strain while boosting service consistency.

However, the study adds a new layer by demonstrating how open innovation amplifies these benefits. Open-source integration allowed for faster development, lower costs, and greater adaptability. An insight that refines prior theories which often treated automation and innovation as isolated variables. By embedding community-driven tools into a structured, automated environment, the findings highlight a symbiotic relationship, automation provides efficiency and open innovation provides adaptability.

This duality supports both Hypotheses 1 and 2. It shows that efficiency does not require vast budgets or extensive ecosystems, but instead can be achieved through strategic alignment of modular automation and collaborative development.

5.1.3 Specific Technological Strategies for Scale (RQ3)

RQ3: *What specific technological developments and strategies within Hyper-Automation and Open Innovation can be implemented to effectively deliver accessible education to five million enrolled students?*

The research notes down a suite of technologies, namely Robotic Process Automation (RPA), AI learning analytics, intelligent chatbots, and open-source LMS such as Moodle, as enablers of scalability. Not only were they additives, they were almost foundational. Together, they formed an integrated digital foundation that could serve five million learners with negligible human supervision. Most importantly, those foundational technologies were built upon community-supported, open-source software. The Learning Specification Model and its technical infrastructure thereafter provided a practical blueprint for automating the entire student life cycle, from registering to graduating. This is in line with the works of Eggert et al. (2020), who argued for the need for composable architectures to achieve agility and rapid iteration. The results from this research support the theoretical assumptions from which this model of digital transformation is built, especially around modularity, orchestration, and systems thinking.

The use of open-source AI libraries to train models, recommend content, and ensure quality in a real-time environment has greatly advanced personalization at scale. The following approaches ensured Hypothesis 1 was confirmed cost-effectively through automation and allowed for growth in a sustainable way. It has been emphasised by Sadjadi (2023) that the agility of educational managers is essential for redesigning courses, investing in technology, and offering virtual alternatives. This evidence strongly supports Hypothesis 1 and contributes to the literature by providing an actionable, replicable model by integrating an agile approach with modular automation to accelerate scalability and affordability, particularly for mission-driven institutions.

5.1.4 Financial Sustainability and Operational Scalability (RQ4)

RQ4: *What strategies can be employed to ensure long-term financial stability and scalability of a Hyper-Automation and Open Innovation solution in the context of online education?*

The research underscores the critical importance of architectural modularity, community collaboration, and revenue diversification for ensuring financial and operational sustainability. Automated exam retakes, enrollment flows, and student surveys reduced costs without compromising quality, while supplemental services such as printed materials and verified certificates offered sustainable revenue streams without commodifying education. These practices were consistent with literature emphasizing the value of ecosystem thinking in innovation (Bahamdain, 2015; Harsono et al., 2024).

The deployment of automated surveys and dynamic learning schedules proved particularly impactful, as they personalized student engagement while ensuring system-wide adaptability. It has been emphasised by Mhlanga (2023) that identified automated instructional design as a key enabler of personalized learning at scale. The modular system

architecture enabled isolated updates and collaborative development without destabilizing core infrastructure.

This directly supports Hypothesis 2. The study demonstrates that sustainable models emerge not just from technical innovations but from an integrated strategy that blends automation, community engagement, and building ethical financial sustainability. This model offers a hybrid approach, where the core education remains free, while value-added services provide funding for ongoing innovation. This is a departure from the common debate between free and paid education.

5.1.5 Open Innovation as Strategic Infrastructure (RQ5 & RQ6)

RQ5: *What Open Innovation strategies are appropriate for implementation in online learning environments alongside Hyper-Automation?*

RQ6: *How effectively can Open Innovation solutions be integrated into the Hyper-Automation technical infrastructure?*

The results affirm that Open Innovation is more than a cost-saving tactic. It is a strategic infrastructure layer that complements and extends the capabilities of hyper-automation. The institution's integration of GitHub-based development pipelines, community-driven plugins, and federated knowledge repositories enabled continuous updates and iterative enhancements. More importantly, the three-layer integration model's core infrastructure, middleware, and community innovation created a framework where innovation is modular, testable, and aligned with institutional standards.

Stakeholders acknowledged that working together with a wider technical community created shared responsibility and helped solve technical problems faster (Bahamdain, 2015). Taken together, these findings validate both research hypotheses. They show that Open Innovation is not a risk but a strategic necessity, especially when embedded within a

governance framework that prioritizes modularity, security, and shared development protocols.

The sixth research question addressed the success of integrating open innovation solutions into the hyper-automated infrastructure. Both technical evaluations and interviews with stakeholders revealed high rates of success (92%) and effective orchestration of the middleware. The architectural decision to follow an API-first approach combined with a modular design enabled the open-source tools to be quickly integrated, tested, and iterated. Although some moderate QA overheads (34% rework) were introduced, the overall agility and cost-effectiveness of the system outweighed the initial customization overhead.

Governance and a small core team remained a minor risk factor, with some gaps in code review processes and contributor training. However, the underlying three-tier architecture, core, middleware, and community layers provided a stable framework for ongoing innovation. The findings validate both Hypotheses 1 and 2 as Open Innovation's strategic use within modular, automated environments not only reduces costs but enhances technological resilience and adaptability.

5.1.6 Risks and Challenges (RQ7)

RQ7: *What are the potential challenges and risks associated with implementing Open Innovation in an online education setting alongside Hyper-Automation?*

Although the overall trend is encouraging, the findings caution against unmoderated automation. Approximately 11% of students found automated systems impersonal, and nearly 6% of open-source integrations required rollback due to compatibility issues. These results suggest there are limitations when it comes to automating pedagogical settings that demand empathy, judgment, and human discretion, as emphasized by Chan and Tsi (2023). The study also revealed governance gaps, such as

limited pre-deployment code reviews and ad hoc QA processes. It's essential that the institution can manage the complexity and risks of digital change (Simkute et al., 2024).

These results partially support Hypothesis 1 to the extent that automation should be applied selectively, and open systems need governance to ensure consistency and compliance. This provides new nuance to the automation literature, suggesting that scalability cannot be at the expense of mindful human judgment and institutional accountability.

5.1.7 Technical Skills and Organizational Readiness (RQ8)

RQ8: *What is the required level of technical expertise to support the implementation and sustainability of digital transformation in non-profit online education systems?*

One of the most valuable outcomes of this study is the discovery that it is possible to produce and maintain highly scalable educational platforms with small human resources of highly technically proficient personnel. This is a solution for the problem of human resources availability in non-profit digital education settings. The construction of a Technical Expertise Matrix and the promotion of DevOps integration, containerization, and internal documentation are proposed to enable small teams to deliver high outputs (Yang et al., 2020; Ejiwale, 2019). This strongly supports Hypothesis 2. It reframes the debate from "how many developers are needed?" to "how to maximize a small team's impact?". This is a vital consideration for any educational organization operating under resource constraints.

Overall, the discussion reveals strong empirical support for both research hypotheses. Hyper-Automation and Open Innovation not only reduce costs and enhance scalability, which significantly supports hypothesis 1, but also support hypothesis 2 by improving system accessibility and reducing dependency on expensive technical teams.

Therefore, the empirical findings of this study have shown that these two digital strategies enable highly scalable educational platforms to be produced by non-profit educational institutions and serve millions of students around the world with different geographical and socio-economic conditions.

5.2 Discussion of Research Hypothesis One

Hypothesis 1 proposed that the integration of Hyper-Automation and Open Innovation strategies within a non-profit global online education institution would substantially enhance cost-efficiency. This would be achieved by decreasing the management and operational expenses associated with online education, thereby empowering the organization to serve a larger student population of five million in a more effective and sustainable manner. This hypothesis is central to the present research and is crucial in demonstrating the viability of implementing advanced technological innovations within resource-constrained educational settings.

5.2.1. Cost-Efficiency Impacts of Hyper-Automation: An Empirical Perspective

The use of automated systems in the Virtual Learning Environment resulted in significant operational savings and improved use of resources. The analysis of the automated major administrative and support services revealed savings in both time and cost, as shown in Table 5.1.

Table 5.1: Manual vs. Automated Process Overview

Process	Manual Time (Annual)		Automated Time (Annual)		Processing Costs (Per Month)		Improved Process (Annual)	
	Time (in Hours)	FTE	Time (in Hours)	FTE	Manual	Automated	Hours	Percentage
Student Enrollments	642	0.33	68	0.04	\$495	\$60	574	89,41%
Pre-Recorded Lesson Scheduling	3.990	2.08	86	0.04	\$3.120	\$60	3.904	97,85%
Assessment & Exam Setup	2.064	1.08	43	0.02	\$1.620	\$30	2.021	97,91%
Live Broadcast Scheduling	544	0.28	18	0.01	\$420	\$15	526	96,69%
Exam Retake Requests (based on 1250 requests a month)	7.500	3.91	21	0.02	\$5.865	\$15	7.479	99,72%
Certification and Verification (based on 32.510 Graduate Certificates)	65.020	33.91	45	5.86	\$50.865	\$30	64.975	99,93%
Support Tickets (Based on 37.500 tickets per month)	59.988	31.24	11.244	6	\$46.860	\$8.790	48.744	81,24%
TOTAL	139.748	72.77	11.525		\$109.245	\$9.000	128.223	91,76%

Source: Created by the Author.

5.2.2 Process Analysis: Student Enrollments

One of the most critical success factors of any virtual learning environment is the student enrollment process. For a non-profit global learning platform running at scale, this

process carries significant operational weight. It represents the first point of contact for learners entering the educational system and sets the stage for all subsequent academic engagement. As such, streamlining and automating the enrollment process is not just a matter of efficiency, but a business-critical requirement in order to be inclusive, reliable, and sustainable. This discussion of results is essential to understanding the transformation of the student enrollment process from a traditional, resource-heavy approach to a hyper-automated, cost-efficient workflow, aligning directly with the expectations outlined in Hypothesis 1 of the research.

The manual enrollment process, prior to the implementation of automation, consumed an annual total of 642 work hours. This translates to approximately 0.33 full-time equivalent (FTE) staff members being dedicated solely to this task. In financial terms, the processing cost of handling enrollments manually amounted to around \$495 per month. These figures reflect a recurring operational burden that scales linearly with student growth. In an environment anticipating upwards of five million enrollments, such a model becomes rapidly unsustainable. Key activities involved in the manual process included the collection and validation of student information, data entry into the learning management system, generation of student accounts, and the distribution of welcome communications. These activities were all characterized by a low tolerance for manual intervention, and in some cases suffered as a result of slow response times, variability in data accuracy, and an elevated number of student support tickets related to enrollment challenges or learning environment access.

With the implementation of Hyper-Automation, the enrollment workflow was reconceptualized using technologies such as Robotic Process Automation (RPA), API-based LMS integration, and automated email orchestration. Together, these tools reduced our enrollment handling time from weeks to just 68 hours annually, and the FTE demand

down to 0.04, an improvement of over 89% in time efficiency. Monthly processing costs with the automated system were reduced to only \$60, an almost 88% reduction. Students enroll in less than a second, and after registering, they are provided access to the Artificial LMS instantly. This increased not only the responsiveness and the learner experience, but also lightened the institutional load during registration spikes.

Beyond the clear improvements in time and cost savings, the automated system also brought qualitative enhancements. The consistency of enrollment confirmations, accuracy of student record creation, and speed of onboarding communications collectively elevated user satisfaction. The automation enabled stronger data governance, as each step in the enrollment pipeline is trackable, auditable, and capable of producing performance metrics that can be generated in real time. Those metrics provide the dashboard information that significantly supports the stakeholders strategic decisions process across support services, instructional design, and system scalability planning.

In relation to Hypothesis 1, the results from the automated student enrollment process provide unequivocal support for the proposition that Hyper-Automation and Open Innovation significantly enhance cost-efficiency and scalability in non-profit global online education. The automated enrollment model serves as a replicable blueprint for similar functions across the organization. The underlying architecture can be extended to automate other core processes. The success of this transformation has therefore catalyzed broader organizational interest in process automation, reinforcing the scalability of Hyper-Automation strategies across multiple departments. This transformation not only validates Hypothesis 1 but sets a high standard for future initiatives seeking to enhance educational delivery through technology.

5.2.3 Pre-Recorded Lesson Scheduling

The process of scheduling pre-recorded lessons within a large-scale virtual learning environment is one of the most labor-intensive and operationally sensitive activities within the online educational value chain. It serves as the core logistical engine that aligns academic content with learner access across time zones, languages, and curricula. Using manual methods, this activity comprised generating calendar events, adding video content to course modules, validating file integrity and format compatibility, synchronising changes across multiple levels of the Learning Management System (LMS), and ensuring that all associated materials, such as transcripts and supplementary files, were correctly linked. This meant that, in addition to being constantly monitored, it required a significant amount of subject-area knowledge and coordination between content developers, the administrative team, and the technical team.

Prior to the implementation of Hyper-Automation, the scheduling of pre-recorded lessons consumed 3,990 work hours annually. This workload was equivalent to approximately 2.08 full-time staff working solely to make sure that lesson content was correctly deployed to the learning environment for students. On a financial level, the cost of that human effort was \$3,120 per month. When spread across regions and language streams, this proved unaffordable for a non-profit organisation. The workload for this activity also increased with each new cohort added to the system. This provided pressure on internal operations as the workload has high peaks between academic study periods that might result in delayed course launches or compromised content delivery quality.

To mitigate these challenges, the institution adopted a Hyper-Automated solution based on a Configuration Management model. This model allowed lesson scheduling to be driven by an organized master server rather than manual server entries. Each LMS server was receiving the lesson schedules and resource links from the master LMS on when,

where, and how lesson content was to be released. Variables such as course duration, start dates, and learning paths were encoded into the master LMS that could be read and executed by the automation engine. The scheduling process was reduced to a simple, single rule-based execution with distribution across 34 LMS instances. This automated configuration-driven approach reduced the total time requirement from 3,990 hours annually to just 86 hours, with a corresponding reduction in FTE burden from 2.08 to 0.04. These gains translated into an annual time saving of 3,904 hours, representing a remarkable 97.85% improvement.

The monthly processing costs fell dramatically from 3,120 USD to 60 USD, marking a 98% reduction in financial outlay for this activity. This drop was achieved not only through automation but also through the elimination of platform redundancy. Functionally, the automated system introduced a significant qualitative shift in how lesson scheduling was executed. While manual scheduling was susceptible to human error, such as broken media links and improper sequencing, the automated system validated each step in the scheduling chain through built-in checks. The ability to simulate course rollouts in staging environments further reduced the risk of disruptions during live course deployment.

Another important advantage of the system was its flexibility for schedule changes. In previous systems, changing a lesson release schedule would require an administrator to make edits to each course calendar individually, typically involving hundreds of course instances. With the new configuration-based system, an institution-wide change was made by modifying the master server, and the change was pushed instantly to the 34 LMSs, decreasing response times during emergencies.

The human impact of automation in lesson scheduling cannot be overstated. By freeing over 3,900 staff hours annually, the institution was able to reallocate staff time to higher-value tasks, such as content development, learner engagement, and instructional

support. Morale among the staff increased because scheduling was no longer a tedious and stressful burden. From the learner's perspective, service quality also increased because lessons were published exactly on time, and therefore, the learning experience became more reliable.

From the standpoint of Hypothesis 1, the results of the pre-recorded lesson scheduling process offer compelling confirmation. Not only were time and cost savings achieved at an impressive scale, but the improvements also supported broader institutional objectives such as learner satisfaction and system resilience. The configuration-driven automation model provides a template that can be applied to other time-sensitive, high-volume workflows in education.

5.2.4 Assessment & Exam Setup

Assessment and examination processes lie at the heart of any educational institution's quality assurance framework. In a virtual learning environment (VLE), configuring, scheduling, and deploying assessments correctly is not only critical for academic integrity but also for supporting the learning and assessment of students. Prior to automation, exam setup was a time-consuming manual process involving multiple passes by both administrative and academic staff, including drafting the exam, uploading questions, answer definition, grading scale creation, exam configuration, randomisation configuration, accessibility options, and verifying compliance with internal assessment policies.

In the pre-automation environment, assessment setup took a total of 2,064 man-hours per year, which would be equivalent to approximately 1.08 full-time employees. They were performing these tasks repetitively across dozens of course modules, multiple LMS instances, and several assessment cycles per year. Given that operational footprint, it's not surprising that human error was repetitive and costly, ranging from duplicate

questions and answers to inaccessible formats and inconsistencies. Manual configuration made it nearly impossible to apply changes at a large scale or enable adaptive testing.

The costs associated with this process were also considerable. The associated labor cost to perform this process each month was around \$1,620. This can quickly add up across LMSs and subject areas, given the fact that this must relate to a non-profit organization with limited administrative staff, performing this process manually with so many enrolled students. To address these inefficiencies, the research introduced a Hyper-Automated system grounded in configuration management, as was implemented and founded with the Pre-Recorded Lesson Scheduling. This involved the abstraction of the assessment logic into the master LMS that could be automatically deployed across the LMSs with little oversight. Each exam was defined by a configuration schema that described the question pools, randomization logic, time limits, pass/fail points, and grading workflows. These configurations were stored on the central Master LMS and deployed across the 34 LMSs via automation scripts.

This shift reduced the annual time spent on assessment and exam setup from 2,064 hours to just 43 hours, an efficiency gain of 2,021 hours, or 97.91%. In terms of human resources, the required full-time equivalent (FTE) was reduced from 1.08 to a mere 0.02, liberating significant staff time for other value-adding activities such as content review, question bank development, and learner support. Financially, the automation brought down monthly costs from 1,620 USD to only 30 USD, representing a 98% reduction in operational spending for this core academic function.

By leveraging pre-validated configuration templates, the research ensured that all assessments were standardized in terms of how they looked and how long they took, and were applied with randomization settings across exams on a scale level to reduce academic

dishonesty. Suspect answer patterns or times were flagged and sent real-time alerts to quality assurance to be checked by personnel for manual review.

Open Innovation significantly accelerated the deployment of these solutions. A set of open-source assessment plugins and scheduling tools were used, with many contributed by peer institutions and supported by the Moodle community. Course coordinators could schedule assessments well in advance without tying up staff time, enabling more effective semester planning and resource allocation. From a broader strategy point of view, this is another step in delivering free and accessible education at a scale that's required. That automated system provides the consistency, traceability, and the ability to change if needed, which are essential for operational excellence and gaining learners' trust.

The decrease in human effort also had several implications for staff health. Prior to automation, staff declared high levels of stress during administration periods between semesters and exam periods, citing long working hours, difficult coordination, and high sensitivity to errors. With automation handling most setup tasks, teams could redirect their energy toward refining question quality, developing formative assessments, and supporting students with special needs.

Given the results of this research, the change in the assessment and exam setup process acts as a strong validation for Hypothesis 1. The data confirms that the integration of Hyper-Automation and Open Innovation can drastically enhance cost-efficiency, reduce labor requirements, and improve service reliability in non-profit global educational settings.

5.2.5 Live Broadcast Scheduling

Live broadcast scheduling within a virtual learning environment (VLE) is a critical task, particularly when operating across multiple time zones and media platforms such as satellite television and live streams on Facebook and YouTube. In the context of a non-

profit global educational institution, the challenge of synchronizing live academic programming with pre-existing television infrastructure adds a layer of complexity that few commercial institutions face. This process involved high levels of manual coordination between technical staff, content managers, regional TV broadcasters, and academic schedulers. Any changes made to the satellite programming or time slots meant updates across 34 individual LMS instances.

Before the implementation of automation, the scheduling of live broadcasts consumed approximately 544 staff hours annually, requiring the ongoing involvement of nearly 0.28 full-time equivalent (FTE) staff. The process included manually inputting broadcast schedules, verifying compatibility with academic timelines, editing course calendars, testing broadcast link integration, and notifying students of changes. This intensive human dependency at the time of change also made the institution vulnerable to operational bottlenecks, delays, and inconsistencies.

The labor cost associated with this manual effort was considerable. Each month, 420 USD in direct human resources was allocated solely for managing and updating broadcast schedules across the LMS instances. Over a year, this totaled over \$5,000, not including potential costs from delayed learning, which affected student progress, satisfaction, and retention. This system was unsustainable, especially as the platform grew to over two million students worldwide during the research period.

The solution implemented through this research introduced a hyper-automated, configuration-managed broadcast scheduling framework. At its core was a templated configuration model capable of abstracting the complexities of broadcast timing and course-to-broadcast mapping into integrated LMS schedules. These configuration templates were standardized and centrally maintained, enabling administrators to define all

scheduling logic. These templates were then deployed across the platform's 34 LMS instances through a lightweight orchestration script, drastically reducing manual input.

The impact was immediate and transformative. The annual time devoted to scheduling live broadcasts was reduced from 544 hours to just 18 hours, an operational efficiency gain of 526 hours, or 96.69%. The staff requirement dropped from 0.28 FTE to just 0.01, allowing teams to reallocate their time toward instructional design and learner engagement. Cost-wise, the automation brought monthly expenses down from 420 USD to only 15 USD, achieving a 96.43% reduction in financial outlay for this process alone.

The main benefit of this solution was strategic flexibility, not just time or cost savings. The institution often faced rescheduling requests from the satellite television provider, which changed broadcast slots for regional programming. Previously, each request could take hours or days to implement across all LMS instances, causing miscommunication and broken links. With the configuration-managed system, administrators could change schedules across all 34 LMS instances in under a minute.

The automation of the live broadcast scheduling process has not only validated Hypothesis 1 but also shown the applicability and scalability of Hyper-Automation and Open Innovation in a dynamic, real-time educational use case. It bridged the gap between traditional broadcast media and modern LMS platforms, creating a hybrid educational delivery system capable of reaching underserved learners even in low-connectivity environments.

5.2.6 Exam Retake Requests

Exam retake requests are a complex, frequent, and costly process in large online education programs. This is particularly the case for global non-profits that provide open education to millions of students who may experience electricity and internet issues. Managing these requests involves operational work, educational decisions, rules, and

tracking. The organization in this study processed about 1,250 retake requests each month, totaling over 15,000 per year.

Prior to the automation, support staff expended approximately 7,500 work hours per year handling exam retake requests, representing around 3.91 full-time equivalents. This proportion of staff time was spent on a number of recursive activities, beginning with receiving and documenting students' requests, then validating against established academic regulations across departments, and then further activities. Staff members needed to determine the validity of learners' reasons for making retake requests, to flag repeat requesters, to audit exam logs for potential breaches of integrity, and to ensure that learners met prescribed course progression criteria. Once validated, retakes required configuration, scheduling, and deployment in the appropriate LMS environment to meet learners' language, academic level, and curriculum pathway.

The costs associated with the manual processing of retake requests were significant. Monthly costs on human resources surpassed 5,865 USD, totaling over 70,000 USD annually for this single administrative task alone. This does not include the associated indirect costs of the manual bottleneck, such as the impact on support, decreased student satisfaction, student exam clashes, and the associated costs of shifting academic and support staff from their primary functions. One clear obstacle that was identified by both students and support staff was the lack of visibility and variability of the manual retake request procedure. In some cases, students were approved for a retake a few hours after submitting their request, while others had to wait a few days. The manual bottlenecks were sometimes amplified during particularly busy periods for academia or when large groups of students had similar problems. Additionally, some students abused the lack of visibility by submitting repeated retake requests with vague justification, hoping that it would be

approved, which lowered confidence in the system and increased the workload for staff to verify these requests.

In response to these operational burdens and academic risks, the research team put in place a comprehensive and automated system for handling retake requests. The automated workflow was purposefully constructed to methodically address every identified challenge through rules-based decision-making within the Learning Management System. The automated solution utilized a blend of Robotic Process Automation, Application Programming Interface integrations, and AI validation checks to enable mass-scale request evaluation, approval, and execution. Academic validations were referred to humans to provide academic safeguards. However, during the final evaluation phase, over 98% of requests were handled automatically. Finally, students were sent automated responses through the communication portal detailing the outcome of their requests and next steps.

The benefits of this automation were profound. Time spent on the process decreased from 7,500 hours to just 21 hours annually, a staggering 99.72% improvement. Staffing requirements dropped from 3.91 FTEs to 0.01, freeing nearly four full-time employees to focus on tasks with greater educational value. Correspondingly, the monthly cost of administering exam retake requests plummeted from 5,865 USD to just 15 USD, a reduction of over 99.74% in operational expenses.

Beyond cost and time savings, the automated solution also significantly improved process quality. Students benefited from faster response times, greater transparency, and predictable handling of their requests. Support staff, once overburdened with repetitive administrative decisions, now engaged in more meaningful work.

Importantly, this transformation was achieved using open innovation strategies. The solution was built on open-source workflow engines, integrated with Moodle via API

bridges, and supported by community-maintained validation plugins. The extensibility of the system meant that as academic policies evolved, the automation logic could be adjusted without needing to rebuild the core process. Furthermore, the modular nature of the implementation allowed the organization to replicate similar validation workflows in other areas, such as assignment extension requests or course withdrawal approvals.

In conclusion, the exam retake automation demonstrates that smart, scalable automation, built on solid policy, can greatly improve how well things work and protect educational standards. It proves Hypothesis 1 by showing a clear, measurable improvement in how cost-efficiently educational services can be delivered.

5.2.7 Certification and Verification

In online educational programs, the creation and verification of certificates is a key service. Within the research, the certificates range from enrollment certification to final graduation certificates. During the study, 783,027 certificates were automatically issued. Of these, 97,466 were unique graduation certificates that needed validation. Before automation, creating certificates was difficult and expensive. Each certificate needed data from a student file; it needed to be formatted, approved, and stamped with a digital signature. Then the certificate needed to be emailed or placed on the student's page. Given the number of students and types of certificates, this consumed a lot of resources.

Quantitatively, the manpower to manually certify students amounted to 65,020 hours per year, or 33.91 full-time equivalents. The cost of labor to perform this function alone exceeded \$50,865 per month, placing a significant financial strain. Additionally, the manual certification process presented potential delays and quality issues. Students had to wait days or even weeks for their certificates. This was problematic for students who needed certificates that required proof of enrollment or graduation.

To address these issues, the research developed an entirely automated end-to-end certification and verification pipeline. The pipeline was developed with a modular design, connected to the Learning Management System (LMS), and accessed data from dynamic student performance, attendance, and enrollment information directly. When triggered by student events such as successful registration, semester completion, or graduation, the system generates personalised certificates with dynamic data fields, including the student's name, program title, academic calendar reference, final grades, completion dates, and official institutional seals.

Three primary certificate types were automated: (1) the Certificate of Enrollment, issued at the time of registration, (2) the Semester Enrollment Certificate, which detailed semester completion, and (3) the Graduation Certificate, featuring academic achievements and a downloadable Grade Overview. The automation logic behind certificate generation was highly configurable through a rule-based engine. For instance, students with completion rates of more than 70% in the required modules were automatically flagged as candidates for graduation. After that, the final grades were assembled, the identity tokens were verified, the digital stamps for verification were attached, and the certificates were sent to the student portal. No manual actions were performed, where the entire annual process took just 45 hours instead of the initial 65.020 hours, an improvement of 99,93%.

The digital verification of these seals was another major step forward. The certificates received their own hash and verification URL, embedded in a QR code which third parties, like employers or schools, could easily use to verify the document's origin and authenticity online. This automated response to verification requests also decreased the workload for support teams to answer verification requests and increased the institution's transparency and trust.

From a financial standpoint, the automation decreased the monthly process costs from 50,865 USD to only 30 USD, resulting in an annual saving of over 600,000 USD. The decrease in FTEs from 33.91 to only 0.02 allowed the institution to realign its staff to concentrate on academic advising, curriculum development, and quality assurance.

The technical infrastructure was implemented based on open-source modules. The certificate templates were processed by open document processing libraries used in the open document processing pipeline of Moodle LMS. Verification logic used open standards for digital signatures. A QR-based verification system was implemented and maintained using community contributions. With these minimal developments, the core development team was able to customize the solution to the organization's needs.

This case study provides conclusive evidence supporting Hypothesis 1, which posits that implementing Hyper-Automation and Open Innovation in a non-profit global online educational organization significantly enhances cost-efficiency by reducing management and operational expenses. Certification and verification automation brought significant financial impact and efficiency improvement, while the experience of learners and trust in the organization improved as well.

5.2.8 Student Support

In large-scale online education, student support is a complex and resource-intensive function, requiring technical troubleshooting, emotional reassurance, and multi-channel academic guidance (Mission, 2021). The selected organization institution has more than two million learners. It was challenging to provide timely responses to various queries. The platform logs approximately 37,500 support tickets monthly (450,000 annually). It is a time-consuming process in terms of manpower and cost.

Before automation, the number of tickets handled was dependent on a huge amount of manpower. Every ticket was read, categorized, assigned to a department or a specialist,

and responded to one by one. Many queries required follow-up, document verifications, escalations, and manual LMS updates. This comprehensive engagement translated into an annual workload of 59,988 hours, equivalent to 31.24 full-time equivalent (FTE) positions, and a monthly labor cost of around \$46,860.

Despite the dedication of support staff, the volume and urgency of certain tickets, especially those tied to emotional and geopolitical challenges, often caused delays. Cases ranged from students who had passed away with grieving families seeking to continue the program on their behalf, to individuals studying under extreme circumstances, such as those residing in active conflict zones. One notable instance involved a group of students from Nigeria who lost access to the internet and electricity for over three weeks, urgently requiring exam rescheduling, resource downloads, and moral support.

These examples show how important and personal online education support can be. They also highlight the need to balance human support in sensitive situations with the need to improve efficiency through technology (Green, Burrow and Carvalho, 2020). Hyper-Automation and Open Innovation were used to improve the support ticket process.

The organization adopted chatbots and AI to filter, classify, and resolve routine queries, including password resets, course navigation, certificate generation, and exam retake requests. These accounted for over 45% of total tickets. Automated responses mimicked human tone, using up-to-date FAQs and integrating with backend systems to execute actions like adding exam retake requests to the student's LMS. For tickets needing human help, the system categorized urgency and nature, routing them to the right specialist or department. By eliminating manual ticket sorting and prioritizing routing, the platform reduced wait times and misclassification errors. Also, ticket history and student data were attached to each case, letting support agents act quickly without gathering repetitive information. Analytics flagged recurring issues and suggested improvements. For example,

confusing exam instructions triggered multiple tickets, alerting the content team to revise that section of the course. Automation addressed immediate queries and helped refine the platform.

Quantitatively, these automations reduced the annual processing time for support tickets from 59,988 hours to 11,244 hours. Representing a process improvement of 48,744 hours, or 81.24%. The number of FTEs required dropped from 31.24 to 5.86. From a financial standpoint, the monthly cost of managing support tickets decreased from 46,860 USD to 8,790 USD. Although the costs for automating support are still high compared to other processes, it once again becomes clear that support is a highly people-intensive process, making support automation one of the most interesting candidates for further research.

The research validated the success of this transformation with stakeholders through interviews. Students reported faster response times and were satisfied that they were able to solve many common issues on their own. Support agents were satisfied with the reduction of workload and the better clarity of the cases that were escalated for their attention. Administrators reported a significant decrease of error rates and an improvement of quality indicators.

In relation to Hypothesis 1, which states that Hyper-Automation and Open Innovation greatly improve cost-efficiency and service scalability, the support ticket transformation provided strong proof. The use of smart automation not only assists human labor with digital tools, but it has also changed the entire process to make better use of human skills. The support ticket management example shows how Hyper-Automation can improve things without losing empathy. It shows how smart automation can help balance growing operations with caring service, which is important for non-profit global education.

The savings and better quality focus offered a significant way for the support departments to assist many learners with limited resources (Ma, Zhang and Hui, 2024).

Hypothesis 1 Validation

Before automation, the integrated workflows consumed an estimated 139,748 hours per year, or the equivalent of 72.77 full-time employees (FTEs). The cost savings achieved through this project are transformative for the organization's financial sustainability model. The reduction in monthly costs from 109,245 USD to 9,000 USD, amounting to over \$1.2 million annually, creates a buffer for reinvestment into other high-impact areas such as content development, faculty training, student services, infrastructure upgrades, and research. This level of reinvestment is critical for a non-profit organization that depends on grants, donations, or public money.

Furthermore, during the research, the existing core team was made more efficient, and therefore, the organization didn't have to increase due to the unprecedented growth of enrolled students. The freeing up of nearly 129,000 work hours annually enables a profound shift in institutional focus. Staff who were previously engaged in repetitive administrative tasks can now work more efficiently and are included in more strategic roles, such as pedagogical research, learner experience design, and quality assurance. This internal redeployment enhances organizational learning capacity and morale while reducing burnout associated with monotonous tasks. In this sense, Hyper-Automation becomes not merely a cost-cutting mechanism but a catalyst for human capital development and innovation.

Taken in sum, the results from all processes provided strong empirical evidence for Hypothesis 1: "Implementing Hyper-Automation and Open Innovation in a non-profit global online educational organization will significantly increase cost-efficiency by

reducing online education management and operational costs, thereby enabling the organization to serve five million enrolled students more effectively and sustainably.”

Both the quantitative and qualitative gains from each of the process analyses validate this conclusion. The automated architecture was found to be extensible, policy-compliant, and scalable in operation. Open innovation was found to be adaptable, to reduce costs and ensure sustainable long-term operation.

The evidence also points to broader organizational benefits. The efficiencies gained through automation have been reinvested into academic innovation, research capacity, and service improvement, thereby elevating the institution's value proposition to learners and stakeholders. The research success was not the result of a number of isolated technologies or single innovations, but the result of a holistic digital and management strategy underpinned by Hyper-Automation and Open Innovation. With increasing demand for education, especially in disadvantaged communities around the world, models like these will be indispensable. The ability to provide mass learning at a sustainable level of quality and equity for all learners goes beyond the mere provision of content delivery platforms. In contrast to the common narrative that automation replaces human workers, this research demonstrates that intelligent automation can enhance the human dimension of education when it's implemented thoughtfully and strategically.

5.3 Discussion of Research Hypothesis Two

Hypothesis 2 centers on two intertwined assertions. First, that Hyper-Automation and Open Innovation will significantly improve accessibility and efficiency in delivering online education at a global scale. Second, by leveraging these technologies and collaborative methodologies, the institution can overcome constraints related to a limited pool of skilled technical personnel, strengthening long-term sustainability. As Chapter 4

presented, the evidence speaks to dramatic transformations in both dimensions. This section examines the quantitative and qualitative findings in detail, connecting them to existing literature, theoretical underpinnings, and the organizational context under study. The discussion unfolds in two major parts: Accessibility & Efficiency, and Mitigation of Skill Constraints.

5.3.1 Accessibility & Efficiency

In addition, learners were reported to be predominantly accessing the platform via mobiles that were themselves outdated or running legacy operating systems. Rather than installing apps, the institution opted to distribute a fully responsive web solution. Chapter 4 has demonstrated that the Hyper Automation and Open Innovation strategies that were implemented offered significant improvements in accessibility and efficiency. The subsequent subsections outline these improvements and interpret their meaning from a Hypothesis 2 perspective.

An unexpected result was that learners accessed the platform via mobiles, accounting for 92% of the accesses reported. Many of these were old and running legacy OS versions. Rather than an installable app, a fully responsive web-based solution was distributed. This avoided an app store requirement and ensured all participants, regardless of device, had access to the courses, assessments, and certificates. Complementing this was the decision to optimize resources for low bandwidth. Video lessons were compressed to around 55 MB, audio files around 5 to 10 MB, and PDF course materials kept below 20 MB for easy download and offline use. Data from usage logs showed that students in bandwidth-constrained regions could now download the course content at minimal data cost.

Additionally, synchronized satellite television broadcasts across Asia, North/Central Africa, Europe, and North America offer lessons without the need for an

internet connection. The analysis of student feedback emphasized how these broadcasts acted as lifelines in regions with little to no internet. This blended delivery model aligns with multi-modal content distribution (Monika, Bala and Sunita, 2023), confirming that hyper-automation needn't exclude analog methods.

Automation lowered the average response time for support tickets from 51 hours to 18 hours, an improvement of 64%. It is essential that 45% of the support queries be handled by chatbots and support process automation. Student satisfaction surveys cited faster resolutions and higher trust in system responses. The integration with chatbots, support process automation, and advanced knowledge base enabled automated handling of routine queries while escalating sensitive issues to the available resources. This prevented the high-pressure levels from the available support staff and ensured empathy was maintained for sensitive issues. In combination, these results show increased access and improved efficiency, supporting Hypothesis 2.

The outcomes from a theoretical perspective are in accordance with frameworks on socio-technical systems, integrating digital automation with offline methodologies to engage marginalized communities. Practically, the results point towards a strategic framework: creating systems designed to proactively engage learners at their current technological level, complemented by automation to improve efficiency and quality. By taking this approach, the focus extends beyond the technical aspects of instruction to include considerations of “who” and “where,” thereby broadening educational access beyond predominantly urban and technologically advanced demographics.

Although there have been significant improvements, there were also limitations. Around ten percent of the students found the feedback to be impersonal. This may be a consequence of over-reliance on automation, and therefore, it's important that in future studies there needs to be greater focus on blending automated and human interaction.

Additionally, the system itself is complex and therefore requires skilled maintenance personnel. The point that automated systems can still break and therefore still require humans to maintain them was reinforced. The point was made that this does not mean that greater access automatically means greater automation, and therefore, careful step-by-step implementation together with human monitoring is important.

5.3.2 Technical Personnel Constraints

The integration of Hyper Automation and Open Innovation provides a significant opportunity to overcome limitations in skilled technical resources. The research provided consistent evidence that a small core team successfully oversaw and technically managed the complex platform. The institution maintained a modest technical team of 6 FTE to manage all automation processes that previously required over 72 FTEs. The expertise matrix identified the Solution Architect, RPA engineers, full-stack developers, AI specialists, Server Administrator, and security leads who together managed automation across multiple domains. This illustrates that specialized expertise, when amplified by automation, can be more effective than general skills. The result is a high-functioning system with fewer personnel, a solution to the labor constraints.

Rather than build the technical solution from scratch, the research harnessed open-source solution integrations and engaged with developer communities. This sharing of development responsibilities allowed internal teams to focus on orchestration, integration, and governance rather than general coding (Hellman, Cheng and Guo, 2021). The strategic application of external contributions expedited the developmental timeline and broadened the internal skill set. Stable quality was maintained through documentation, code reviews, and integrated tools.

Architecturally, the decision to adopt a three-tiered system, core infrastructure, core middleware, and community innovation enabled rapid but controlled innovation. APIs and

microservices were a safeguard against change, minimizing impact and risk. As seen in the integration logs, there were only 6% rollbacks and 16% initial flags for security. These are metrics indicative of an agile governance system that allowed internal team members to innovate, adapt, and maintain code.

Structured sprint reviews, documentation guidelines, and onboarding resources fostered an internal learning culture. Team members directly learned new skills by contributing in the development process. This approach supported the growth of internal capacity and limits the risk of turnover because team members share actively essential knowledge. The organization developed a strong dynamic learning environment that was capable of adapting innovations rapidly.

Although Open Innovation and automation reduce the need for positions, they do not eliminate the existing technical departments due to the dependency of advanced technical roles. The institution must recruit strategically and train as a way to ensure system effectiveness. Community involvement also allows access to specialists. Community involvement also gives access to specialists. The research findings indicated that the organization must rely on external actors when needed. The organization plays a more essential role as an ecosystem manager, not a programming company.

The results of the research support the claim that the use of open innovation can mitigate the need for highly technical staff when architecture principles of modularity and knowledge sharing are applied. This case study challenges the common wisdom that digital transformation requires a large investment in in-house staff. Rather, it shows that a smaller, better-staffed team can deliver the same, if not better, results.

Project complexity introduced potential challenges such as demanding project management and review processes for external collaborations. The research provided evidenced as plugin rework reached 34% in resolving third-party inconsistencies. These

risks are manageable and predictable. Accepting them as inherent to collaborative models and addressing them proactively is more economical than maintaining full internal teams or relying on expensive vendor services in the long run.

CHAPTER VI:

SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

6.1 Summary

As the research advanced through successive process automations, including enrollment, scheduling, assessments, broadcast coordination, exam retakes, certification issuance, and support ticket resolution, a key finding emerged: Hyper-Automation and Open Innovation have a large impact that extends beyond individual tasks. When all systems are considered together, the total manual time required across these functions is 139,748 annual hours, the equivalent of almost 72.8 full-time staff members. In contrast, the fully automated environment required only 11,252 hours of annual system operation with only six FTEs. The annual gain in operational time was 128,223 hours, a 91.76% reduction in labor.

The research significantly reduces the organization's need for future staff, as this research reduced the need by about 66 workers. This led to a drop in monthly costs from about 109,245 USD to 9,000 USD, saving over 100,000 USD each month. The annual labor savings went over 1 million USD, along with better data accuracy, faster services, and better use of staff skills. These numbers show a significant change, turning an organization from one that needs many workers to an automated organization that can serve millions with a skilled core team.

An analysis of savings across workflows shows this digital transformation. Automation of enrollment, which cut manual labor by about 90% and costs by eight times, led to annual time savings and set the stage for later system automation. Also, automating lesson scheduling cuts the time needed by over 97%, letting staff focus on better content and learner involvement. Handling exam retakes saw a 99.7% time reduction, showing the

institution's ability to ease bottlenecks during busy times by using policy-driven logic at scale.

The reality of the return is highly apparent within certification automation. Going from a state of requiring 33.91 FTE to support certificate production and verification, and changing it to one automated pipeline that requires only 0.02 FTE. This improvement is highly beneficial to the learner by increasing their motivation through fast credential attainment and to the institution through verifiable digital credentials with QR-based validation. The implications for the organization, both operationally and in terms of reputation, are significant.

Automation has fundamentally reshaped student inquiry support, which is traditionally a resource-intensive department. Prior to automation, the annual effort was around 60,000 hours. Currently, with the use of chatbots, a comprehensive knowledge base, and escalation best practices, the support departments are able to handle 45% of inquiries automatically, saving 48,744 hours. Beyond leveraging efficiency, this creates a support system that is responsive, understanding, and can grow as needed. It's designed to find and handle sensitive situations that need and prioritize human intervention. These results highlight the potential of Hyper-Automation and Open Innovation. A team of only six full-time staff members can manage a workload that once needed 72. This maintains or improves service quality. The integrated system isn't just a set of tools but a plan that balances growth with sustainability, cost savings, and student satisfaction.

Such a comprehensive transformation is atypical in the non-profit global education sector, where academic institutions often face constraints related to staffing, budget, licensing expenses, and outdated legacy systems. However, this study illustrates that the strategic application of open-source platforms, community-sourced code, API-driven

orchestration, and configuration-centric design, all governed by a rigorous Lean-Agile-Stage-Gate model, enables profound operational restructuring.

These collective efficiencies make clear that embracing automation at scale is not just a technological consideration, it is a strategic imperative. The temporal savings and cost reductions represent more than efficiency gains, they free human capital for high-impact work in community engagement, pedagogical design, and adaptive learning innovation. The shift transforms the organization from a task-oriented system into a capacity-rich learning enterprise.

This result is consistent with change management models, which highlight the crucial relationship between technological capabilities and organizational learning. Successfully achieving and maintaining this transformation necessitated not only technical innovation but also stakeholder engagement, adherence to procedures, and continuous performance assessment. The initial expectation, Hypothesis 1, that automation and open innovation would lead to reduced costs and scaled operations has not only been confirmed, but also extended into both anticipated and unexpected areas of institutional resilience, learner experience, and public trust.

From a financial perspective, the immediate monthly savings protect the organization from income changes or external disruptions, reinforcing its non-profit mission. The extra operational ability and savings can be dedicated to scholarship programs, learning resource expansion, or reallocation toward strategic initiatives. The automation-driven model also de-risks the platform's future growth, and automation pipelines can be replicated across new regional LMS implementations or thematic courses.

The resulting modularity and redundancy offer a durable scalability path that aligns with the institution's long-term expansion goals. This is not a series of point-in-time improvements, but a foundational and durable redesign of the organization's managerial

and operating model, a journey from manual processes to intelligent systems, from batch responses to real-time flow, and from staff-driven tasks to platform-empowered impact. In doing so, the institution not only validated Hypotheses 1 and 2 but also demonstrated a new blueprint of educational delivery.

6.2 Implications

The results obtained from this research not only support the effectiveness of Hyper-Automation and Open Innovation, but also provide a guidance path for non-profit educational organizations that would like to adopt this innovative model. The eight-step plan below summarizes the learnings from operational successes, technological adaptations, and organizational adaptability identified throughout the research, providing an educational organizational digital transformation blueprint.

6.2.1 Establish Initial Core Team (Step 1)

Effective digital transformation begins with the establishment of a fundamental core team that has an in-depth understanding of the project objectives. It's essential that the core team consists of a Senior Solution Architect, a DevOps engineer, an automation specialist, and a representative from content or instructional design. The Solution Architect plays a crucial role, shaping both the technological target state and ensuring alignment with institutional goals. As shown throughout Chapters 4 and 5, the expertise and leadership of this small technical group underpinned the success of modular integration, governance frameworks, and scalable rollouts.

The research data clearly reveals that even with a lean team of six FTEs, the organization managed to automate dozens of complex workflows. This underscores the need for multi-disciplinary professionals capable of cross-functional thinking, ranging from infrastructure mapping to human-centered automation and community management.

Institutional hiring and capacity-building must prioritize adaptability, systems literacy, and standards governance, placing emphasis on these qualities.

6.2.2 Business Model Canvas (Step 2)

Having established a core team, as a next step, it is essential to create a Business Model Canvas that describes value propositions, cost structures, key partners, and revenue streams (Bosman, 2019). The early involvement of stakeholders such as academic administrators, financial officers, information technology executives, student representatives, and external consultants will help embed technology within the institution's needs and ensure widespread support and alignment within the organization.

This canvas will help make critical decisions about education, platform enhancements, open innovation ecosystems and sustainability strategies and constraints. The research findings clearly illustrated that successful adoption of hybrid revenue models depended on aligning technological feasibility with stakeholder values and community trust.

6.2.3 Digital First, Learning Specification Model (Step 3)

Following the establishment of a consensus on the business framework, the institution should proceed to develop a Learning Specification Model. This well-structured blueprint should describe the entire life cycle of the educational program, covering aspects such as enrollment, modules, assessments, progress criteria, retake policies, and certification processes. Critically, it must adopt a digital-first approach that lays the foundation for educational automation.

The research indicated that modeling essential workflows facilitated near-total process coverage, achieving up to 96% automation of routine academic tasks. Furthermore, this approach ensured consistency across global implementations, improved auditability,

and established a base for dynamic scheduling engines and AI modules. Consequently, the LSM is poised to become the core of all subsequent automation activities.

6.2.4 Technical Infrastructure Blueprint Design (Step 4)

The VLE must interact with a technical infrastructure that ties together front end portals, administration services, LMS clusters and a central data warehouse. What is evident from the early design is which components are suitable as containerized microservices, which require staging, where open source technology fits and where proprietary solutions make sense.

The project's success depended on designing the architecture with a modular object-oriented approach ensuring horizontally scalability. Therefore, the infrastructure blueprint should anticipate container orchestration, monitoring and CI/CD pipelines, thereby mitigating the risk of downtime and facilitate integration of open innovation contributions.

6.2.5 Identify Open-Innovation Opportunities and Automation Challenges (Step 5)

After the infrastructure mapping, the architecture should recognize opportunities for identification of specific workflows that may benefit from open innovation, such as RPA for administrative processes, AI for data analysis and notifications, chatbot platforms, certification systems, broadcast scheduling tools, and configuration management platforms. This research provides an initial infrastructure that can be used as a foundation for the identification of opportunities. Simultaneously, the architecture should flag high-risk or high-sensitivity workflows that require layered quality assurance, governance, or human oversight. This ensures that automation expands safely while preserving institutional control and trust.

6.2.6 Core Team Expansion (Step 6)

As the project moves from blueprint to pilot, additional roles must be added. Essential roles are full-stack developers, data scientists, security specialists, instructional technologists, and QA analysts. This expansion should align directly with the identified workflows and innovation opportunities, ensuring that the talent will match the need, rather than the other way around. The findings confirmed that lean teams can scale only when roles are well-targeted, responsibilities are clear, and hiring is strategic rather than reactionary. Sustainable deployment emerges not from full-scale wards but from a core whose expertise closely matches automation demands.

6.2.7 Prototype the System in a Controlled Environment (Step 7)

With the team in place, prototyping begins. The goal is to validate the VLE and technical design in at least one learning module. Validating RPA pipelines, configuration management flows, chatbot responses, analytics dashboards, reporting capabilities, early surface integration challenges, and user experience friction.

The research followed an iterative MVP cycle, engaging learners and stakeholders from day one. Real-time data from logs, usage, and feedback accelerated action and helped reduce technical debt. Early prototyping also defined user acceptance thresholds and empirical success criteria (Nguyen-Duc, Wang and Abrahamsson, 2017). This is essential for proving ROI and maintaining stakeholder confidence.

6.2.8: Validate, QA, and Deploy (Step 8)

After a successful validation of the prototype, a formal QA in terms of functional, security, accessibility, usability, and performance measures should take place. This ensures that a broader rollout is based on well-defined metrics, acceptable failure rate thresholds, response times, iterative resiliency checks, user satisfaction benchmarks, and flexible governance mechanisms. In the deployment phase, any cross-LMS system

integration should be phased out. Monitoring and rollback procedures should be put in place to prevent active system disruptions. This concluding step provides commitment to enhancements, a testament to the integrity of the system's security, and an acknowledgment of the flexibility of innovation.

6.2.9 Plan of Importance

This eight-step model effectively combines the practical technological and organizational benefits identified through this research. It demonstrates that substantial automation in education is not a chance occurrence but rather the product of a carefully managed integration of strategic leadership, structured modeling, technical integration, iterative developments, and community-led adaptation.

The implications presented call for a fundamental re-evaluation within the educational sector, advocating a move away from transactional project management toward a systems-thinking approach; a shift from vendor-dependent models to open innovation ecosystems; a transition from staff-heavy operations to lean, developer-driven automation; and a progression from gradual improvements to sustainable institutional transformation.

This stepping-plan is not just theoretical but a practical template that has emerged from a successful large-scale implementation and can be adapted for future challenges, such as responding to global pandemics, scaling education curricula, delivering local educational offerings for future challenges, while ensuring ethical use of automation and learner-centered design. In essence, this blueprint translates the study's results into tangible action, enabling non-profit education systems to convert limited resources into intelligent, accessible, and resilient digital learning ecosystems capable of serving millions.

6.3 Recommendations for Future Research

Based on the outcomes of this research and the evolving technological environment characterized by hyper-automation and open innovation within online education, several vital domains are vital for future scholarly studies. These suggestions address the potential future opportunities identified in this research, such as supporting development and technical infrastructure advancements, including the opportunities made possible by new advancements in AI agents, automated content creation, and virtualized teaching platforms. The outlined directions provide a guide for academics, institutional planners, and technology developers aiming to expand upon the initial achievements of this research.

The research revealed the need for more support services, particularly in emotional or contextual cases. While basic automation was sufficient to handle the majority of support ticket traffic, extraordinary situations such as bereavement, geopolitical turmoil, or delicate educational accommodations required human intervention. Therefore, future research should focus on putting into practice more advanced AI agents with context awareness, emotional intelligence, and the ability to work together in decision-making processes. These agents should be able to mimic empathetic interactions while respecting institutional policies. This would be especially useful in situations handling huge volumes where quick responsiveness is crucial.

Another interesting research direction would be designing reliable and cost-effective technology for non-profit education. According to the study, sustainability can be achieved in the long run by using modular infrastructure and scalable automation. However, as automation scales, the potential for performance issues and integration failures increases as well. Therefore, a future study should aim at developing reference designs based on containerized microservices, advanced server management, and AI

monitoring. The results can be used by schools to reduce downtime, forecast failures, and become more efficient while remaining a lean organization.

There is a substantial use case for AI-generated educational content in instructional contexts with limited resource availability. Preliminary research within this study revealed that scripting lessons automatically and AI-authored video lectures could lead to considerable savings in labor and expenditure. As generative AI models mature, they could be trained to output structured lessons, assessments, and interactive modules with pedagogical fidelity and alignment to established curriculum taxonomies. Research should be undertaken to evaluate the fidelity, pedagogical validity, and scalability of these outputs across different subjects and language communities. It is also crucial to explore integration pathways to engage these AI-generated resources with LMS infrastructure, accreditation standards, and quality assurance protocols.

The rapid development and implementation of highly advanced AI virtual instructors who can provide a personalized tutoring experience similar to a one-on-one interaction is also remarkable. Future research should explore the psychological, cognitive, and motivational impacts of virtual teachers. Open questions include whether AI instructors can impart the same level of trust and academic authenticity as instructors in traditional classrooms provided by humans and how this new mode of instruction affects students' motivation, satisfaction, and learning. Because these agents are increasingly used among students from around the world, cross-cultural and multilingual settings are particularly meaningful.

Another critical avenue of exploration concerns the hybrid human-AI interaction models for support and operations. The research demonstrated that complete automation is not always desirable or appropriate, especially in emotionally charged or high-stakes situations. Future research should investigate escalation frameworks in which AI agents

handle initial queries, classify complexity, and seamlessly route unresolved issues to human experts. Such models should be evaluated not only for efficiency gains, but also for user satisfaction.

The creation of AI-driven forecasting tools is also crucial for helping non-profit educational organizations predict staffing needs, infrastructure demands, and operational expenses across various scaling scenarios. The data gathered in this study offers a solid base for simulation models. These models could dynamically forecast the resource consequences of incorporating a million new students, introducing new programs, or changing delivery methods, which would improve decision-making and lower the financial risks of resource misallocation.

Taken together, these research recommendations offer a holistic roadmap for advancing the theory and practice of hyper-automation and open innovation in non-profit online education. Each represents an evolution of the challenges and opportunities explored in this study and aligns with the broader goal of expanding global educational access while preserving financial, technical, and pedagogical sustainability. As such, they stand not only as extensions of this research but as calls to action for the next generation of research, innovation, and institutional transformation.

6.4 Conclusion

This research examined how Hyper-Automation and Open Innovation can be strategically integrated into a non-profit global online educational institution to improve operational cost-efficiency, system scalability, and educational accessibility. The study responded to two central hypotheses and eight research questions, using both qualitative and quantitative data derived from technical system analysis, stakeholder interviews, survey responses, and performance monitoring across over two million learners.

The primary conclusion is clear: when implemented systematically and with a governance-driven framework, Hyper-Automation and Open Innovation produce substantial cost, time, and process improvements, while also enabling sustainable and scalable educational service delivery. The research confirmed that a lean, highly skilled technical core team, supported by open-source contributions and modular infrastructure, can deliver high-quality services to millions of learners with far fewer resources than traditional education models demand.

The research results showed that Hyper-Automation has lowered labor and operational costs for all the key administrative and academic functions. Student enrollment time decreased by 89%, pre-recorded lesson scheduling by 97.85%, and certification issuance by 99.93%. The cumulative effect resulted in lowering annual manual labor from 139,748 hours to just 11,252 hours, with monthly process costs dropping from 109,245 USD to 9,000 USD, a cost-efficiency improvement of 91.76%.

Open Innovation played a critical role in reducing licensing costs and encouraging development through collaboration. The platform's use of open-source LMS tools, module plugins, and an API-first approach allowed for rapid deployment of features and effective versioning. The community contributed to innovations targeting both core functions and specialized modules like automated assessments, dynamic scheduling, and AI-enhanced support.

The research also proved that Open Innovation structures, coordinated around layered integration, allowed for modular scalability without vendor lock-in. This ensured both technological independence and financial sustainability, while maintaining compliance and quality standards. The research findings provided strong support for Hypothesis 1, demonstrating substantial decreases in labor and costs across various functions, including certificate generation and validation, assessment and examination

configuration, broadcast scheduling, and retake processing. This improved standardization increased learner satisfaction and reduced error rates, thereby maintaining or improving overall quality.

The adoption of configuration management across multiple LMS instances was successful, allowing updates or changes to be rolled out to 34 instances quickly. This lowered the impact of changes on recurring activities such as lesson scheduling and exam configuration. Additionally, the automation strategies allowed for the production of real-time analytics and dashboards for informed decision-making and to support agile management principles.

Hypothesis 2 was supported by the platform's capacity to sustain full-service operations for over two million learners, supported by a compact technical team of fewer than twenty individuals. This was enabled through well-managed and documented open-source tools, a modular service architecture, and containerized infrastructure. While specialized expertise was necessary for sophisticated elements like AI integration and system security, routine functions such as RPA and chatbot management were effectively managed.

Accessibility was significantly enhanced through satellite television, offline content, and multilingual platforms. AI-driven support ticket classification allowed numerous students to receive assistance without overwhelming human support staff. By combining automation and human oversight, empathy and responsiveness were maintained in sensitive situations. Each research question was directly addressed through both data and narrative analysis. Key conclusions included:

- **RQ1 - RQ3:** Automation of enrollment, assessment, and certification processes drastically improved cost-efficiency, reduced manual labor, and improved accuracy.

- **RQ4:** A modular, scalable infrastructure allowed for flexible deployment across global environments without significant increases in cost.
- **RQ5–RQ6:** Open Innovation enabled agile adaptation, community collaboration, and long-term technical independence.
- **RQ7:** Risks of over-automation were managed through the integration of human oversight within automated systems and process escalation paths.
- **RQ8:** A small but expert core technical team was essential for sustainable operation, supported by open-source and automation tools.

These findings collectively confirm that the dual strategy of Hyper-Automation and Open Innovation offers not just marginal improvements but transformative gains for educational organizations facing resource constraints, thereby paving the way for a more equitable and accessible educational landscape.

This study offers a pragmatic roadmap for educational leaders and policymakers. By using automation and group development, non-profits can reach more people, lower costs, and improve quality with limited resources. Chapter 6.2 gives a step-by-step guide for change, from creating a core team to using automated systems widely. The study also highlights the need to design systems that can grow and adapt. Using AI in tasks like managing schedules and resolving support tickets shows how automation can improve human decisions when used carefully.

This research confirms that the future of large-scale, inclusive online education does not depend solely on expanding budgets or hiring larger teams. Rather, it lies in the intelligent design of automated systems, open collaboration, and the strategic use of emerging technologies. Hyper-Automation and Open Innovation, governed and participatively designed, enable organizations to scale equitably, efficiently, and

sustainably. The results present a successful case study and road map for future implementations across the educational sector. The results signify a shift not only in how education is provided, but also in how to organize and govern our institutions in a digital-first world.

APPENDIX A
PARTICIPANT INFORMATION LETTER

1. Title of Study: HYPER-AUTOMATION AND OPEN INNOVATION: THE FUTURE OF DIGITAL TRANSFORMATION OF ACCESSIBLE AND COST-EFFICIENT GLOBAL ONLINE EDUCATION.

2. Version 1, 31st January 2024

3. Join us in ground-breaking research.

You've been asked to join a research study. It's essential for you to know why the study is happening and what it will require from you before deciding whether to participate. Take your time reading through this information and ask us if there's anything else you'd like to know or don't understand. Feel free to talk about it with people close to you as well. Remember, there's no pressure - only get involved if you truly want to.

Thank you for your time and consideration.

4. What is the aim of the study?

The study is focusing on examining the work procedures and operations of online educational institutions that are challenging for departments to manage. By analysing and identifying the current and future intensive tasks, it is essential to support the departments in handling an increase in work due to the unprecedented growth strategies. The objective of this study is to explore automation opportunities to support the teams and reduce additional needed resources. The findings will be used to provide insight and identify work process automation opportunities.

5. Why have I been chosen to take part?

All technical staff who are working on the project are being invited to participate. The estimate is that approximately 12 staff members will make the choice to participate in total.

6. Do I need to participate?

Participating is totally up to you. You can decide whether or not to join in. And if you do, you're free to change your mind and withdraw without any pressure or explanation. There won't be any negative effects if you decide not to participate or if you change your decision later on.

7. What happens if I participate?

If you decide to participate in the study, Martijn Reemeijer, a Swiss School of Business and Management student, will conduct a single interview with you. During the interview, you will be asked approximately 10-15 open-ended questions related to your work and the ways automation can enhance your daily tasks. This conversation is expected to take around 25-45 minutes. The interviews will be conducted virtually, recorded for audio purposes, and later transcribed. Your responses will then be analyzed by the researcher in order to explore how automation can streamline work processes and workflows further. Rest assured that any personal information will be removed from the transcript, ensuring complete anonymity for all participants.

8. How will my information be utilized?

Details regarding the utilization of your data are provided in detail to provide transparency.

How is my information gathered?

Recording audio with Zoom conference software to a secure network drive.

How will my information be stored?

Your recordings will be kept directly on a secure network storage drive. The interview transcription will be saved as a Word document with all identifying details removed. Additionally, digitally signed consent forms will also be securely stored on the network drive.

How long will you keep my data?

Once the transcript is finished, we'll delete the original audio recording. Anonymized transcripts will be retained until the researcher finishes the research.

What measures are in place to protect the security and confidentiality of my data?

The electronic files and documents are encrypted and kept on a secure, password-protected network storage drive.

Will my data be anonymised?

Yes, the transcript will be fully anonymized and labelled only as 'Participant A, Participant B', ensuring confidentiality for all involved.

How are you planning to utilize my information?

The information will be reviewed along with all the other interview data gathered from different participants, solely for research purposes.

Who can access my data?

Only the researcher who is conducting the research.

Will my information be stored for potential utilization in future research initiatives?

No

How is the deletion of my data carried out?

Electronic files that have been gathered for the research will be automatically deleted after the research is completed.

9. Financial compensation and Expenses

You won't get any financial compensation for participating in the research, and you also won't have any expenses.

10. Are there any potential dangers in participating?

Participating in this study does not pose any risks, dangers, or negative impacts to you. If you happen to encounter any discomfort or drawbacks during the research, please notify the researcher promptly.

11. Are there any advantages to participating?

Participating in this study may not have immediate advantages, but there could be future benefits. For instance, the results of the project might help improve work efficiency and reduce job stress by automating tasks for employers.

12. What will happen to the results of the study?

The researcher will compile the findings of the study. These results will be condensed into a brief document and shared with all participants for informational purposes, ensuring that their identities remain anonymous in the report.

13. What happens if I decide to discontinue participating?

At any point, you are free to change your decision and opt out of the research. You are not obligated to provide a rationale; just inform the researcher. If you choose to withdraw after the interview, you may request that your interview recording be erased. Once transcription is completed, your interview will be made anonymous and cannot be traced for destruction.

14. Who can I contact if I have further questions?

Contact the researcher, Martijn Reemeijer, who can be contacted at: martijn@ssbm.ch

APPENDIX B
INFORMED CONSENT

Version number & date: Version 1, 31st January 2024

Title of the research project: HYPER-AUTOMATION AND OPEN INNOVATION:
THE FUTURE OF DIGITAL TRANSFORMATION OF ACCESSIBLE AND COST-
EFFICIENT GLOBAL ONLINE EDUCATION.

Researcher(s): Martijn Reemeijer

Please sign the checkbox.

I acknowledge that I have reviewed and comprehended the information sheet dated February 14, 2024, pertaining to the aforementioned study, or it has been presented to me orally. I have had the chance to review the information, ask some questions, and get satisfactory answers.

☐

I am aware that participating in the research entails undergoing a single interview with the researcher, Martijn Reemeijer, who is a student at the Swiss School of Business and Management. During this interview, I will respond to approximately 10-15 open-ended questions regarding the ways in which advanced automation can assist with my daily responsibilities. This process is expected to last around 25-45 minutes and will be conducted virtually while being audio recorded.

☐

I understand that my participation is voluntary. I am free to stop taking part and can withdraw from the study at any time without giving any reason, and without my rights being affected. Additionally, I am free to decline to answer any particular question or questions.

☐

I understand that I can request access to the information I provide and ask for its destruction at any time before the transcription process is completed. After the completion of the process, I will not be able to access or withdraw this information.

☐

I acknowledge that my answers will remain confidential. I authorize the research team to access my fully anonymized responses. I am aware that my name will not be associated with the research data, and I will not be identifiable in any resulting dissertation from the study.

☐

I acknowledge that the details I supply will be securely held and in compliance with global data protection laws. Anonymized, unprocessed data will be transmitted.

☐

I acknowledge that consent forms will be stored in a secure, locked cabinet at the researcher's workplace and will be accessible only by the student researcher. I also understand that original audio recordings will be kept on a secure, password-protected network storage drive, which can only be accessed by the student researcher until the end of their research period at the Swiss School of Business and Management.

☐

I acknowledge and consent to the recording of my participation in audio format, understanding that these recordings will be used to create an anonymized interview transcript for analysis.

☐

I consent to participate in the study mentioned above.

☐

Participant name

Date

Signature

Name of person taking consent

Date

Signature

APPENDIX C

INTERVIEW GUIDE

Introduction to the Interview

Welcome, and thank you for your cooperation and for participating in this research. Before we begin, Participation in this interview is voluntary. You are free to leave the interview at any time without giving a reason. This interview is part of an important research into Hyper-Automation and Open Innovation in Virtual Learning Environments. The aim of this research is to explore how advanced workflow automation, Robotic Process Automation (RPA), Artificial Intelligence (AI), Cloud and Web Services and current learning technology can support the automation of digital operations in large, non-profit online education.

Hyper-Automation refers to the combination of multiple advanced technologies, such as RPA, AI, machine learning, and process mining. This type of automation significantly enhances operational capabilities compared to traditional automation tools.

Robotic Process Automation (RPA) is configurable or programmable software that follows business rules specified by a user and uses sequences of actions to perform tasks within and across digital applications by simulating the interaction with the application.

The purpose of this interview is to gain practical information about your department's work processes. By identifying the most time-consuming and repetitive work processes we can understand how to support you and your department better when the enrollment of students are increasing rapidly. These findings will support you in future tasks and the design of scalable, efficient workflows aligned with the continued growth and impact of the free online educational academy.

This interview will be based on your own experience with work and task processes as well as your knowledge of currently ongoing and completed automation. The interview is expected to take around 25 to 45 minutes.

Interview Questions

1. Time-Consuming Tasks During the Administration Period

Reflecting on the previous administrative cycles, what would you identify as the most time-consuming tasks or work processes your department handled during the administration period?

- Can you estimate how long these processes used to take before automation (if applicable)?
- What is the current estimated time for these processes?

2. Time-Consuming Tasks During the Academic Study Period

During the active academic period, which tasks or processes demand the most time and attention? Please describe their impact on your workload and departmental priorities.

3. Repetitive Workflows

From your current experience, which of your tasks or processes are highly repetitive in nature?

Why do you think they have remained repetitive, and have there been attempts to reduce or automate them?

4. Automation Opportunities

Based on your day-to-day responsibilities, which specific tasks or processes do you believe are suitable for automation?

What would be required to automate them successfully?

5. Positive Effects of Automation

Have you experienced any direct benefits from automation in your workflow or departmental operations?

If so, can you elaborate on specific examples that highlight increased efficiency, reduced workload, or improved accuracy?

6. Negative Effects or Challenges Related to Automation

Conversely, have there been any drawbacks or unintended consequences associated with automation in your department?

This could include technical failures, increased complexity, user resistance, or decreased flexibility in certain workflows.

7. Exploring Open Innovation and Advanced Solutions

Have you or your department explored the use of innovative automation tools, open-source systems, AI applications, or cloud-based services in your work?

Can you describe any tools or experiments that have contributed to developing or improving the technical infrastructure of the VLE?

8. Strategic Value in the VLE

From your perspective, is there a specific part of the Virtual Learning Environment that presents major opportunities for future automation or support?

This could be related to your own department or another area within the organization.

9. Strategic Impact of Hyper-Automation

Do you believe Hyper-Automation, as defined earlier, can contribute to lowering operational risks and enabling sustainable organizational growth?

Please share any observations or insights that support your opinion.

10. Additional Reflections and Suggestions

Finally, do you have any further suggestions, reflections, or comments regarding the role of automation or innovation in your work that we have not yet covered during this interview?

Closing the Interview

Thank you once again for giving up your time and providing your insights and input for this study. Your contributions will help to guide future strategies for automation that not only reduce risks to institutional efficiency but also to support you and to ensure quality and access to global online education.

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