Entrepreneurial Universities: Examining the role of universities as sustainable innovation change catalyst for regional development.

A thesis submitted for the degree of Doctor of Philosophy

By

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Abstract

This thesis explores the evolving role of universities as sustainable innovation change catalyst for the regional development, positioning them not merely as educational institutions but as entrepreneurial hubs embedded within broader societal and economic ecosystems. Rooted in the growing discourse around the Triple Helix and Quintuple Helix models, the study is contextualized against the backdrop of increasing global emphasis on sustainability, digital transformation, and knowledge-driven economies. It critically examines how universities can shift from passive knowledge disseminators to active catalysts for social innovation, industry collaboration, and regional transformation.

Methodologically, this research employed a robust multi-method design combining primary qualitative data collection through six focused group discussions across three university settings which included Birmingham City University, QA Higher Education, and Ulster University with complementary secondary data was analysed. Data was analysed using thematic analysis within the NVIVO environment, allowing for the identification of key patterns and thematic clusters that reflect both disciplinary perspectives and institutional experiences.

The findings underscore universities' expanding role in facilitating innovation ecosystems by fostering industry partnerships, community engagement, and entrepreneurial education. It offers an original contribution by advancing the conceptual understanding of the Triple Helix model into a Quintuple Helix framework, one that incorporates societal and environmental dimensions alongside academia, industry, and government.

This thesis contributes significantly to new knowledge by providing empirical evidence of universities' integrative roles in innovation-led regional development, while also offering a grounded framework for policymakers and academic leaders to rethink institutional strategies. It bridges the gap between theoretical models and practical application, emphasizing the strategic necessity of aligning university functions with sustainability imperatives and regional socio-economic goals.

Dedication

With profound gratitude to Allah, the Most Merciful, for granting me the strength and opportunity to fulfil this cherished dream.

This thesis would not have been possible without the heartfelt prayers of my beloved parents. Though I deeply wish my late mother could be here with me today, I find solace in knowing that your blessings and love have always been with me. May Allah grant you the highest rank in Jannat-UL-Firdous....Aameen.

I dedicate this work to my incredible wife, **Ayesha Asim**, whose unwavering commitment, strength, and encouragement have been the cornerstone of my journey. Ayesha, thank you for believing in me when I doubted myself, for your endless patience, and for being my rock through every challenge. Your tremendous support made this achievement possible.

To my children, **Iman Asim**, **Muhammad Daniyal Asim**, and my youngest son, **Muhammad Suleman Asim**, who was born during this journey, I owe my deepest gratitude. Suleman, your arrival brought immense joy into our lives, yet I regret that I could not spend as much time with you as I wished during these crucial moments. Iman and Daniyal, your smiles, love, and boundless energy sustained me when I needed it most. Your presence reminded me of my purpose and gave me the strength to persevere. Thank you, my beautiful children, for filling my life with love and inspiration. I love you all to the moon and back.

This thesis stands as a testament to the unwavering love, support, and sacrifices of my family. Without you, this journey would not have been possible.

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List of Abbreviations

SMEs - Small and Medium-sized Enterprises

BCU - Birmingham City University

STEAM - Science, Technology, Engineering, Arts, and Mathematics

STEM - Science, Technology, Engineering, and Mathematics

SDGs - Sustainable Development Goals

EUA - European University Association

PU - Plymouth University

UK - United Kingdom

HU - University of Applied Sciences Utrecht

VUCA - Volatile, Uncertain, Complex, and Ambiguous

CDR - Cross-Disciplinary Research

ECE - Early Childhood Education

R&D - Research and Development

DFV - Desirability, Feasibility, and Viability

REF - Research Excellence Framework

GDP - Gross Domestic Product

EU - European Union

KT - Knowledge Translation

MOOC - Massive Open Online Course

IP - Intellectual Property

AE - Academic Entrepreneurship

AI - Artificial Intelligence

HTS - High-Throughput Screening

LILA - Living Labs

SI - Social Innovation

U-I-G - University-Industry-Government

COVID-19 - Coronavirus Disease 2019

SBA - Small Business Administration

IPO - Initial Public Offering

GPS - Global Positioning System

NOD - Nottingham Obstacle Detector

CAS - Complex Adaptive Systems

HEIs - Higher Education Institutions

IPRs - Intellectual Property Rights

MIT - Massachusetts Institute of Technology

IT - Information Technology

EDA - Exploratory Data Analysis

GCF - Grounded Conceptual Framework

NVIVO - NVivo (software for qualitative data analysis)

QIS - Quantum Information Science

UIC - University-Industry Collaboration

CEBE - Centre for Business Innovation and Enterprise

EE - Entrepreneurial Education

UICs - University-Industry Collaborations

WIL - Work Integrated Learning

TM - Trademark

OTM - Office of Technology Management

AUBG - American University in Bulgaria

NSF - National Science Foundation

PDA - Proceeds Distribution Agreement

HE - Higher Education

ASC - Academy for Sustainable Communities

RISs - Regional Innovation Systems

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Chapter 1: Introduction

1.1 Background and Context

In the 21st century, universities are increasingly recognised not only as educational institutions but as pivotal change catalysts of innovation, economic development, and societal transformation. As global challenges such as climate change, inequality, and digital disruption intensify, the role of universities has expanded beyond traditional teaching and research. They are now expected to operate within complex ecosystems that require collaboration with industries, governments, and communities to address pressing regional and global issues. This shift necessitates a re-evaluation of the university's purpose, its engagement mechanisms, and its capacity to act as a sustainable innovation change catalyst.

The diverse sectors of modern society (e.g., information communication technology, economics, law, business, engineering, sociology, and health care) have shown replete developments in technology spotlighting innovation. The term innovation is explored and studied by various disciplines and is no longer embryonic, however, it is often confused with terms of change, invention, or creativity. A diverse range of innovative products (e.g., gadgets, tablets, iPods, and iPads) are used in the modern world but these lack in defining the aspects of innovation (Cai & Lattu, 2021). Different people have understood the term innovation differently and have ultimately raised diverse opinions among scholars and academics (Chulok, 2022). According to the New Oxford Dictionary of English, (2022), the term innovation is defined as, introducing something new while making changes to something already established.

According to Edgar & Kharazmi, (2022) innovation is neither required to occur exclusively to just products nor it must be radical in dealing with an individual entrepreneur, making businesses or larger organisations instead the concept of innovation is as relevant for several disciplines of life such as a hospital, local government or for a business. This leads to the understanding that innovation can occur in products, processes, and services. From an organisational perspective, it may occur at various levels (e.g., management groups, departments, project teams and individuals) and could be incremental or radical (Fischer et al., 2022).

According to Fernandes & Ferreira, (2021) to cultivate innovation, a university needs to address various problems that hinder the process. Insufficient funding, academic staff resources recognition for innovation activities, the role of universities, the role of SMEs as well and government support in modern-day universities are just some of the issues that should be addressed. Another problem is the absence of partnerships with the industry.

Innovation is no longer confined to the realm of technological advancement or entrepreneurial ventures. It now encompasses social, environmental, and systemic dimensions that require interdisciplinary collaboration and institutional responsiveness. Against this backdrop, this study explores how universities can contribute to sustainable regional development through innovation, entrepreneurship, and partnerships. The research focuses particularly on the UK context, using Birmingham City University, QA Higher Education, and Ulster University as case examples.

1.2 The Country's Government and Universities as Platform of Innovation

Universities play a pivotal role in driving technological development that meets human needs and social problems, through creating public-private partnerships to support technical inclusion and address barriers to entrepreneurship (Brundiers & Wiek, 2011). Developing novel forms of collaboration between businesses from knowledge sharing through ecosystem partnerships to value creation networking; that meet real human needs (Smith et al., 2014). A good example of how to promote university-industry collaboration is the Meyerhoff Scholars Program, started in 1989 by the University of Maryland Baltimore County, which works to develop a pipeline of diverse STEM students, particularly African-American ones. Other universities are following suit by increasing the number of women and under-represented minorities studying STEM fields. There is another example of Birmingham City University (BCU) STEAM house providing scholarships to students to pursue research based on their ideas.

1.2.1 Government's Role in Promoting University-Industry Collaboration

The government has a major role in promoting the collaboration between universities and industries since all stakeholders acknowledge its importance in innovation, growth of an economy, as well as societal progress This collaboration between universities and industries is established to link the gap between theoretical knowledge and practical implication. In this way, creating a dynamic ecosystem that benefits both sectors equally while serving society at the same time. A crucial role that the government should take is

to establish suitable policies to push for such an arrangement between universities and industries in those regions as described by Bartoloni et al. (2021). Through these focused policies, governments can tend to have various joint research projects, technology transfer agreements between both sides as well as exchange of expertise and tax breaks or grants enhance the favourable environment for innovation and entrepreneurship.

There is an additional role for government in creating research parks/centres and innovation hubs as physical locations to ignite collaboration between universities, industries. The places where researchers, students, and industry workers can collaborate on the cutting-edge projects. Creating the groundwork for these types of partnerships makes collaboration more accessible and appealing to both parties helping propels economic development further down its growth trajectory. A further way in which the government can promote university-industry collaboration is by implementing legal frameworks that would facilitate joint ventures (Watts & Dodds, 2007). These frameworks need to simplify bureaucratic procedures, cut down on red tape, safeguard intellectual property rights and offer guidance on how technology can be transferred or commercialized post-research. These are vital elements in building a robust relationship.

The government acts as an intermediary in matching universities and industries by using their network to gather the relevant stakeholders. In terms of organizational culture, by establishing meetings such as conferences, seminars and networking events that allow academia and industry to meet each other in learning sessions organised for both stakeholders to share ideas with a view to possible areas of collaboration the government can set up opportunities combining academia/industry interaction with problem-based life scenarios allowing positive results knowledge transfer (Scuotto et al., 2020). University industry collaboration needs a fundamental requirement of educational and skill development.

In addition, the government can fund programs that promote interdisciplinary education. This way shows students how theoretical knowledge, and practical capabilities are interrelated, thereby enhancing both graduate employability and the ability to prepare a workforce who can immediately be helpful in industry projects. Programs that can help to improve the collaboration between academia and industry include those with

opportunities for students to gain practical experience externally, such as internships or research facilities sponsored by the industry itself (Heidkamp, Garland, & Krak, 2021).

Governments can facilitate joint research centres involving academia, industry, and government to address the problem together. Investing in research initiatives that utilise national precedence and investment to concisely target inventive solutions for economic expansion can play a big role in catalysing innovation along with economic growth (Heidkamp, Garland, & Krak, 2021; Hansen & Ockwell, 2014). Revealing new technology developments or solutions to societal problems can all make more impression of being able to build that evidence base, proving once again the importance and impact of such university-industry partnerships.

1.2.2 Indirect Knowledge Transfer

The process of knowledge transfer from universities to businesses is the focus of university-industry collaboration, which is broken down into three categories: shared, indirect, and direct. As learning levels for innovation subjects increased, so did the degree of knowledge variance. Knowledge transfer was facilitated by cooperation among innovation subjects (Kang & Kraus, 2019). These characteristics led to higher collaboration efficiency. Direct and indirect knowledge transfer between organisations is necessary for improved innovation performance and technological innovation. Research is a critical component of innovation. It creates new products, promotes technological advantages, and contributes to the development of new products and services. Recently, technology has increased cooperation between researchers and higher education. Knowledge transfer occurs through various methods, including international cooperation, conferences, and exchange of researchers. Several factors have contributed to the increasing importance of research. While the SME-university collaboration is important, the process of knowledge transfer can also be indirect.

1.2.3 Relational Involvement & Institutional Setting

University researchers have identified a need for more relational involvement in the innovation process. This involves engaging in knowledge transfer, establishing mutual trust, and sharing resources. According to Schaffers & Turkama, (2012), this process is the first step of the helix model and, as such, can benefit future universities as well. The relationship between university research and industrial innovation is widely acknowledged among academics and industrial practitioners. Indeed, the volume of research in this field emphasises the need to translate academic knowledge into the

industrial domain. However, little attention is paid to the role of educational involvement in university-industry collaboration. The primary objective of universities is to impart knowledge and enhance competencies, but this role is often undervalued (Smith et al., 2014).

Several factors contribute to the success of a university's platform of innovation. As discussed by Cai, Ferrer & Lastra, (2019) these include the institutional setting, the research and teaching environment, and the research-to-industry pipeline. These factors influence the degree to which universities will benefit from collaboration with industry. The university's impact on the industry, for example, can be measured through co-patenting, funding, and the number of start-ups and scientists recruited (Scuotto et al., 2020).

As discussed by Kang et al., (2019) the dominant perspectives are embedded into the institutional setting of the university. These perspectives constrain the behaviour of individuals and organisations, while the latter is empowered to act (Scuotto et al., 2020). Moreover, the institutions have different pressures on the non-core innovation approach. Therefore, it is important to recognise these pressures and develop an approach to overcome them. By understanding the institutional setting of innovation, universities can make informed decisions about the direction and scope of their collaboration.

As discussed by Ståhlbröst et al., (2015) exploring how universities act as innovation platforms, researchers seek to uncover how academic knowledge translates into practical applications. Technology transfer plays a central role in driving innovation. Universities, with their diverse faculty and research centres, act as incubators of cutting-edge ideas and technologies that encourage creative thought and invention. Uncovering this aspect of university activity provides insights into how local industries may take advantage of the wealth of knowledge generated within academic institutions to encourage economic development in the area.

Universities play a vital role in regional development by contributing to skill development and human capital building. Research conducted in this area explores how universities educate and train the workforce with the necessary skills for emerging industries. Coordination among universities, local industries, and job markets allows educational programs to better fit with job market requirements; understanding how universities contribute to skill development helps craft policies which enhance the employability of graduates thus fuelling economic growth and prosperity within regions (Ribeiro & Bao,

2021). Universities play an essential role in nurturing an entrepreneurial ecosystem. By studying universities as change catalysts, researchers seek to elucidate how these institutions support and nurture startups and innovation-driven enterprises. Furthermore, universities often attract talented individuals who encourage an atmosphere of risk-taking that encourages a culture of entrepreneurship; studying their dynamics as change agents provides invaluable insight into how regional economies can leverage startup innovation potential to generate jobs and stimulate economic development.

1.3 Purpose and Scope of the Study

The primary purpose of this research is to investigate the extent to which universities are positioned and can be strategically enabled to act as entrepreneurial and sustainable innovation hubs that influence regional development. This study addresses a significant gap in current literature by linking the conceptual frameworks of entrepreneurial universities and sustainable development, extending the Triple Helix model to the more inclusive and socially conscious Quintuple Helix model.

The scope of this study is both theoretical and practical. Theoretically, it contributes to the evolving discourse on university-industry-government collaboration, innovation ecosystems, and sustainability. Practically, it offers insights into institutional practices, stakeholder engagement, and innovation mechanisms that support sustainable regional development. This research is particularly timely as policymakers and educational leaders seek to realign universities with national and regional development agendas post-COVID and amidst evolving socio-economic challenges.

1.4 Research Aim

The aim of this research is to analyse the role of universities as sustainable innovation change catalysts that contribute to regional development through entrepreneurship, collaboration, and social impact.

1.5 Research Objectives

To achieve this aim, the study sets out the following key objectives:

1. To explore the extent to which universities are acting as entrepreneurial leaders in innovation ecosystems.

2. To identify the mechanisms through which universities function as innovation catalysts.
3. To determine how universities contribute to promoting and sustaining regional development.
4. To explore the institutional, policy, and societal factors influencing universities' innovation capacities.
5. To propose a conceptual model that repositions universities within a sustainable regional development framework.

1.6 Research Questions

The central research questions guiding this investigation are:

1. To what extent are universities acting as entrepreneurial leads within their regions?
2. What mechanisms enable universities to function as sustainable innovation change catalysts?
3. What strategies and partnerships are required to enhance universities' contribution to regional development?

The research questions are discussed fully later on.

1.7 Research Rationale

The rationale for this study stems from the growing recognition of universities as pivotal drivers of innovation and development in an increasingly knowledge-driven economy. While previous studies have examined university-industry collaboration, few have explored the holistic and sustainable roles universities can play within a regional development framework. This research seeks to address this gap by investigating how universities can actively shape innovation agendas, engage stakeholders, and generate positive societal impacts beyond their academic boundaries.

By examining the internal and external conditions under which universities operate, this study contributes to a deeper understanding of how higher education institutions can reframe their missions and practices to support long-term, sustainable, and inclusive regional growth.

1.8 Structure of Thesis

This thesis is structured into six chapters.

Chapter 1 introduces the research topic, presents the background and rationale, and outlines the aims, objectives, and research questions.

Chapter 2 offers a comprehensive literature review, critically examining key theoretical frameworks such as the Triple and Quintuple Helix models and identifies gaps in the existing research. Together with the context given in chapter 3, Potential research questions are also identified.

Chapter 3 provides a contextual overview of the evolving role of universities in regional development and innovation.

Chapter 4 explains the research philosophy and the methodology used, including the multi-method research design, data collection procedures, and thematic analysis using NVIVO.

Chapter 5 presents the data analysis and findings, drawing out thematic insights from the focus groups and secondary data.

Chapter 6 concludes the thesis with a synthesis of key findings, theoretical contributions, policy recommendations, limitations, and suggestions for future research.

Chapter 2: Literature Review

2.1 Overview of Innovation

The practical implementation of ideas in a creative way to respond to a change which may include conducting new research and development, generating new ideas, improving processes, and services, or revamping products is innovation (Hansen & Ockwell, 2014). A particular business or organisation can be linked to this mindset where executives and staff continuously focus and think about bringing improvements.

According to Majeed et al., (2016) user innovation and entrepreneurship have a growing body of literature addressing systematic innovation not only in small- or large-scale businesses but also in academic environments. The literature is still embryonic and does not extensively explore the impact of community uses on entrepreneurial activities and sustainable performances through innovation concepts. The innovation methodology has gained significant popularity, particularly in universities. Modern universities provide real-world locations to analyse and conduct research along with measuring the performance of those experiments and innovations for a sustainable future (Findler et al et al., 2019). Further discussed by Provenzano, Seminara & Arnone, (2020) universities provide an important stage where community users can work collectively within in a favourable environment while expressing their skills to develop ideas into concentrated projects. Many universities in the UK have adopted this concept and continuously growing and merging it into their several programs that involve the user community, university staff, management, researchers, and students (Acosta, 2019).

According to Waheed, (2017) the advancements in technology and the effects of globalisation have had a significant impact on research and development (R&D) practices, as well as the conduct of businesses and entrepreneurial activities worldwide. Modern research and development (R&D) have transformed its conventional approach of technological research, invention, and entrepreneurship, which was primarily conducted by corporations and government entities within laboratories. Ultimately, this shift has given rise to a broader, contemporary, and methodical type of innovation, facilitated by notions such as systematic innovations. This collaborative process encompasses a diverse range of stakeholders which includes universities, public agencies, institutes, users, and individuals who align with the principles of user and open innovation. Together, they engage in co-creation, co-development, co-innovation,

testing, and enhancement of existing and emerging technologies, services, products, and systems within real-world contexts. However, the extent to which this notion truly enhances user engagement in innovation and entrepreneurship must be ascertained (Hasche, Höglund & Linton, 2019).

According to Lopes, Farinha & Ferreira, (2019), it is crucial to conduct a comprehensive assessment of the outcomes achieved in innovation projects, with active involvement from community users. Therefore, the investigation into systematic innovations inside universities will shed light on the significance and function of community users in the innovation process. It will also aid in comprehending the extent of user involvement and contribution in their projects using this concept. The concept of innovation facilitates user entrepreneurship by enabling the transformation of their ideas and initiatives into marketable products, services, and apps, ultimately leading to the establishment of a firm (Cai & Lattu, 2021).

2.1.1 Types of Innovation

There are several types of innovation, and these include Entrepreneurial innovation, Radical innovation, Incremental innovation, sustainable innovation, Business model innovation, Product innovation, Organisational innovation, Process innovation, social innovation, Transformative innovation, Systematics innovation, Open innovation, and Disruptive innovation.

Figure 2.1: Types of Innovation

(Source: Wang et al., 2021)

There are many examples of each kind of innovation and in this thesis, the researcher discusses them.

2.1.1.1 Entrepreneurial Innovation

The definition of entrepreneurial innovation was first developed by Joseph A. Schumpeter in "Theory of Economic Development" in 1905. In this work, he defined innovation as a new combination of processes, products, or services. According to Elias, (2021) an entrepreneur can develop an innovative product or service. While the term innovation is subjective, it has strong ties to the concept of entrepreneurship. Entrepreneurial innovation involves the creation and marketing of new products or services. The power of creativity in an innovative society explores various forms of innovation and asserts that entrepreneurial innovations are essential for fundamental change in society (Wang et al., 2021).

2.1.1.2 Radical Innovation

According to Yiu, Lau & Bruton, (2007) in today's world of digital disruption, incremental innovation will not cut it anymore. To stay competitive, they must continually disrupt existing systems and offer new, disruptive business models. If they can embrace radical innovation, they will stay on top of the industry (Stirling, Maxey & Luna, (2013). In addition, radical innovation can help the business build a loyal following by providing superior products and services through it will not happen overnight. It takes practice and failure. According to Smith et al., (2014), the first step in defining the innovation process is deciding what constitutes a radical innovation and this could be the development of a brand-new product or service. It could also be new technology or a better process. But what is the difference between incremental innovation and radical innovation? Generally, incremental innovations are more cost-effective and require fewer resources to develop, whereas radical innovations are riskier. In addition, radical innovations take longer to become profitable.

2.1.1.3 Incremental Innovation

One of the most profitable innovations is incremental. A product can be improved by making small changes that are responsive to customer needs and preferences. The third type of innovation is the addition of new features to existing features. Designers and manufacturers are responsible for creating innovations that can lead to greater adoption. The trick here is to introduce new features without overburdening customers because

they don’t want to pay for features, they do not need. The concept of incremental innovation is an effective tool for rapid growth and high profitability.

According to Nidumolu Prahalad & Rangaswami, (2009), the goal of incremental innovation is to improve and extend a known product or service related to assessment and response. Bertrand, (2010) further described it as adding new ideas to an existing product or service to improve its quality or customer benefits. In this process, a strong opinion patent is not required. Large Organisations should consider the process of increasing innovation as a distributed process throughout the organisation (Clifford & Petrescu, 2012). According to Ståhlbröst et al., (2015), the development of centralized systems will be very slow and may lead to bottlenecks. Rather than horizontal innovation being implemented across the enterprise, sharing tools and experiences between teams can help teams adopt new ideas faster Organisations should strive to avoid creating silos and ensure they can drive innovation and prediction. This helps promote a culture of continuous improvement.

2.1.1.4 Sustainable Innovation

According to Rouxle & Pretorius, (2016) sustainable innovation addresses the growing consumer demands for a more sustainable world. By creating more sustainable products and services, businesses can improve their economic performance and create a more stable, fair, and healthy environment (Majeed et al., 2017). The need for sustainability is only going to increase as the world's population continues to grow, and environmental concerns will rise. Non-sustainable businesses will be left in the dust as they attempt to compete with those that are committed to being more sustainable.

2.1.1.5 Business Model Innovation

According to Lozano, (2006) the concept of business model innovation refers to a new technology or a new way of doing things creating a strong competitive advantage. It can even disrupt industries that have long been established. The challenges of business model innovation are many making it crucial for executives to have a solid understanding of the different stages of business model innovation and apply that knowledge in making key decisions about new business models (Maruccia et al., 2020).

Business model innovation is one of the most challenging types of innovation because it involves radical changes in the way a company generates value. Its change in the business model can have a profound effect on an industry. Meanwhile, process

innovation involves improvements to internal processes and can be moderately disruptive. In terms of risk, process innovation is the least risky form of innovation. The focus is to improve internal processes while driving revenue. As surveyed by Zabala-Iturriagagoitia et al., (2021) 90% of business model innovations are a fusion of existing models, they often come from different perspectives. Regular approaches to business model innovation focus on using existing capabilities and ensuring that existing markets retain competitiveness (Trivellas et al., 2021). Often, these new models are based on old firms' existing products and services, and they can have substantial control over the market. Therefore, entrepreneurs must understand the value of business model innovation.

2.1.1.6 Product Innovation

The concept of product innovation arose when the computer was first invented. Since then, computer technology has evolved from giant computers to personal computers and smartphones. According to Trencher, Terada & Yarime, (2015) product innovation has increased the number of options in the marketplace and made it possible to manufacture these products in bulk at a lower price. However, the process of product innovation is not as simple as it sounds. There are three main types of innovation. For a product to qualify for an innovation award, it must solve a problem for consumers, be able to address the issue at hand and be superior to competitors.

In today's world, product innovation is essential for a company's growth and survival. According to Zhou & Wang, (2020) technology continues to advance and customer needs change. Every business innovation raises efficiency, facilitates structural reforms, and/or enhances the performance of a good or service (Valle, Gantioler & Tomasi, 2021). Product innovation enables businesses to find an audience and escape oversaturated markets. New goods and technology not only increase the overall usefulness of the good or service but also give businesses a competitive advantage.

2.1.1.7 Organisational Innovation

Since Organisational innovation is still a relatively new idea, more research is needed to properly comprehend both its advantages and disadvantages. Determining aspects that encourage innovation within an Organisation is also challenging. Organisational innovations do, however, have a few key traits in common. These include novelty, technology use, and the development of fresh Organisational structures and forms. Thomakis & Daskalopoulou (2021) state that the term "innovative Organisation" can

refer to a wide range of ideas and elements of the creative process. It is an idea that covers Organisational forms, procedures, and structures as well as numerous managerial facets of innovation. It has the strongest resemblance to the innovation typology created by Tiekstra & Smink, (2021). These typologies focus on the role of the organisational innovation process.

According to Secundo et al., (2019) technological and organisational innovation are closely related, but their relationship is not deterministic or simple. Organisational innovation can either be the result of technological innovation or be a prerequisite for successful technological innovation. Existing studies have focused on the relationship between technological and organisational innovation and the antecedents and consequences of the two types of innovation (Dechezleprêtre, Glachant & Ménière, (2008), Buabeng-Andoh, (2012), (Hasche, Höglund & Linton, (2019), Gallardo-Vázquez et al., (2021). The goal of organisational innovation is to improve productivity, profitability, and overall performance. However, it cannot replace technological innovation. Technological innovations always include practical tools. New technologies make it easier to provide these tools.

The researcher expresses that the boundaries between technological and organisational innovation would begin to blur, and organisations would be increasingly influenced by organisational technology. To better understand how to improve organisational innovation, the researcher considers this area of research from a sustainable perspective.

2.1.1.8 Process Innovation

Process innovation involves introducing new ways to produce a product or service. According to Heidkamp, Garland & Krak, (2021) although less visible to customers, process innovation is still an important part of modern production. It can result in more efficient and timely production, as well as less waste. The manufacturing industry is a prime example of process innovation, but even service companies can use it to improve their processes (Theodoraki, Dana & Caputo, 2021). The benefits of process innovation may be hidden from customers, but the advantages to the company are great.

In the manufacturing industry, it can significantly improve productivity and product quality while reducing costs and enhancing service levels. Process innovations can also

improve warehouse asset management, boost supply chain performance, and improve key metrics such as employee satisfaction (Espinoza-Sánchez, Peña-Casillas & Cornejo-Ortega, 2022). An example of process innovation is automating replenishment orders. Before, employees would manually go through the product line to determine the quantity needed. This process is time-consuming and prone to under and over-stocking. Now, the employees can simply select the quantity they need to order. Process innovation also makes it easy to visualize and communicate. Automation can also increase profitability and service lifecycle. For example, a new automated assembly line in the manufacturing industry could make the production process more efficient Ali, (2021).

2.1.1.9 Social Innovation

Unlike technological innovation, social innovation involves individuals overcoming the limits and rules of society. Individuals create new ideas and solutions to existing problems that society has created. The results are often a benefit to society. This is the goal of social innovation. Social innovations could not only solve social issues but also open new markets for goods, services, and procedures.

Organisations must initially understand social innovation to successfully implement it. This kind of innovation deals with transformations, new modes of labour and collaboration, and the creation of a society that is more sustainable. The process of innovation known as responsible innovation considers the effects that the research's findings will have on society and its actors. Other factors to consider for responsible innovation are ethics, open access, and gender equity.

The goal of this innovation is to support diverse needs, which call for significant investments in institutions, infrastructure, equipment, training, human capital, and Organisational structures. The ability to execute multiple types of innovation at once makes the new regulatory framework especially favourable to social innovation. Coordination of planning, coordination of priorities, and a well-thought-out mainstreaming mechanism are all necessary for social innovation.

Moreover, group idea generation is the engine of social innovation. As such, a diverse range of actors are involved in it. A multidisciplinary approach is also involved. It also highlights the significance of the human element in innovation and the part that communities and Organisations play in it. It emphasizes institutional interdependencies and is predicated on the value of group idea generation. It is simpler to choose the best

innovation process to use when the different elements that lead to social innovation are recognised.

2.1.1.10 Transformative Innovation

There are no simple solutions, but a single resource that is influencing our world is the innovation pocketbook. This tool has been developed by the International Futures Forum since 2001. The Innovation Pocketbook describes transformative innovation's advantages and methods. Ultimately, it aims to make the world a better place.

According to Datta, Saad & Sarpong, (2019) embedding innovative practices requires trusting employees. If organisations want to attract and retain top talent, demonstrating a commitment to innovation is a great recruiting tool. In short, transformative innovation is when an entire system is shifted into a different framework, creating a new, more profitable, and more sustainable business. Transformative innovation often requires a completely new business model, but it also often generates substantial commercial and cultural rewards (De Bernardi & Azucar, 2020). But this large reward comes with a great deal of risk.

To create a product that will be successful, start with an initial vision for its long-term impact. Next is to develop a sequenced user adoption strategy. By integrating these two strategies, organisations can lay the foundation for long-term success. This approach is often the most efficient method of creating transformative innovations. It involves many review points. In the process of creating new products, organisations should be able to make changes that will benefit a larger population and ultimately, the company.

2.1.1.11 Systematic Innovation

Systematic innovation universities possess the power to generate knowledge that transforms society by way of new products (Lewis, 2013). Such innovation will assist in solving today's most daunting problems while creating greater business success opportunities than ever before. However, to effectively innovate in a complex environment, a method must be employed that guides the team in correctly defining the problem at hand and prevents wasted time on ineffective solutions that look attractive on paper but turn out to be flawed (Liening et al., 2021). By employing the tools of systematic innovation provided by TRIZ, it's possible to accurately identify and state problems, craft great concepts for solving them, and select those with potential (Liyanage & Netswera, 2021). Most engineers and technical professionals don't learn

this skill due to an educational system which emphasizes strong analytical capabilities over teaching them how to recognize opportunities, articulate them clearly, and come up with solutions (Lo & Theodoraki, 2021).

The second generation of systems approaches developed methodologies and techniques for making people's thinking more systemic and stressed the significance of dialogue processes that allow stakeholders to explore multiple boundaries, purposes, and values relevant to an innovation initiative (Liyanage & Netswera, 2021). Through metacognitive thinking - exploring all possibilities involved with any given project -- participants become more aware of their economic, social, and environmental responsibilities; it allows reframing if stuck; anticipate potential negative repercussions of an innovation while anticipating those which might constitute positive value; these types of thinking also allow participants to reframe when stuck and anticipate both negative as well as those which might represent positive value when considering its implementation (Lo & Theodoraki, 2021).

However, translating our understanding of systematic innovation to practical applications has proven challenging (Lewis, 2013). A key reason could be due to a lack of an evaluation framework for universities to measure and assess their capacity to promote and facilitate systematic innovation (Liening et al., 2021). Our proposed framework attempts to address this gap by highlighting key factors affecting a university's systematic innovation capacity (Liyanage & Netswera, 2021).

This framework draws from literature on entrepreneurship and institutional innovation within firms (Fayolle, Gailly & Lassas-Clerc, (2006); Hansen & Ockwell, (2014). Living systems theory (Miller 1978; Johannesson 2013) distinguishes between economic innovations that produce new products and services and institutional innovations which affect governance metasystems that enable or restrict economic activities. This framework addresses two forms of innovation through systematic collaborations among universities, businesses, and government agencies. This process emphasizes creating an organized approach for managing collaborative networks based on shared methods; creating an Organisational culture conducive to entrepreneurial practices; as well as offering several recommendations for research and practice.

2.1.1.12 Open Innovation

Alongside various innovation methodologies, there exists the Open Innovation (OI) strategy (Goddard, Hazelkorn & Vallance, 2016). Open innovation has become an

indispensable tool for businesses seeking to stay ahead of the competition and stay innovative. While there are various methods and approaches for using open innovation, selecting the appropriate solution for innovative ideas is paramount (Cockurn, 2006). No matter if the goal is to expand the open innovation capabilities of the development team or simply accelerate and enhance projects, finding the appropriate tools can make all the difference. Selecting an open innovation platform may seem intimidating at first but university students and mentors should take the time to carefully vet and shortlist options before investing in development (Etzkowitz & Leydesdorff, 2000). Testing drives an open innovation platform before investing can give you an understanding of its functionality; many providers provide free trials or pilot evaluation programs so you can get hands-on experience before determining if it suits the business or not.

Universities were traditionally seen as providers of knowledge and ivory towers (Haites, Duan & Seres, 2006), yet today universities are seen more as active agents capable of revitalizing society through multidisciplinary collaboration that generates innovative solutions to social, public, and productive problems. External networks encourage these interactions while the academic community also facilitates them. As part of their digital transformation efforts, UK universities today exhibit high levels of engagement with innovation ecosystems and the local business world to produce social, economic, and environmental value creation. However, their relations may be complicated due to heterogeneity and inequality that dictate such interactions between stakeholders (Schaffers & Turkama, 2012). To assess the relationship between university-enterprise interaction and open innovation, Lozano, (2006) analyses the role that academic community profiles and innovation and technology management as mediators play.

Open innovation provides an effective means of connecting universities and local enterprises. This process depends on interactions among various exogenous and endogenous factors. Functional university open innovation hinges upon having an effective operational innovation policy, an interdisciplinary approach, and the presence of an academic community (Athreye & Cantwell, 2007). Innovation ecosystem development does not depend on public resources being allocated or technological developments taking place within it, however, new models of interaction between universities and innovation ecosystems must be established to strengthen ties between them and universities; operating new models that prioritize interaction with ecosystem and knowledge production oriented toward specific purposes is key in this regard; both

universities and states face the challenge of accomplishing this goal together (Buckley & Casson, 2009).

2.1.1.13 Disruptive Innovation

New markets can be uncovered because of disruptive technologies. It can make a piece of technology that might otherwise be out of reach available in low-income markets. To attract customers who have less disposable income, the makers of the new, subpar product have made it more portable and hence cheaper (Burke, 2007); Jerzmanowski, 2008); König & Evans, 2013). Over time, the previously uncompetitive disruptive product becomes more so. Christensen discusses more than just low-level disturbance. New market disruptions directly compete against high-end, high-cost products (Foray, 2009). The fields of education and medicine are not safe from the effects of technological change. Traditional education is being displaced by distance learning, which now accounts for a sizable and growing portion of the education sector. Online courses became less subpar and began competing with regular universities as technology for online instruction improved (Finley, 2003). Education and healthcare that are both high quality and reasonably priced are critical on a regional, national, and international scale.

Most patients are beyond the scope of care for highly trained physicians. Health care can be enhanced by developing new technologies that require less close medical supervision and allow for more self- or practitioner-monitoring. New, disruptive technologies enter the market with lower-priced offerings and a new set of customers. Eventually, the original market will embrace the substitute when it has had enough time to catch on and benefit from technological advancements. As time goes on, it becomes recognised as a strong contender to the items offered by well-established corporations. Managers' perspectives are formed by experience and the current customer base, which prevents them from seeing the impact of disruptive innovation, according to (Ferrer-Balas et al., 2008); (Jonker & Pennink, 2010). They are missing out on new business prospects and countering newcomers by focusing on their current clientele Hong et al., (2019) argue that even huge Organisations may survive in the face of competition from disruptive low-end items.

The ability to operate independently of the parent company's resources, values, and processes is crucial to the venture's success. Buying an existing company whose values and processes are well-matched with the objectives of the new product is another competitive strategy for major Organisations. Successful businesses that choose to

invest in disruptive technology run the risk of not just shifting focus away from their present portfolio of products, but also of being pushed out of business entirely. Any successful business leader will tell you that taking calculated risks is one of their biggest challenges (Evans et al., 2015). Successful businesses will be those capable of disrupting themselves (Farinha et al, 2020).

It's not necessarily the most cutting-edge technologies that cause disruption. Most of these solutions are hybrids of preexisting technology or procedures that combine to provide accessible, low-cost options. Disruptions in existing systems and procedures will result in novel approaches that will not only enhance but also save people's lives. When difficulties arise, we rise to the occasion and develop new approaches. The COVID-19 virus altered our world in the year 2020. It would be fascinating to see where this leads us. As a species, we have adapted to new technologies and grown as a result. There are now more online courses than ever before and new methods of conducting meetings have been developed to help save small firms. People's needs for Organisational goods have changed as they've learned to adapt to the realities of working remotely.

2.2 Living Lab: A Co-Innovation Platform

Living labs are open innovation ecosystems characterised by systematic co-creation processes that involve individuals in research and innovation processes taking place within real-life communities and settings (Budwig, 2015). Such labs allow people to become active participants in science processes themselves. With his experience gained through participating in the Liveable Cities project, he has used this concept to incorporate it into Birmingham's strategy for greener, fairer, and healthier places (Burke, 2007). With an increasing emphasis on impact in research environments, this lab offers support for collaborative projects focusing on co-creation through monitoring and evaluation methodologies (Cai et al., 2020). Furthermore, it explores both their challenges and benefits with non-academic partners (Cai, Ferrer & Lastra, 2019).

This hands-on approach to solving complex social problems through student interaction with external partners – the local councils and companies in Birmingham City University students' work have given them a deep understanding both challenges they face in real-life societies as well as improved their research acumen and problem-solving skills (Cai et al 2020). Benchmark 3: The extent to which problem-driven research is integrated in the University's culture of research(outputs) Moreover, this form of work leads the

institution to bring academia and policymakers closer as the intermediation between academia and policymaking actors is one of institutions' connecting functions provided (Calignano & Jøsendal, 2018).

A separate team of Birmingham City University students, in collaboration with local authority colleagues, found an innovative way to address issues surrounding climate change and sustainability in urban areas (Carayannis et al., 2021). Their efforts helped inform Birmingham's current 'City of Nature' plan - a 25-year framework to become more "biophilic" (Chen et al., 2020). Living Labs were created to reduce the risks of innovative solutions with potential high returns, by ideation and experimentation within real-life settings and then incubating these using emerging technologies (Chulok, 2022). Infosys draws upon its culture of innovation as well as an expansive ecosystem including customers, startups, universities, and emerging technology alliance partners to drive joint innovation within Living Labs. Birmingham serves as an experimental laboratory for numerous social issues. As such, its social milieu includes income polarization, urbanization, health disparities, migration flows, security concerns, and environmental protection as key themes (Budwig, 2015). The M&E lab is providing a practical response to current concerns regarding co-creation and collaborative research by developing methods for the impact evaluation of media and cultural projects in academic as well as non-academic settings (Carayannis & Campbell, 2019). Given the change in emphasis that REF requirements have made to impact evaluation, this work has never been more important.

The Project enables customers to test new, promising, and innovative solutions with a high return on investment and low risk potential in safe sandbox conditions that do not touch the customer's funds or resources (Chen et al., 2020). Projects presents a novel way for researchers and policymakers to engage, building these relationships that are integral to interactions around science-engagement work is an important part of developing meaningful connections. But difficulties remain – in particular, concerning how the new concept is framed and defined because there are varied perspectives on what productive participation means and how to nurture an environment for generating these collaborative ideas (Chulok, 2022). This special issue attempts to unpack these aspects from different angles and experiences to establish a kind of common language for making sense of this developing concept. The bottom line in any product's success is how well it delivers to a customer's critical needs and wants, or that all-important

criterion for commercial success (Budwig, 2015). Design thinking offers a method framework where we can address these requirements as Desirability, Feasibility and Viability (Burke, 2007). Teams that grasp these three criteria and how they play off one another (regardless of the focus of their project) can use this knowledge to drive out refined ideas which align with target targets. The Desirability Feasibility and Viability (DFV) is a holistic business model to guide companies in developing minimum marketable products that are both desirable by users and service a particular user need, while also being feasible on an organizational level and sustainable for themselves (Cai et al. 2022).

With product desirability, this should initially be considered during the ideation process of innovation through generative research and experimentations. It is then continually evaluated throughout development with a prototype, pilot/pioneer group analysis and finally assessing to a wider customer base (Cai et al., 2022)! An evaluation should help you understand customer pain but also identify features to build, as well if the product solves meaningful customer problems. Meanwhile, the product designs of teams must satisfy technical feasibility due to afforded resources at a time. (Cai et al., 2019) This also considers technology, cost, and timelines constraints on whether they are compatible with current system or is likely to influence legal or regulatory issues (Calignano & Jøsendal, 2018).

Desirability, feasibility, and viability are the three pillars of Thgersen's (2007) paradigm for launching innovation in the context of living labs.

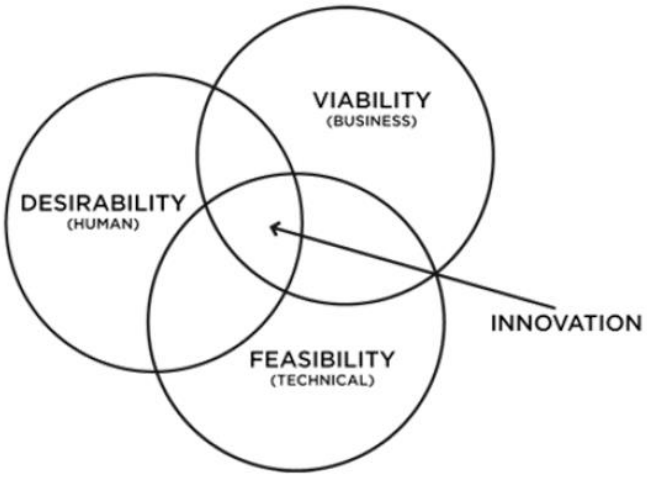


Figure 2.2: Pillars of Innovation Paradigm

(Source: Thøgersen, 2007)

By emphasizing the importance of the relationship between the customer and the provider, Thgersen (2007) explains how co-development differs from co-innovation topologies. Users' input has led to the development of novel approaches to improving the service delivery process. As opposed to being passive observers, users are expected to participate as active builders (Hansen & Ockwell, 2014). Therefore, they argued that the collaboration of research Organisations, users, and suppliers has a huge impact on the novella tea of innovation, while on the nvelother side collaboration with competitors could hinder the business. Organisations are drawn to the co-innovation strategy because of the dynamic interplay centred on fundamental knowledge between competitiveness and collaboration (Jonker & Pennink, 2010). Clusters of new ideas for project-based businesses emerge from cooperative studies with other businesses working toward the same objective (Smith et al., 2014).

This project was a collaborative effort between Birmingham City University and the Living Labs community, with the shared goal of creating a cane for the visually impaired. Lifecycle development of this cane was carried out within a living lab at Birmingham City University, with participation from a wide range of students, researchers, electronics engineers, and computer scientists. The project was funded in its entirety by Living Labs.

2.3 Universities as an Innovation Catalyst

Encouraging technological advancement in developing industries can be achieved using universities as an innovation catalyst. Though many are unaware of their full potential, universities are currently the primary source of new ideas in the United Kingdom. The Catalyst for Innovative Partnerships program was successfully launched by Birmingham City University (BCU) in 2015 as an innovation festival, and it will continue to run until 2023. It is recommended that different teams deepen their multidisciplinary cooperation to establish centres and look for answers to worldwide issues. Universities can support innovations in a variety of ways, such as:

2.3.1 University-Hubs

Arora, Fosfuri & Gambardella, (2002) state that university hubs, which serve as catalysts for innovation, experience several difficulties. They have limited funding cycles often a year and must complete a wide range of tasks in that time. Apart from the financial obstacles, the hubs also must deal with contextual and administrative problems like power outages (Beiske, 2007). However, these Organisations have shown to be successful collaborators in promoting innovation despite their difficulties.

As per Buabeng-Andoh's (2012) case study, the implementation process of a network of university hubs was investigated. Documentation, team conversations, and post-implementation surveys were the sources of the data. A modified policy analysis framework was used to analyse these data. The study's findings may vary slightly amongst nations. In addition, there may have been differences in focus in terms of geography, and different implementation approaches could have affected the results. Furthermore, language barriers may have affected the success of the implementation of the hubs in different countries. As such, a cross-country comparison of the experiences of hubs may not be possible. The use of digital strategies in pedagogy could lead to innovative learning experiences (Athreye & Cantwell, 2007). By leveraging digital technologies, a university can improve the student experience through new pedagogical approaches and create efficiencies in assessment. Digital learning innovations may also impact institutional initiatives on a large scale. As discussed by König & Evans, (2013) these innovations may arise from novel pedagogical approaches in individual courses, collaborative experiments across disciplines, and student feedback. The University as innovation catalysts is committed to enabling new ideas.

According to Clifford & Petrescu, (2012) storytelling was very important and a key component to the success of the hubs, as it helped in overcoming factual interpretations. University hubs as innovation catalysts are vital for attracting the next generation of faculty, students, and corporate partners (Budwig, 2015). They must provide the right kinds of technical facilities and supportive amenities to attract researchers and innovators. It is vital to include amenities for students and their families, as well as housing and cafes. Ultimately, an innovation hub's success depends on its tenant mix, which is crucial to its success (Kulikauskienė, 2021).

2.3.2 Science & Technology Parks

There are many benefits of universities as innovation catalysts for science & technology park development, including commercialisation. The Beauce region of Canada has numerous small innovation centres, but none have critical mass. A study by Cunningham & O'Reilly, (2018) identified the need for more research on science parks. In addition, Žemaitis, (2019) argued that science parks should be oriented within technology departments of the universities.

Various studies have investigated the benefits of universities as innovation catalysts for science & technology park development (Lozano, 2006., Comin, Hobijn & Rovito 2008.,

Brundiers & Wiek., 2011, Wendin et al., 2015). One aspect of the park development process is the attraction of talent. This may include attracting specific knowledge or reaching highly skilled workers. The Park manager must understand the needs of a firm to attract talented individuals. According to Budwig, (2015) universities are a key source of talent, and informal and formal collaborations with universities can benefit science parks.

Further discussed by Evans et al., (2015) universities and science parks help firms overcome barriers to innovation. University R&D investments can provide additional income and experience with real-world problems. In addition, universities may act as knowledge intermediaries, searching for local and non-local knowledge that can benefit firms and enhance their innovative capabilities. In general, government and regional development organisations are promoting universities' role as innovation catalysts in science parks. This type of relationship is a significant advantage for both parties.

A science park serves as a meta-organisation that supports innovation and helps firms start new companies (Bencke et al., (2019). The role of universities as innovation catalysts in a science park is emphasized in various publications (Sachs, 2018; Scuotto, 2020). As intermediary structures around universities, science parks are important in the knowledge generation and diffusion subsystems. Furthermore, universities are critical in developing new firms, which can be part of a science par and as a result, universities play a key role in developing local economic development (Elsamny & Gianoli, 2022).

Science parks and university hubs can collaborate to build a vibrant ecosystem that supports startup businesses. Research parks aid in the professional development of researchers and draw in industry. They can also support academic institutions in cultivating an entrepreneurial mindset. Science parks have benefits, but they are not for everyone. They must possess both flexibility and a long-term outlook. Universities can serve as research catalysts to develop a cluster of capacity in an area, draw in new companies, and improve the standard of living.

The most evident advantage of universities acting as catalysts for innovation is their ability to support the expansion of tenant companies. Universities can gain access to the intellectual capital of academic staff by collaborating with them as their incubators. These professionals can offer guidance on starting a new business. Moreover, universities also have access to many new ideas that may help tenants grow. Moreover, they can also be a good source of talent attraction for tenants.

2.3.3 Industrial Innovation Campuses

The role of universities as innovation catalysts on industrial innovation campuses is gaining momentum as companies increasingly recognise the value of university knowledge (Smart et al., 2019). Lancaster University 2019 has launched two new initiatives to encourage business innovation. These programs will use the University's Innovation Catalyst program to help students develop innovative ideas and identify University expertise that can help businesses solve their problems. These programs will be supported by the Community Renewal Fund (Meissner, Gokhberg & Saritas, 2019).

In addition to universities, many leading companies and research institutions are creating industrial innovation campuses that are integrated with universities. According to Vallance, Tewdwr-Jones & Kempton, (2020) these collaborations provide an ideal platform for innovation which leads to university-industry partnerships built upon university research and the development of creative solutions to address the challenges. They also encourage interdisciplinary research and translational partnerships. This partnership also allows companies and academics to expand their reach. Further, the innovation districts serve as a hub for bringing together companies, universities, and research organisations (Shabanov et al., 2021).

A recent study conducted by López-Rubio, Roig-Tierno & Mas-Tur, (2021) showed that the university's research and development activities could be strengthened by establishing technology licensing offices. The university's Intellectual Property Resource Centre can help identify and develop intellectual property assets that can benefit the region's economy. Further discussed by Elsamny & Gianoli, (2022), such programs could also help the universities earn royalties from companies and sponsor research. The goal is to grow both the regional economy and the university. These partnerships and alliances will enable the creation of new companies within this area.

Moreover, in pursuit of academic research, institutions must also facilitate an environment that enables collaboration between faculty members and industry (Rosenberg, Trencher & Petersen, 2015). Together, these partnerships need to address the thorny issues and deliver world-class infrastructure and long-term services so that all Australians take pride in their national heritage, nor should they be fearful creating a safe space for diversity of narrative.

(Diniz et al, 2019). In addition, the atmosphere ought to be supportive of business, with faculty members receiving remuneration for their inventions, mentorship, and academic achievement. The effectiveness of a university should be evaluated based on its capacity to establish solid public-private alliances and develop an atmosphere that encourages business ventures (Zhang, Chen & Fu, 2019).

University partnerships with industry are just one goal; another is to establish a collaborative culture that promotes innovation. Among the events Silicon Catalyst has hosted are multidisciplinary courses on company building and collaborative panel discussions (Zhang, Chen & Fu, 2019). In addition, the university's campus offers capstone project mentors, internship programs, and a vibrant environment for faculty members to conduct research. Universities can act as innovation catalysts on industrial innovation campuses in addition to promoting collaboration (Scuotto, 2020).

Universities are becoming more and more important on campuses of industrial innovation. Universities can collaborate with business and industrial innovators through the Research Enabled program to quicken the pace of innovation (Mehari et al, 2021). The initiative has also created a new platform that connects researchers at universities and industrial innovators. This platform allows universities to work with industrial innovators in mutually beneficial ways. There are many ways to leverage this collaboration. These two programs are essential for the success of industrial innovation campuses.

2.4 Evolutionary Models Explain Differences in Innovation Outcome

According to Stirling, Maxey & Luna, (2013) many challenges are unpredictable, such as those of climate change, environmental change, and technological change. It is possible for individuals to exhibit adaptive behaviours on these challenges. These behaviours may be learned, or they may be the result of innovation (Evans et al., 2015). The outcome of an innovation is often contingent on the type of adaptive behaviour that it is associated with.

The rate of innovation and trait specialisation are strongly influenced by the environment (Evans et al., (2015). Firms believe in the potential of large payoffs compared to their competitors. The failure of selection neglect models to account for observational bias can lead to overconfidence and an irrational boom in innovation. In addition, bias in

censorship may lead to overconfidence and overinvestment. Nevertheless, the results show that a combination of these factors may contribute to the success of an innovation.

2.4.1 Conceptual Approaches Explaining Differences in Innovation Outcome

Different conceptual approaches to innovation result in different models. Some focus on the role of small firms or the market, while others examine the relationship between small firms and large companies. It refers to the process in which firms use external ideas in their own innovation processes and incorporate ideas from other sources. This approach explains the participation of various entities. However, it is not clear which innovation model is the best model to use to understand the role of small firms.

2.4.2 Impact of Research on Social, Economic and Cultural Development

Academic research and policymaking are becoming more and more detached from one another, leading some observers to surmise that researchers and policymakers live in different universes. According to Stake, (2013) discusses that there is little overlap and frequent conflicts between the professional ties and values of policymaking and research. As Whelan & Fink, (2016) state that counting the social, economic, and cultural benefits that research has brought about for a nation is one way to gauge its impact. For instance, the UK government alone invests about $3 billion in research annually and demands that applicants show how their projects benefit the economy and society (Pique, Berbegal-Mirabent & Etzkowitz., 2018). This is but one illustration of the numerous advantages that research can provide. It has the potential to significantly impact every facet of society, including the environment and entrepreneurship.

To achieve maximum impact, communication is a crucial process. Yun and Liu (2019) assert that there has been a significant change in research communication and policy influence compared to the previous top-down and trickle-down communication approaches. In this age, social knowledge as a resource has surpassed the limitations of partisanship and ideological divides. This might have become valuable for researchers and policy professionals now. This is because for modern development, efforts need the flow of findings from research. Nevertheless, one form of communication on its own could not accomplish the expected result. To engage the research community to maximize the impact of research outputs (Kim et al., 2020). Researchers can contribute to the strengthening of social conditions and public policy by engaging in democratic governance. To enable important contributions to democratic governance and public policy we must engage the scientific community more fully. This,

in turn, ensures the validity and relevance of research findings in practice. Research has a significant role in the development of social, economic, and cultural aspects if only rigorous research will be done with proper involvement of the community.

If we want our research to have the biggest impacts, then we need to shift the focus onto ways they can be translated into practice and policy (Tang, 2020). But how can one achieve that? How does one go about sparking policymakers' interest, convincing them of their worth and prompting changes in behaviour? Society: The UK's Research Council acknowledges these effects on society, economies, and societies but places greater importance on the transformation of society. (Ali 2021) In addition to the above, it is important that the results of research are used in such a way as to improve public services and increase economic efficiency and environmental quality.

2.4.3 Impact of Research on Sustainability

It has been widely acknowledged how research and development centres around universities affect local economies. Universities contribute significantly to regional development, but few have strategically controlled their influence and taken advantage of the local economy to strengthen their competitive edge, according to Stephen et al. (2008). Smith et al. (2014) present a strategic approach that universities can use to assess their influence on the local business economy.

As sustainability has become an increasingly important topic, universities and researchers are expected to be actively engaged in regional deliberation and decision-making processes (Kang, Li & Kraus, 2019). Although definitions of sustainability vary greatly, most would agree that it involves achieving some combination of economic, social, and environmental goals. Evaluating the research and development efforts through a spectacle of sustainability, plays an important role in all these processes. The influence of regional development to sustainability includes the role played by universities and local universities to regional planning and deliberation (Liening et al., 2021).

Package the funding by institution, and science that universities and researchers can effectively leverage against global markets. It is impossible to catalogue the innovation assets of all regions. Thus, the country's government should fund regional innovation asset assessments, which must be tailored to meet the unique needs of each community. In this way, universities and local businesses can capitalise on the local

impact of research and development to support economic development. Further, universities and research institutes can create new jobs and improve the quality of life in regional communities (Liening et al., 2021). Another important topic in regional development research is the role of infrastructure investments. Investment in technological infrastructure will help improve regional development, but it will also require additional benefits for remote areas.

2.4.5 Impact of Research on Social Entrepreneurship

The earlier discussion needed to incorporate the impact of social entrepreneurship on economic and social welfare, including literacy rates, income inequality, and environmental welfare broadening the definition of entrepreneurship to incorporate environmental, social, and economic welfare. Various empirical studies (Dechezleprêtr, Glachant & Ménière, 2008., Budwig, 2015., Rouxle & Pretorius, 2016) have shown that entrepreneurship is good for employment and GDP, few studies show its role in improving social, environmental, and poverty indicators. Yet, several recent studies (Buabeng-Andoh, 2012; Sultan, 2020; Majeed et al., 2017) have found that entrepreneurship benefits people's well-being, and can improve regional development, particularly in developing countries. Several researchers have shown that self-employment decreases poverty, a measure of economic well-being. Other research by Pique, Berbegal-Mirabent & Etzkowitz, (2018) shows that the creation of new firms boosts national modified Human Development Index scores in developing countries.

While the impact of entrepreneurship on a region's economic performance is often viewed as positive, there is evidence that the effect is modest or negative in rural and less agglomerated regions (Buckley & Casson, 2009). In this literature, the researcher found that the size and density of a region's entrepreneurial activity are directly related to the economic performance of that region. New firms have a greater positive effect on regional development than do established firms. Social entrepreneurship has many benefits for society. In addition to providing jobs, social enterprises also help to reintegrate large groups of workers. Social enterprise organisations account for approximately 6.5 per cent of aggregate employment in the EU (Scuotto, 2020). Incorporating people from these groups into the economy, provides social and economic benefits for everyone while aiming to better understand the factors of social entrepreneurship and regional development (Shabanov et al., 2021). Several academic investigations required the examination of spatial units, as these units are deemed more

suitable for assessing the influence of entrepreneurship. Research conducted using industry units, such as those found in the business sector, is deemed insufficient. Furthermore, it is imperative to integrate longitudinal panel data, alongside aggregated data, while also considering political and demographic shifts. This implies that the community can anticipate a significantly more comprehensive depiction of the correlation between regional development and social entrepreneurship.

2.4.6 Impact of Research on Start-Ups

There exist multiple techniques for assessing the influence of research on the development of start-ups and regional economies, one of which involves analysing its effects on employment rates and wage structures. According to Correa, (2007) a novel approach to evaluating the impact of start-ups on labour productivity is through the utilization of a new business formation analysis. Nevertheless, these analyses are not suitable for quantifying indirect effects. The data should pertain to a comprehensive performance indicator of the local economy in the region. Tawney, Miller & Bazilian, (2013) employ the revolving door model to illustrate the influence of new firms on employment levels in Central and Eastern Europe as well as the United Kingdom.

In addition to the analysis of employment and wage levels, scholarly investigations on start-ups can provide valuable insights for entrepreneurs in effectively mitigating risk. Damanpour and Marguerite (2009) assert that entrepreneurs encounter various risks, such as the possibility of failure, which can significantly impact their capacity to sustain the growth and advancement of their enterprises over time. Hence, the impact of research on start-ups and regional development is significant. With more funding available, it is possible to increase the number of new start-ups in a region.

Moreover, studies that look at the start-up rate alone risk overestimating the effect of entrepreneurship, which is largely driven by factors other than entrepreneurship (Clifford & Petrescu, 2012). The most used method is the sector-adjusted start-up rate, which controls for the influence of the composition of industries in a region. Further discussed by Tawney, Miller & Bazilian, (2013) this approach tends to underestimate the level of new firm formation and entrepreneurship in high start-up regions, which distorts the selection process.

According to Tawney, Miller & Bazilian, (2013) accelerator programs are a new form of institutional support for the entrepreneurial ecosystem. These programs provide

educational programs for start-up founders and often culminate in a public pitch event to pitch their companies to investors. These programs are critical in facilitating an entrepreneurial ecosystem, and various researchers have developed an algorithm to measure their impact on regional development (Yiu, Lau & Bruton., 2007; Wielemaker & Gedajlovic, 2011; Soleas, 2021). But their success is hindered by the environment. The start-up ecosystems must be facilitated by local government agencies, and local governments must support ventures that scale deeply and sustainably (Bartoloni et al., 2021).

A culture-based perspective on start-ups can identify differences in entrepreneurial behaviours and psychological characteristics. Entrepreneurial culture and regional culture have a profound impact on enterprise development and start-up behaviours. These factors will impact the way start-ups perform in the region and how they participate in the regional economy. It is important to explore cultural differences in regional economic development, as it will improve the quality of business gang enterprises in the region (López-Rubio, Roig-Tierno & Mas-Tur, 2021).

2.4.7 Impact of Culture on Innovation

The culture of an organisation has a great impact on the outcomes of innovation. To improve innovation, organisations need to measure their culture and compare it to the results of innovation leaders. However, to achieve lasting change, organisations must go beyond superficial surveys and use science-driven approaches to improve their innovation culture.

Observations, research, and opinion are all used to assess innovation cultures. Be wary of instruments that combine the two concepts. Observation and opinion are crucial, but do not mix them as large companies may have elaborate innovation governance, but a tight, oppressive culture. The results of these two areas are often not representative of the culture of smaller companies. However, both studies highlight the importance of evaluating innovation cultures. The literature on the results of innovation in businesses, regions, countries, and on a worldwide scale is extensive. What they share is an examination of the roles played by the private sector, the academic community including universities, and the public sector.

The dynamics of this collaboration between three parties playing by various sets of rules have been summed up by the Triple-Helix concept (Etzkowitz and Leydesdorff, 2000).

It symbolizes the collision of two cultural traditions. However, the promise of this partnership has brought in many academics, professionals, and politicians. Various interpretations of the Triple-Helix concept emphasize either the microlevel involvement of the state or the macrolevel role of university-industry partnership. This differentiation is discussed further below, with emphasis first placed on the state's role. Innovation, as defined by Calignano & Jøsendal, (2018), includes new technological, economic, Organisational, and social solutions that are applied and used but may not be marketable in an economic sense with direct monetary impact.

The prior discussion has enlarged the research gap and differentiated the point of interest in enhancing the innovation outcome of a country. According to Carayannis & Campbell, (2019), governance encompasses the totality of institutional arrangements including rules and rule-making agents that regulate transactions inside and across the boundaries of an economic system. This latter part of institutions is governed by a set of rules and agents responsible for creating those rules. Institutions come in numerous forms, each with its own set of rules for how to engage with others, govern, and share information (Alunurm, Rõigas & Varblane, 2020). Market, organisation, state, network, community, and association are all distinct from one another, as stated by Borah & Ellwood, (2022). While it would be impossible to go into depth about the differences between the various formats, this study aims to add to the ongoing discussion and fill in the knowledge gap about the benefits of various institutional setups for international knowledge transfer in the sense of the processes outlined above that are outsourced. Therefore, the network versus hierarchical approach will be introduced as the two ends of the continuum of institutional arrangements.

A network describes stable relations and interactions among people or Organisations without sacrificing the independence of any of the participants (Cai, Ma & Chen, 2020). Those participants are not part of a centralized authority or a free-for-all market. Instead, the link within a network is long-lasting but ad hoc, making it ideal for transferring resources that cannot be priced accurately on the open market (Cai, 2022). The network studies are infrequent within the framework of governance of the innovation system. Research from management disciplines that seeks to explain why certain companies are more innovative than others is far more common. This research, as pointed out by Cobben et al., (2022), highlights the importance of networks within Organisations in establishing novel resource or knowledge combinations that ultimately result in novel

innovations. As a result, the enterprise-centric nature of these studies limits their ability to accurately assess the impact of innovation throughout the entire innovation system. More importantly, this line of inquiry fails to justice the innovation system premise that new inventions and technologies are the outcomes of collaboration between different actor types (Cobben et al., 2022).

2.5 Role of Universities in Innovation Activities

The role of a university in so much innovation activity is thus central to this inquiry. This section discusses the main responsibilities and opportunities of universities in developing innovation, interacting with external actors, and supplying knowledge to social innovators. As Gallardo-Vázquez et al., (2019) stated that the role of a university is not limited to research and teaching, but it may also involve development of wide relation s and promoting citizenship. Third, a university can connect with various stakeholders in and around the city of practice to form alliances and have a local presence.

2.5.1 Managing Relations with University Stakeholders

According to Van den Bulte & Joshi, (2007), managing relationships with university stakeholders in innovation activities necessitates a diverse strategy. Corporate cultures and goals diverge from those of universities. Additionally, their governance is more dispersed and autonomous. Mapping university culture to corporate culture is challenging because of these distinctive characteristics. A wide variety of instructors, courses, and engagement opportunities are also frequently provided by universities. These distinctions may lead to a serious mismatch between business goals and academic goals. Businesses need to focus on developing their innovation strategies to meet this challenge.

Choosing key university partners and establishing business objectives are two approaches to managing relationships with university stakeholders (Manuelli & Sheshadri, 2003). This requires a thorough selection process. Then, the collaboration format should be aligned with the focus areas and objectives of the organisation. Further discussed by Trenche, Terada & Yarime, (2015) the people, processes, and organisational structures should support university partnerships. Finally, it is critical to evaluate the performance of each university partnership to ensure it is aligned with the ompany's goals.

2.5.2 Managing Relations with External Environment

Managing relations with the external environment in innovation activities has many dimensions and influences (Pique, Berbegal-Mirabent & Etzkowitz, 2018). Firms' internal characteristics and external environments are interconnected. Firms' market structure, adoption rate in their sector, and spatial location are all important to consider. According to Scuotto, (2020) the firm's organisational structure and geography can also affect innovation efforts, influencing the outcome of innovation. Some firms' internal characteristics also influence external relations. Some studies (Lozano, 2006., Ferrer-Balas et al., 2008., Schaffers & Turkama, 2012., Tiekstra & Smink, 2018) have examined these relationships to reveal their complementarity.

2.5.3 Providing Knowledge to Social Innovators

According to Pan & Guo, (2021) successful social innovators must understand the issue they are trying to address and the context in which they are working. They need to carefully listen to others and be analytical about any issues that may arise. Further discussed by Chen et al., (2020) they also need to be flexible enough to make changes based on the circumstances. Facilitators must follow the Road Map carefully and avoid skipping entire modules. To ensure the success of a social innovation project, facilitators should make sure that they consider every element in the process, from the idea to the final product (Baier-Fuentes & Guerrero & Amorós, 2020).

In these scenarios, systematic innovation is increasingly used to solve pressing issues of creating new forms of organisation and network processes (Baier-Fuentes & Guerrero & Amorós, 2020). This creative approach is generating global impact and increasing the number of social innovators. However, there are still many challenges that need to be addressed. Hence, providing knowledge to social innovators is crucial to its success. Once these innovators have successfully developed their ideas, they can then scale them up to larger levels of society.

2.5.4 Managing Relations with Business

Successful innovation management starts with managing relationships with the business, which includes customers, vendors, and other stakeholders (Findler et al., (2019). In other words, it’s a strategy that ensures ongoing engagement with an audience. It is a way of developing client loyalty, building brand support, and establishing a partnership between an organisation and its patrons (Valle, Gantioler & Tomasi, 2021).

While relationship-building most often takes place at the customer level, it can also be applied to other kinds of relationships, such as between businesses.

2.6 Universities as Innovation Platform for Regional Development

According to Zabala-Iturriagagoitia et al., (2021) the role of academics in regional development is varied. Traditionally, they have played various roles, such as fund recipients, project partners, and project leaders. The roles of academics depend on their motivation, funding needs, and access to contacts and collaborators (Martinidis, Komninos & Carayannis, (2021). However, sometimes additional actors are involved in the project or act as coordinators, requiring further effort. In such cases, universities must take more initiative to align their operational involvement and leadership roles.

2.6.1 University-Firm Collaboration on Firm Performance and Regional Development

This part of the literature review concentrates on university-firm collaboration's influence upon firm performance and ultimately, regional growth. It concludes that the balance of firms' interactions with universities is widespread but significantly varies by size and location of business, and crucially extensity of university collaboration and Lo & Theodoraki, (2021) indicated that their research is enabling them to bring a unique date set and show how the presence of universities in value chain's specific areas may be supportive for innovation. Analysis of the relationship between university-firm collaboration and firm performance would help in determining "what matters most" when it comes to a regional economy's formation (Mehari et al., 2022). This policy is designed to improve research outputs but more importantly to help strengthen the links between universities and firms with a view of contributing to regional development (Cobben et al., 2022). While universities are expected to contribute to innovation in their regions, the relationship between development or creativity and research output is not well defined. While research-intensive universities produce frontier research, the impact of these activities is ambiguous. Some universities suffer from mission overload or an inadequate match between their research output and the needs of the local region. In such cases, local firms must search elsewhere for a suitable university.

The results of the study conducted by Cobben et al., (2022) show that university-firm collaboration positively influences the development of eco-innovations. The effects are significant and positive and the mechanism that mediates this effect is eco-innovation. It also discusses that university-firm collaboration increases firms' operational flexibility,

which contributes to firm performance. The results support the view that collaboration between universities and firms improves regional development. The role of university-firm collaboration on firm performance and regional development has been understudied (Elias, 2021). However, the potential of university-firm collaboration cannot be denied. According to Carayannis et al., (2021) it helps firms increase their sales and benefits and boosts their reputations. Moreover, the university-firm collaboration will help firms reduce their environmental impact and encourage eco-innovations. It is important to note that these benefits are not limited to regional development only.

According to Gamidullaeva et al., (2022), R&D and public-private partnerships continue to grow in importance, and university-firm collaborations between universities and firms will likely play a vital role in the transfer of technological knowledge and innovation. In some cases, universities will even install research centres within firms, focusing on information technologies. University-firm collaborations will be more effective if they strengthen the firm's product development and regional economic development (Liening et al., 2021). Whether these relationships are formal or informal, the researchers hope to generate new knowledge about the links between universities and firms. A good mix of universities and industrial firms is critical. Political support and collaboration platforms can help bring the two sectors together (Robaeyst et al., 2021). Moreover, online collaboration platforms help match overlapping research interests between firms and universities.

2.6.2 Impact of University Research on Regional Innovation

According to Santos, Zen & Bittencourt, (2021), the traditional missions of teaching and research are still important, universities have also begun focusing more on societal and regional development. This entails starting fresh initiatives to enhance their community's social, cultural, and economic aspects (Edgar & Kharazmi, 2022). Universities may be in a better position than ever to support regional development.

Here are a few instances of university-industry partnerships. Below is a quick summary of each of these collaborations. In every case, the university has been at the forefront of local innovation.

- For example, in Porto Alegre, the regional government and universities are viewed as the hubs of the innovation ecosystem. They are viewed as facilitators of cooperation and reciprocity. The interviewees underscore the significance of

research excellence and universities' neutral position as intermediaries between government and industry in the region, even though the educational mission of these institutions is frequently disregarded. This sustained dedication results in more creative fixes for local issues.

Businesses and regional governments frequently look to universities as a source of innovation. They draw on their expertise and develop regional innovation networks. Ultimately, they collaborate with regional authorities to develop regional innovation policies (Gallardo-Vázquez et al., 2019). However, their roles differ depending on the context and scale of interaction. As a result, universities are increasingly shifting their practices to enhance their roles in regional development and innovation (Soleas, 2021).

- In China, universities from neighbouring regions can help provinces obtain innovative capabilities. This attracts talent to the region from surrounding developed areas. This in turn attracts new universities. In Langfang, Hebei Province, more than twenty universities have established branch campuses. In Hainan Province, the "Hundred Experts" program and the Interim Measures for Attracting High-Level Professional Personnel are examples of this.

The research uses both provincial-level macro-statistical data as well as listed companies to calculate the Gini Coefficient of the optimal university. The results of this analysis show that higher education is more likely to result in greater innovation, with a smaller gap between the educational levels of institutions in the same region. The quality of university operations may also have a larger influence than the Gini Coefficient. In some regions, the difference between higher education and regional innovation is greater than the Gini Coefficient. According to Meissner, Gokhberg & Saritas, (2021), although the impact of university research on regional innovation is not yet clear, it has been the subject of extensive empirical research. The economics of science and technology has been closely tied to agglomeration economies. For example, in Switzerland, universities of applied sciences (UASs) are in regions with similar economic structures. As such, the location of UASs can be interpreted as an exogenous expansion of higher education.

2.6.3 Formal and Informal Modes of Interaction in Universities

This section of the literature highlights the role of four stylised facts in identifying formal and informal modes of interaction in universities for regional developments. These

frontrunners are well-known in their regions and serve as key contacts for stakeholders, as well as role models for university colleagues (Bruton et al., (2008). According to Bertrand, (2010) they are not necessarily aligned with top-management directives or government expectations. Moreover, networks and individuals do not always operate as expected. These elements include the fact that non-technical knowledge exchange and technology transfer activities mostly depend on individuals rather than institutions for support (Schaffers & Turkama, 2012).

Universities now carry out new planning-related tasks like mediation and consultation in addition to their traditional academic duties (Secundo et al., 2019). Universities participate in regional governance processes to varying degrees depending on their institution, so it is important to coordinate strategically to guarantee optimal engagement. The dual character of university-regional interactions is revealed by different viewpoints and theories of regional engagement (Yoon, Vonortas & Han, 2020). For instance, a university's autonomy regarding its involvement in the region is compared to that of public policy.

One should not undervalue the contribution that universities make to regional development. They are essential to the regional economy. Universities need to be studied in the right context to be fully understood in their role. It is impossible to choose the best strategy. The most suitable approach of evaluating the efficiency a university being in operational or examining its policies and practices against other universities within an area (Alunurm, Rõigas & Varblane, 2020). Universities, in addition to many others thing functions properly when they know how to interact with their society/family.

As much as it is vital that formal and informal modes of interaction co-exist, both are necessary to engage in the region with efficacy (Lozano, 2018). The cooperation with the university shall allow people involved in regional development to do something for their local economy as well (Žemaitis, 2019). Good examples are the University of Aveiro in Portugal, which has a solid connection with local government, business and industry and is also considered as privileged partners. The university must also take advantage of the partnership with local authorities and interface structures (e.g., Creative Science Park in Lisbon).

Therefore, as Secundo et al., 2019, the legitimacy of the relevance of universities' impact on community development is higher in all systems. It's not those informal dynamics conflicted with but rather co-evolved over time as formal ones. With the tolerance and

openness of the University, new ideas developed in this environment whilst its reputation led to a community of colleagues (Rypestøl, 2020). This generated a domino effect of collaboration, creating collective impact from what might have otherwise remained fragments. In addition, these factors encouraged the proper alignment of incentives and rules related to new paradigms.

Increasingly collaborative approaches to innovation and regional development have raised expectations for universities to play key roles in strategy-making processes (Wojnicka-Sycz, 2020). However, the complexities of regional context and the policy process have not been adequately explained.

2.7 Community-Led Innovations and Universities

According to Rouxle & Pretorius, (2016) while many community-led approaches seek to build trust between community members and institutions, the principles of community-led innovation are a little different. They focus on the empowerment of the community by leaving the innovation process to them. Institutions have a support role and actively try to move out of the way while staying engaged with community partners (Lozano, 2018). They also act with humility, reflexivity, and pause. In short, they practice the art of the pause.

- One example of a community-led innovation is the dry toothbrushing program. While this program was initially developed by a grassroots group, it was later adopted by the state-run dental health service. This program received funding and policy-level support. As such, it became an accepted innovation within the health regime. But how does a community-led innovation enter the health system? It should be designed to be compatible with the existing regime.

According to Zhou & Wang, (2020) the theory of community-led innovations assumes that ideas generated by the grassroots level of a system are important. The social context of the problem allows innovators to evaluate the feasibility of potential solutions. However, research suggests that many community-led innovations never reach a physical realization. This is because community-led innovations are often enmeshed in a social context. In this way, community-led innovations can be more effective when they are conceptualized as a partnership.

2.8 Academic Entrepreneurship (AE) And the New Business Sector

The role of academic entrepreneurship is growing in importance, as disruptive innovations often originate from university spinoffs. As a result, academic entrepreneurship has made significant contributions to the economic growth of countries and regions. Understanding how academic entrepreneurship operates and how it contributes to regional and national economies is essential for the success of academic ventures.

Among the many ways that universities and industries can improve mutually beneficial collaboration is through AE. This new paradigm of technology transfer between the two may help overcome myopia associated with path-dependent learning (Tarkowski, 2021). Additionally, AE might encourage more original and significant research. Furthermore, it calls for a unique set of abilities.

Some helpful background information on the AE as a mechanism for university-industry technology transfer is provided by recent research published in the IEEE Transactions on Engineering Management in 2021. The authors (Thomakis & Daskalopoulou, 2021) looked at how universities transfer technology, the effects of unofficial industry contacts, and the function of unofficial contacts in encouraging industry-industry collaboration on research projects. Both AE practitioners and academics can benefit from the information found in their findings. Although not all countries have conducted this research, the findings apply to any jurisdiction that follows this procedure.

The success of the AE process in transferring university technologies can serve as a basis for the significance of comprehending it (Rush et al., 2021). The researcher of this current study has drawn a class diagram as below while collating it's all actors and entities to look at how universities act as change catalyst while performing innovation activities.

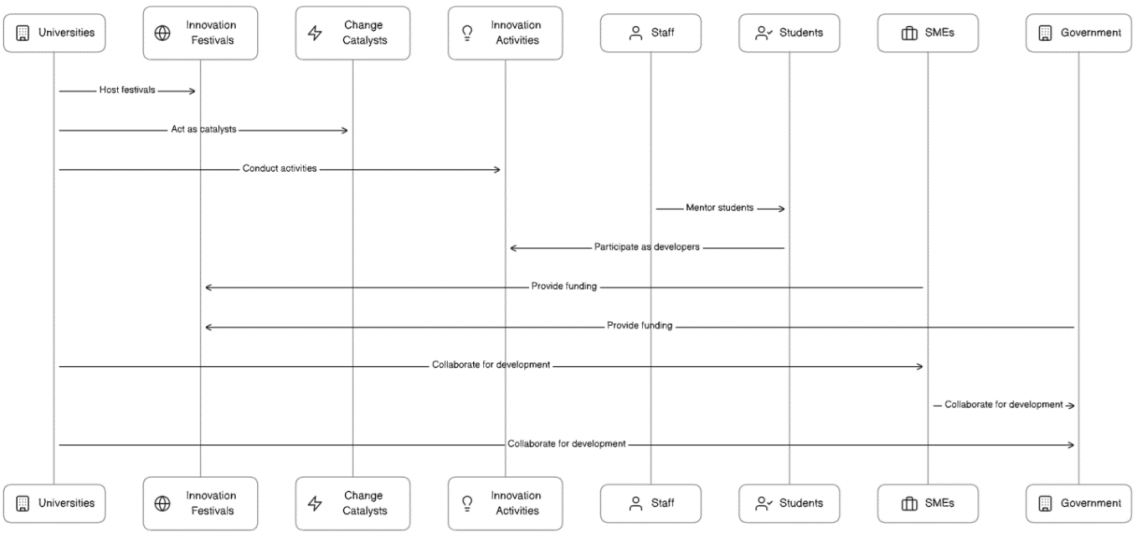


Figure 2.3: Actors & Entities of Universities Acting as Change Catalyst

(Created by Researcher, 2023)

The above diagram represents that the innovation process at universities for the emergence of digital technologies along with the community involvement in the knowledge base are enabling researchers to improve access to scientific knowledge and integrate it into the innovation process. This is important in the current global context of distrust and fear of medical advances and interventions. A case in point is the Covid-19 pandemic, which highlights the unequal distribution of disease risk. People from low socio-economic status are among the highest risks and most vulnerable to this pandemic. Those who choose academic entrepreneurship must demonstrate a unique blend of skills and attributes. Despite the rigours of academia, they must also have a practical perspective on market challenges. They must have a deep knowledge of science, patient needs, and innovation and be able to de-risk breakthrough ideas (Rush et al., (2021). One of the most significant factors influencing the economy today is the role of entrepreneurship in higher education, which plays a crucial role in reducing unemployment and poverty (Musari & Fathorrazi, 2021). The focus on entrepreneurship and its pedagogy has grown with recent advancements in the field of entrepreneurship education. Problem-based learning and entrepreneurship learning models that connect students to local economies are two examples of these tools (Cai, 2022). Universities have formed joint ventures that give doctorate and post-doctoral students the tools and guidance they need to launch their businesses, in addition to offering programs that teach entrepreneurs.

2.8.1 Knowledge Sharing and Innovation

Universities today are being pressured to play a greater role in supporting industry through Knowledge Translation (KT), or the dynamic use of research results by businesses (Cunningham & O'Reilly, 2018). Research advances and scientific advancements are often made through collaborative efforts. Researchers from various institutions are often willing to work on the same project. (Damanpour, & Marguerite, 2009). There are however challenges associated with collaborative research. Collaborative research does allow for innovative new ideas and improvement, offering gains in the communication between researchers, but how to agree on a shared vision of what part the proposed projects should be pursuing; intellectual property rights concerns or handling conflicts among team members (Datta et al., 2019).

To challenge this, researcher should plan their research and the outcomes they aim for. Authors due (De Bernardi & Azucar,', 2020). parties in addition, collaborators also need to clarify terms of their appointments in order to prevent disputes and conflict between them as well as reduce the risk for misunderstandings or disagreements with each other (Dechezleprêtre, Glachant & Ménière, 2008). In arose, the system that would allow sharing resources and data as well as an agreement for authorship crediting/owning research results need to be implemented (Diniz et al., 2019).

research collaboration can be small such as between two people or it can involve many participants across multiple institutions. Hence, on one hand, research collaboration can be described using only numeric data. Scientists from around the world gathered to explore these changes that microgravity makes in human physiology and to design the experiments to take their research down on planet Earth aboard the International Space Station (Draca, 2013). Finally, collaboration may also take place between universities and government agencies to answer socio-economic questions such as poverty reduction or environmental degradation (Edgar & Kharazmi, 2022).

It also increases the odds of funding (Elias, 2021). Moreover, funders are more inclined to support research having a meaningful effect on society or industry. Close collaboration with the company is beneficial as students will gain insight into what it means to work for one and develop professional connections as well. As difficult and messy as research collaboration can be at times, it is essential to furthering scientific endeavour. Although, when everything is done well, any collaboration can give great joy

and a sense of accomplishment but only in serious cases! To succeed in the cooperation of people from dissimilar experiences *Espinoza-Sánchez et al, 2022+.

Knowledge transfer is the mechanism by which information and knowledge are disseminated between organizations (Etzkowitz & Leydesdorff, 2000). It would assist the organizations exposed to develop their best practices and benchmarks, enhance process areas, and stimulate innovation; help continuous learning and improvement activities/systems in establishing a culture of continual enhancement and growth; keep on being competitive by repressing high-priced blunders (Evans et al., 2015). The answer is ample to help organizations stay ahead in the competitive world and avoids costly mistakes that take place simply due to the non-availability of an effective knowledge transfer strategy. The knowledge sharing modalities can be categorised into training sessions, workshops, mentoring and coaching or documentation amongst others Farinha et al., 2020. This makes it important to find ways that suit your team the best; albeit some may learn more through lecturing, others may prefer hands-on experience. (Fayolle, Gailly & Lassas-Clerc 2006) Moreover, elusive ways of communication and collaboration should also be kept in mind. (Fernandes & Ferreira, 2021)

University establishments share it via a bit of extra spherical-about manner. Through the creation of informal partnerships between universities and local business, knowledge transfer can be further enhanced when students and graduates are brought in to work on projects with firms that operate within their study field (and vice versa) as they gain valuable first-hand experience whilst honing entrepreneurial skills – this model embodies real entrepreneurship lessons (Ferrer-Balas et al., 2008). Such relationships could even open doors to internships or job positions. Studies have demonstrated the value of knowledge transfer as an asset to both universities and businesses alike. Knowledge transfer can increase employee productivity while decreasing turnover rates; improve customer service quality; support long-term growth strategies; enhance image and reputation through brand promotion; as well as strengthen relationships with clients (Findler et al., 2019).

University campuses can strengthen their partnerships with the business community by giving employees opportunities to participate in innovation festivals and academic events or increasing visibility by sponsoring or hosting conferences and seminars - increasing visibility because of which can also help draw in more students and

researchers to the university (Cai, Ma & Chen, 2020). A university can develop relationships with institutions and companies within its region to encourage its research and development activities, as well as encourage innovation and economic growth by identifying key issues facing industries, creating an atmosphere conducive to collaboration between groups, and using this data to devise an overall plan for its future success (Chen et al., 2020).

Innovation festivals provide an ideal platform to bring students, businesses, and industry partners together for educational and networking purposes (Chulok, 2022). Additionally, it connects companies with students - future employees - through networking events. The students work in multidisciplinary teams to solve real business challenges faced by organisations like companies, municipalities, third-sector organisations and experts and researchers from diverse domains (De Bernardi & Azucar, 2020). Challenges set by these entities require innovative perspectives and solutions from students; thus, providing them with an opportunity to put theoretical knowledge into practice as well as gain new meta-skills (Dechezleprêtre, Glachant & Ménière, 2008).

Entrepreneurship is the practice of taking risks to make a profit through starting or expanding an existing business, whether by taking on risks and incurring losses or by exploiting knowledge that benefits individuals and society (Diniz et al., 2019). Universities should recognize this process and incorporate it into their teaching and research activities - additionally using it as part of their 'third mission' to contribute to regional economic development (Domínguez-Gómez, Pinto & González-Gómez, 2021). Universities can contribute significantly to regional development in various ways, and they need to select the appropriate approach according to their local environment (Draca, 2013). A university with expertise in high-tech research may play a different role than one that specializes in heavy manufacturing; similarly, those located near large numbers of small and medium-sized enterprises (SMEs) will have distinct needs and priorities than ones in less entrepreneurial regions (Edgar & Kharazmi, 2022).

Although universities take many academic initiatives to promote their contribution to regional economies, there is limited research that examines their actual effects (Elias, 2021). This study is one of the first qualitative examinations that attempt to understand how university entrepreneurship departments engage with their communities by serving as vehicles for regional development rather than simply acting as sources for knowledge transfer (Elsamny & Gianoli, 2022).

2.9 Higher Education & Seamless Learning Model for Innovation

In today's knowledge-based culture, information and understanding are constantly evolving. This indicates that the importance of employees' efforts to continue learning throughout their careers is growing. In addition to massive open online courses, universities also provide continuing education programs that allow workers to delve more deeply into theoretical topics. Blended learning formats which blend distance learning with on-campus learning phases are a prevalent method for continuing higher education. The foundation of higher education that lasts beyond the traditional four years is the opportunity to balance work and study. A strong link between formal learning in the schooling environment and the informal or non-formal work field context is essential to facilitate the adaptation of newly gained theoretical information to the field of work (Bencke et al, 2019). According to Garcia-Alvarez-Coque et al., (2021) the Seamless Learning Model (SLM) encompasses settings that include learning in a variety of contexts, at a variety of times, in a variety of places, individually and in groups, face-to-face and via media transfer. The SLM also highlights the importance of connecting formal and non-formal learning, as well as analogy and digital pedagogies.

In addition, the SLM integrates the requirement for flexibility, considering the varied circumstances of lifelong learners, and the opportunity to connect practical experience with academic study, and vice versa (Lewis, 2013). Continuing education is more widely accepted and produces better results now than ever before thanks to digital media's ability to seamlessly integrate multiple sites of study into a single, cohesive whole. There are many benefits to having corporations and public institutions work together on the development of continuing higher education programs, according to Orazbayeva, (2019). Meanwhile, she stresses the importance of reforming both educational policy and the culture of cooperation to facilitate such partnerships. When businesses and universities work together to create new academic programs, both can reap the benefits of knowledge transfer (Oliveira et al., 2021).

Several characters improve their chances by going to university. Initially, the person can increase his or her potential for monetary and professional success. The university obtains insight into corporate demands and can refine its research, while the industry gains access to knowledge that can lead to innovation (Yoon, Vonortas & Han, 2020). Initially, when businesses and universities work together to provide continuing education, they may not give much thought to things like the diverse aims of cooperative

research initiatives. Universities and businesses need to talk to one another and learn to work together across cultural lines to create a successful study program (for more information on the patterns of the collaboration process, see Trisetyarso & Hastiadi, 2022). As a result, collaboration for education can contribute to additional cooperation and knowledge transfer because of increased trust brought about by interpersonal interaction.

2.9.1 Online Courses Referring to Innovation Collaboration

Innovative projects have become an essential element in staying competitive and profitable, yet companies often struggle to locate the resources and expertise required for their development (Datta, Saad & Sarpong, 2019; Vallance, Tewdwr-Jones & Kempton, 2020; Trisetyarso & Hastiadi, 2021). Online courses can be an ideal solution to these difficulties by giving employees access to training courses on novel products and services; and creating an environment in which resources and ideas can be shared freely with each other developing continuous synergies that benefit all involved parties involved (Blunck & Bradler, 2009).

Asynchronous courses can be provided to vastly different numbers of employees compared with traditional face-to-face seminars, and Organisations can disseminate their agency-specific message more broadly while also promulgating collegiality within the Organisation (Rosenberg et al., 2015). Moreover, online learning platforms allow participants to access the experience of employees from other departments and even other regions or countries; similar experiences may be a source to share best practices, potential obstacles for innovation or alternative solutions Roig et al., 2020).

For instance, some Mexican university's educators innovatively collaborate with professors from two research group to develop a MOOC on energy sustainability. Together their collaboration has resulted in an unrivalled model for online education unlike any other currently available. Results of quantitative surveys have shown that after the course, expectations were globally met in terms of the view on career being influenced by a MOOC and competencies being acquired down, although students demonstrated lower engagement levels than expected at start: it could be interesting to reinforce their motivations based on medium/ long term attractiveness of taking such trainings for studying leaving prospective.

Moreover, we must keep in mind that there are some things which cannot be taught remotely by any means. This includes subjects like public speaking or surgery where the learner must physically open something and practice as well with full-motion body activities involved like sports. For these courses, hybrid access that incorporates traditional classroom time along with online learning platforms may be the answer, allowing students to have the expertise of an in-person professor while utilizing all the opportunities created by an online world. Also, hybrid classes might be recorded and posted to an online resource section for watching later. This resource section may also provide links to relevant scholarly articles, institutions or resources that provide an extra boost to classroom instruction.

2.10 Innovation Policy, Law, and Ethics (Government Guidelines)

As long as there have been ethics legislation and innovation policy, private interests have been at odds. This outmoded perspective fails to consider the government's current role as a partner in the innovation process. However, recent events have started to alter this perception. Some of the most pressing questions of innovation policy and ethics are discussed here.

2.10.1 Ethical Framework for Innovation

According to Wendin et al., (2015) an ethical framework provides information on the ethical underpinnings and approaches in each scenario, rather than picking a certain orientation and delivering a specific decision-making process. A framework without a predetermined direction may not be useful in all circumstances. Instead, it poses certain generic ethical questions that might be used by policymakers to assess the gravity of a given situation's moral implications. This framework is useful during a policymaking process that may be continuous.

The scope of its usefulness and applicability is too narrow. Its goal is to direct decision-making while ensuring that essential British ethical principles are not compromised, and it does not impose compliance obligations on program managers (Kang, Li & Kraus, 2019). It's written in general terms; therefore, it could not apply to all R&D initiatives. It's also possible that some inquiries are pertinent to a given technology while others are not. It may be necessary to use discretion when dealing with these restrictions (Cai, 2019).

Several recent research (Damanpour & Marguerite, 2009; Buabeng-Andoh, 2012; Bencke et al., 2019; Costa, Neves & Reis, 2021; López-Rubio, Roig-Tierno & Mas-Tur, 2021; Mehari et al, 2022), among others, have brought up moral concerns about scale, humanity, and technological flaws. In addition, they highlight challenges linked to the possible employment of emerging technologies for military and civilian reasons, resulting in unplanned crossovers between these sectors. Therefore, it is crucial to think about how new technology might affect these people and the rights they have. Innovators can aid policymakers in deciding which technologies and services to pursue by taking these into account.

2.10.2 Integrated Approach to Law and Ethics

The integration of law and ethics in innovation policy requires students to be able to conduct original research and critically assess and discuss various perspectives. They must be aware of the current debate regarding innovation ethics. They must be able to participate in discussions with experts, develop critical positions, and solve problems in a dynamic setting. Students acquire these skills through class participation, open discussion, and problem-based written assignments (Tang & Qian, 2020). There is also a range of additional challenges that students must overcome to effectively learn from the class.

The Integrated approach to law and ethics in innovation policies will develop students' ability to analyse policy issues that involve the intersection between law and ethics (Sachs, 2018). According to Hou et al., (2019) this integrative approach involves a diverse range of actors and focuses on individual values, such as human dignity, privacy, and well-being. Existing ethical approaches are limited in scope. Many have a broad application and do not consider specific issues involving big data. Several authors (Majeed et al., 2017., Ribeiro & Bao, 2020) have written about the integration of law and ethics in innovation policy. This research highlights the strengths and weaknesses of these approaches. In general, the Integrated approach to law and ethics in innovation policy emphasizes the importance of integrating legal, social, and technological considerations into policymaking processes.

2.10.3 Global Legal Responses

According to (Stua, 2013) technological advances have induced exponential increases in the interconnection of individuals, economies, and states. Rarely do technological innovations remain within one country. Therefore, innovation regulation must be

conceptualized at a global level, considering the ethical norms of different cultures. Often, it is impossible to identify a causal relationship between a technological innovation and its impact. Global legal responses to innovation policy and ethics should consider these concerns.

Today, political liberality dominates modern societies, and its tendency to privatize morality and religion is often reflected in a lack of ethical controls (Hasche et al., 2019). Consequently, ethical controls have become a complex process of continuous negotiation, where ethical standards are constantly reshaped in the context of the interests of all stakeholders. For example, a free market can promote exacerbated competition among major players in technological innovation, and therefore, requires a system-based approach to ethical control.

The problem with innovation control is the imbalance of power between stakeholders (Zhang, Chen & Fu, 2019). While technological innovation can be beneficial to all people, there are two significant flaws in this system. First, there is no universally recognised way to guarantee the general good, since large corporations and other vested interests possess more resources than universities or non-governmental organisations. This creates a problem of imposing respect for the general good on a global scale.

A key issue is the devaluation of Intellectual Property (IP) rights. Given that the UK has one of the most significant innovation capacities in the world (O'Kane et al., 2020), this policy decision is especially confusing. The current legislative proposals to boost R&D activities are based on a top-down strategy in which taxpayer funds are distributed through administrative and grant-making procedures. This method is more costly and prone to misallocation, even though it might be effective for some basic research. Therefore, bolstering intellectual property rights would give private capital the groundwork for property rights and enable it to invest in innovative, high-risk ventures.

2.10.4 Public-Private Partnerships

The phrase "public-private partnership" has garnered significant attention in recent years due to governments' growing reliance on private enterprises to address intricate issues (Ma et al., 2018). Although at first glance this arrangement seems like a good idea, there are several ethical and societal ramifications to consider. Even though the

partnership process might be advantageous to both public and private Organisations, it's crucial to consider the associated ethical, legal, and transparency concerns.

A publicly owned asset is given to a private party through a public-private partnership. This Organisation plans and funds a structure or infrastructure element (Terstriep Rehfeld & Kleverbeck, 2020). After that, the public body leases the private party's land or infrastructure for a predetermined amount of time. Following the lease's expiration, the private party gives the public partner ownership and operation. Some critics argue that public-private partnerships blur the line between legitimate public purposes and the perceived exploitation of the public. For example, a city may be heavily indebted, and the private enterprise may be interested in a capital-intensive building project that could yield operating profits once completed.

In addition to collaboration between the public and private sectors, public-private partnerships involve the exchange of ideas and information (Olsen & Shanks, 2019). As public and private spheres become increasingly intertwined, personal information and data may be transferred between them. Moreover, citizens expect government services to be delivered with the same speed and efficiency as the private sector. Emerging technologies could accelerate the breakdown of traditional lines and allow data to move without warrants (Bartoloni et al., 2021).

2.10.5 Impact of Technology Adoption

The impact of technology adoption in various sectors of the world is a controversial and emotional issue. For example, to provide the best possible treatment and health care for a population, society must be able to pay for new technologies. For example, medical innovation (e.g., Xplor Cane) can help improve healthcare quality but underfunding and misallocation of resources may prevent the benefits from being made available to the public. The adoption of new medical technology can benefit society, but if it is delayed by political and ethical considerations, it may be counterproductive to the development of a better health system (Wang et al., 2021).

Technology adoption has an enormous effect on modern society, shaping how we live, work, communicate and conduct business. Technology's incorporation into daily life has immense ramifications for individuals, organisations, and entire economies alike. One of the main impacts of technology adoption is increased efficiency and productivity. Automated processes, artificial intelligence, and other technological advances all work

towards streamlining processes, decreasing manual labour, speeding up task completion, and saving both time and resources to promote economic growth and competitiveness within organisations. Technology's adoption in communication has transformed how we connect globally. From social media platforms and instant messaging apps to internet services such as the World Wide web and instant messaging services - internet adoption has revolutionized how we access information and instantaneously exchange it with others worldwide. Not only have these revolutionized personal interactions but they have also allowed businesses to expand globally by reaching a broader audience and operating on a wider scale.

Technology adoption in education has revolutionized the learning experience. Online platforms, digital resources, and educational technologies have transformed education to make it more interactive, flexible, and accessible, offering students access to an abundance of information at their fingertips, collaboration with peers worldwide, and immersive learning experiences, democratising education through technology adoption has the power to close educational gaps while opening doors to individuals who would have otherwise never received access. Yet the widespread adoption of technology also raises some serious concerns, particularly related to privacy, cybersecurity, and the digital divide. The collection and storage of vast amounts of personal data raise questions of individual privacy and data security while the digital divide illustrates disparate access to technologies by certain populations or regions, providing challenges in making use of technological opportunities available today.

On an economic front, technology adoption has reshaped industries and opened new job markets. While automation may have resulted in the displacement of certain positions, it has also spurred the creation of tech-driven professions requiring skilled labour such as data science, artificial intelligence, and cybersecurity specialists - underscoring the necessity for ongoing education and upskilling programs in today's workforce. Environmental sustainability is another area heavily influenced by technology adoption. Innovations in clean energy, smart infrastructure and sustainable practices play a crucial role in mitigating human activities' effects on the environment; thus, technology adoption plays a key role in devising and implementing solutions to address climate change, resource depletion and environmental degradation.

Technology adoption has far-reaching and complex ramifications on society at large, altering how we live, work, communicate, and address social challenges. While adopting

technological innovations may provide many efficiencies and advancements that enhance productivity and connectivity between fields, consideration must also be given to ethical, social, and environmental implications of adoption to ensure it contributes to individual well-being and society overall.

2.10.6 Regulatory Coherence and Innovation

The development of self-driving cars, the internet, and other disruptive technologies will require new ways of meeting consumer demands. Regulatory issues will arise if new ways of facilitating these developments do not take the current regulatory structures into account. These changes are just around the corner. The future of innovation and technology depends on avoiding regulatory capture. While technological developments are becoming increasingly complex, regulators must take these trends seriously (Pique, Berbegal-Mirabent & Etzkowitz, 2018). It is especially crucial for the development of new technologies, as these developments have broad implications for multiple social processes. Techno-regulation has also risen in parallel with the study of code (Maruccia et al., 2020). Value-sensitive design embeds ethical principles in design. A legal environment that reflects these values is also important for society. The goal of regulation is to ensure that emerging technologies do not disrupt or negatively impact society (Unger & Polt, 2021).

According to Pan & Guo, (2021) the Fourth Industrial Revolution is a disruptive force, and this uncertainty and disruption is no easy feat to face. Regulatory coherence in innovation policy law and ethics should be part of that effort. The legal requirement to demonstrate the adoption of ethical principles must not be a sleight of hand (Edgar & Kharazmi, 2022). It should be a shared responsibility between regulators and industry, and it should not stop at identifying responsible innovation principles. Responsible innovation focuses on the values of the European legal order, and the entire design process should be shaped around these principles (Chulok, 2022).

The evolution of regulation needs to become cyclic and dynamic, with more stakeholders and quasi-regulators bringing their concerns to the fore (Liyanage & Netswera, 2021). Regulation that lacks enforcement is a research tiger. Smart regulation requires a carefully chosen combination of regulatory instruments grounded in a strong framework of rights and values. The resulting regulatory regime should have the best balance of these three elements. This is possible only if the process is more interactive and involving.

2.10.7 Taking Humans out of The Loop

The implementation of intelligent programs will pose new ethical and regulatory challenges (Liening et al., 2021). These systems may produce unexpected results or harm other actors. Examples of such technologies include Tay and Google Photos. The future of innovation policy should take these new technologies into account. A lack of ethical considerations may lead governments to abandon their AI pledge (Liyanage & Netswera, 2021). This may have negative consequences for international security, but ethical concerns must be addressed to ensure that AI is developed responsibly.

2.10.8 Privacy Regulation

While privacy regulation is vital, it is not the only topic that requires regulatory oversight. The asymmetric information between consumers and firms can result in asymmetric harm (Moon, 2008). Many of the concerns discussed in the data privacy and security community are not the result of firms deceiving consumers. According to Ma et al. (2018), lack of data hygiene education is another major cause. Therefore, policymakers must choose between privacy and security as the most important issues.

As privacy concerns grow more important, so do regulatory efforts. While new privacy laws can be helpful, they are unlikely to address emerging abusive behaviours. For example, few proposals address the chilling effect of ambient surveillance. Moreover, a new privacy law may not have the teeth to curb the proliferation of surveillance advertising (Hasche et al., 2019). The motivations for such advertising must remain legal. Privacy regulation must be dynamic and balance competing priorities. It is important to recognize the asymmetric nature of online surveillance and make sure that the balance is not too lopsided in favour of one another (Ricardo & Rabelo, 2021).

According to Joana et al. (2021), to address the asymmetric risks associated with online privacy, the UK should pursue aggressive antitrust enforcement and update its federal privacy laws. Regardless of the size of the Internet market, a comprehensive new regulatory approach is essential. If the government fails to anticipate the dangers that will emerge in the coming decades, it will fail its citizens. According to Edgar et al. (2022), there should be a hybrid approach to privacy regulation that balances competing interests. For example, a single opt-in regulatory tier is proposed for online infrastructure companies, such as Google and Facebook.

Whether or not privacy regulation is necessary is another matter; however, the problem is that online service providers are increasingly using surveillance to gather data on their users. They then use this information to create predictive statistical models of users' behaviour. These companies also sell these models, resulting in an unintended outcome - the data obtained will be used to target advertising and other activities. While these techniques are not illegal, they can have material impacts on people's lives.

2.10.9 Trade-Off Between Innovation and Privacy

The trade-off between privacy and innovation is a key issue in the ongoing discussion over cybersecurity (Budwig, 2015). Considering the growing importance of the internet to our everyday lives, the protection of individual privacy is critical. With the advent of digitization, privacy has become part of innovation policy. But until now, policymakers have considered the use and protection of data as two separates, competing interests. Certain countries have implemented regulations that severely limit the exchange of data, hindering creativity and offering minimal privacy protection (Datta, Saad & Sarpong, 2019).

The matter of privacy and security gained significant attention during the COVID-19 pandemic (Heidkamp, Garland & Krak, 2021). As the virus started to wreak havoc on society throughout the world, governments were forced to monitor its spread using data-driven tools and tracking technologies. To safeguard public health, this necessitated privacy-invading measures like location and travel information identification. More stringent measures were implemented as the pandemic spread, even though privacy regulations were loosened to help keep people safe.

Majeed et al. (2017) enforced that the security and privacy are interdependent and do not conflict with one another. The most common factor influencing the trade-off between security and privacy is economics. Organisations and people are gathering more data because of the falling cost of information storage. Despite worries about security and privacy, people are willing to divulge more personal information about themselves as the cost of storing it decreases (Vallance, Tewdwr-Jones & Kempton, 2020). Both parties to the trade-off are concerned about these issues: individuals want to prevent the misuse of their personal information, and organisations want to make sure they don't annoy the other party.

2.11 Policy Implications – Procedures and Processes and Legal Implications

The relationship between patent boxes, investment-innovator partnerships, and high-throughput screening are just a few of the important topics covered in this section. To ensure equity and compensation for inventors and entrepreneurs, it looks at several policy options in its conclusion.

2.11.1 Investment-Innovator Partnerships

Apart from supporting the expansion of the private sector, the government ought to support investments in innovative concepts. For instance, the UK. Small Business Administration (SBA) leads programs for high-growth small companies, which support R&D for commercially viable innovations. Public-private partnerships support SBA's Office of Investment and Innovation, which helps small businesses on their path from idea to IPO. For example, the SBA's Office of Investment and Innovation provides financial capital to support high-growth small businesses. The other example is the LILA (Living Labs) who provides funding to the innovators.

2.11.2 Patent Boxes

Incentives for research and development (R&D) conducted in the country in which the patent was first granted are one of the main goals of the patent box regime (Rosenberg, Trencher & Petersen, 2015). It provides a low tax rate to businesses that locate their IP within the country, thereby enhancing the overall competitiveness of the tax code. Another type of tax break, R&D tax credits, also promotes R&D and helps companies reduce their tax bills. The main purpose of patent box systems is to stimulate innovation by reducing the tax rate on intellectual property assets (Rouxle & Pretorius, 2016). Patent box legislation has been introduced in Congress several times but is not yet law in the United States (Rush et al., 2021).

2.11.3 High-Throughput Screening (HTS)

One of the main challenges in setting up an automated screen is ensuring stringent quality controls and an effective assay. Clearly distinguishing positive and negative controls is necessary to ensure high-quality data. The use of robotic platforms in high-throughput screening can speed up data acquisition by managing multiple plates at one time (Lozano, 2006). Such systems can range from simple automated liquid handling machines to complex multidimensional workstations. They are supported by mechanical

arms and can manage microplates from one station to another and carrying out several steps in the process (Lozano, 2018).

HTS is a relatively recent innovation and has been made possible by modern robotics and high-speed computer technology. To perform this type of screening, however, an expensive screening lab is necessary. As a result, smaller research institutions will access these services from third-party providers. However, institutions that can afford such high-tech screening services are usually able to use existing screening facilities.

2.11.4 Lifecycle of Innovations

According to (Stua, 2013) during the lifecycle of an innovation, its environmental impacts must be minimized. However, the lifecycle of a particular innovation is not always predictable. For example, a bank may discontinue a particular service due to low customer demand. Similarly, consumers may switch to a different method of payment, which can affect financial institutions' procedures and processes. The bank must provide advance notice to its customers about such changes.

A person's acceptance of an innovation depends on the timeframe that it takes for it to reach the market (Kang & Jiang, 2019). The adoption process follows a five-stage decision-making process that occurs over time among similar social systems. Ryan and Gross first identified this process in 1943. The five stages of innovation adoption are crucial, because individuals can reject an innovation at any point along the way (Finley, 2003). According to Lozano, (2006) studied the diffusion process critically, and asked questions about the spread of technologically inefficient innovations. He also suggested methods for evaluating the diffusion of efficient innovations.

2.11.5 Policy and its Implementation – Consent Approved

Despite their similarity, there are some key differences between a Consent Approved and a Consent Policy. Both policies require consent from individuals, but different ways of obtaining this consent (Pique, Berbegal-Mirabent & Etzkowitz, 2018). Consent policies must be carefully implemented, and the consent mechanism itself must be clear and easy to understand. Long lists of checkboxes may seem granular, but they also carry different risks, including a lack of interaction or inability to understand the information provided (Prokop et al., 2021).

2.11.5.1 Importance of Careful Implementation of Consent Policies

The importance of the careful implementation of consent policies cannot be overstated. Participants must consent to their wish to participate in research before they can be considered a subject of ethical research (Provenzano, Seminara & Arnone, 2020). A patient must sign and date an informed consent form for it to be recorded. The international norm for gaining consent was established in 1947 and is known as the Nuremberg Code. Medical research is overseen by an ethics committee. Nonetheless, a lot of organisations are ignorant of the ethical and legal obligations surrounding informed consent. For instance, medical ethics, which includes the right to information about medical procedures, is the foundation for the principles of informed consent (Purcell, Henriksen & Spengler, 2019). Signed consent forms must uphold this essential tenet, even though medical consent forms and pre-operation talks are useful instruments in putting the informed consent doctrine into practice. Patients must consider the advantages and disadvantages of a treatment plan to give their informed consent (Quinlan, 2011). Findler et al. (2019) state that there are several benefits to using dynamic consent policies. Initially, consent can be given with greater specificity by participants, which facilitates consent withdrawal.

2.12 The Triple Helix Model of Innovation and University Entrepreneurship

The Triple Helix Model of innovation is based on the development of individuals and institutions.

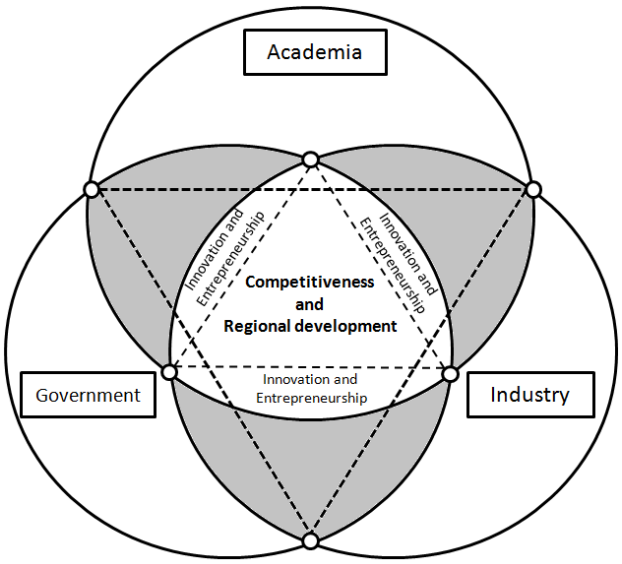


Figure 2.4: Triple Helix Model

(Source: Henry & Leydesdorff, 1990)

The role of institutions in the Triple Helix model has changed over the last decade. Universities maintain an important role during the inception stage. Industry agents include accelerators and business angels. Governments have tried to develop closer ties with universities and the industry. However, their roles in the launching phase are relegated to the secondary tier. As a result, these three strands play a pivotal role in creating new companies.

2.12.1 Impact of the Model on University-Industry Interactions

Academic circles have been discussing a lot about the Triple Helix model, according to Robaeyst et al. (2021). Its effect on interactions between academia and business, however, has proven complex. What is it, and how does it affect the relationships between academia and business? The Triple Helix model's primary proponents, Rouxle & Pretorius (2016), contend that it represents a paradigm shift in university-industry interactions and encourages an entrepreneurial mentality in higher education.

By developing close relationships between the public sector, academic institutions, and the private sector, the Triple Helix model drives innovation in communities that are marginalized (Rosenberg, Trencher & Petersen, 2015). The model acknowledges the contribution of civil society to the generation of novel ideas and the resolution of underlying issues. In particular, the Triple Helix model encourages the mobilization and debate of diverse sources of innovation. Further discussed by Rush et al. (2021), this model is controversial, but it is essential for developing a thriving innovation system.

The Triple Helix model describes a new paradigm for university-industry interaction that involves an overlapping of the three sectors (Rypestøl, 2020). This paradigm is described as an ideal Triple Helix and develops from two main modes of interaction: statist models and laissez-faire models. Statist models are common in the former Soviet Union and many Latin American countries. The laissez-faire model places more autonomy and independence between industry, universities, and government.

Moreover, the Triple Helix model calls for a new paradigm for innovation. The three interlocking elements are key to generating new ideas (Sachs, 2018). As the Triple Helix model highlights, universities increasingly take the role of commercial actors, and their role has evolved beyond the production of basic research. As these three elements are hybridized, intermediaries will emerge between them, resulting in a new system of knowledge creation and innovation.

Santos, Zen & Bittencourt (2021) state that the Triple Helix model emphasizes the social experience and the significance of innovation. Studies indicate that this framework has a noteworthy influence on the advancement of academic institutions and industry. Having been said, some countries lack the appropriate intellectual property laws to support a robust Triple Helix model (Alpaydin et al, 2015; Rutten and Van den Broek, 2019).

2.12.2 Complex System of a Triple-Helix Model

The university, business, and government are the three distinct stakeholders whose local advantages and responsibilities can be measured using the Triple-Helix model (Kang et al., 2019). This model's theoretical and methodological analysis directs our search for solutions by incorporating the fundamental concepts of complexity. It considers the differences between various systems of reference and concentrates on characterizing the function of institutions in the growth of the knowledge-intensive economy (Chen et al., 2020).

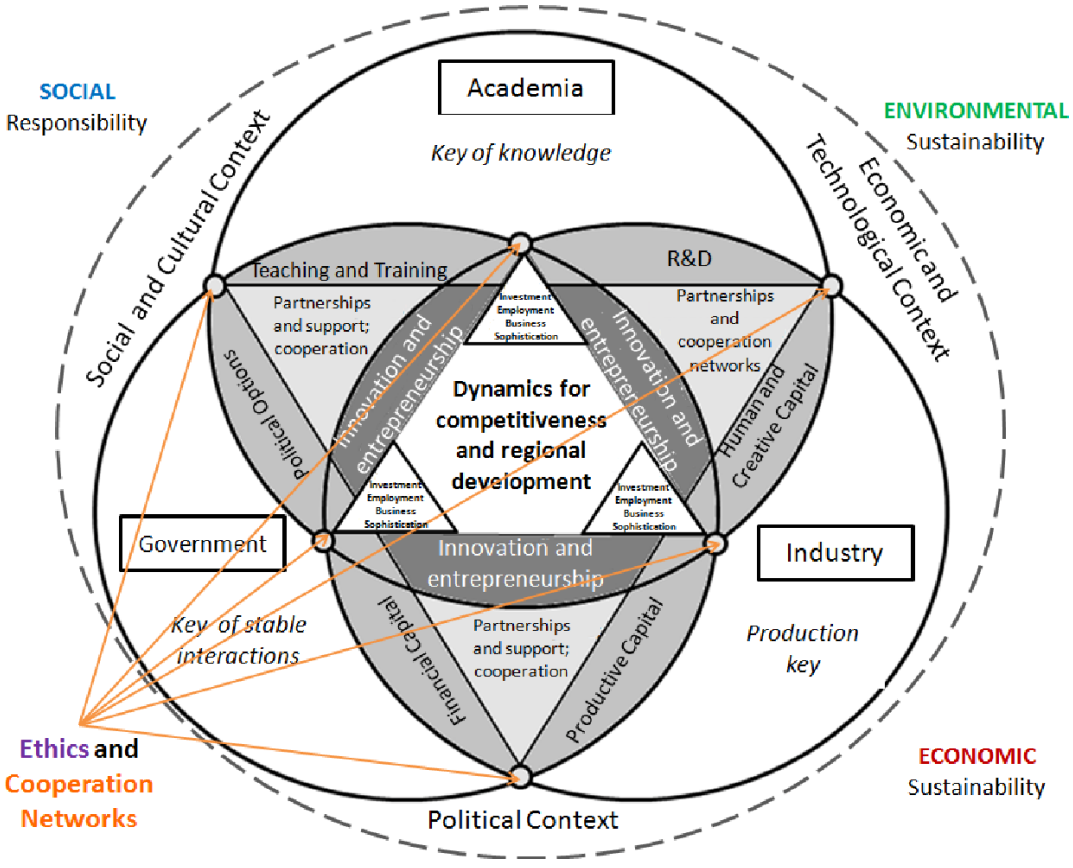


Figure 2.5: Complex System of Triple Helix Model

(Source: Chen et al., 2020)

Numerous studies have acknowledged the triple-helix model's complexity (Budwig, 2015., Cunningham et al., 2018, Vallance et al., 2020, Wang et al., 2021). These studies have brought attention to the need for novel strategies, like putting Educational Action Research into practice to assist student learning and creative endeavours. This method also enables us to comprehend the role that innovation networks and entrepreneurial communities play in promoting innovation (Rush et al., 2021). As a result, the society and community are also able to understand the reasons behind corruption and the obstacles to innovation.

To achieve these ends, the Triple-Helix innovation model is a helpful tool. It means shifting priorities to innovation, developing environments that are conducive to new ideas, and providing support for them (Musari, 2021). New technological developments can also be modelled using the Triple-Helix approach. To achieve this, we must develop a comprehensive theory of the entire process of innovation. To fully comprehend the Triple-Helix model, Robaeyst et al. (2021) assert that systematic studies capable of capturing the interdependence of the various parts and their relationships are required. This approach also considers knowledge of innovation networks and clusters.

2.13 Recursive Nature of The Model

The concept of the triple helix serves as the cornerstone for the advancement of knowledge. It is an example of intra- and inter-reciprocal learning that facilitates the active interpretation of meaning and serves as an antecedent to the proposition. According to Whelan and Fink (2016), the triple helix also encourages government and academic institutions to collaborate in developing innovation and facilitating access to knowledge-intensive economies. The goal of this framework is to promote creativity, innovation, and the recognition of innovation as a human possibility.

The government, academic, and business sectors are all integrated under the triple helix model. As organizers of local and regional innovation, universities play a quasi-governmental role (Pique et al., 2018). The industrial R&D laboratory, which may serve as a historical illustration of Organisational complexity, is comparable to this strategy. An intermediate level of agencies characterizes the current "post-modern" research system. The task of promoting knowledge exchange falls to these Organisations (Secundo et al., 2019).

SME innovation strategies adopt a triple helix approach, acknowledging the importance of knowledge capture. According to Hou et al. (2019), the triple helix model facilitates coordinated knowledge and cooperative efforts around opportunities. This hasn't been widely accepted, though, as the SMEs have mostly kept up their bilateral activity intensification instead of organizing additional BMI. According to Chen et al. (2020), the limited resources coordinating innovation among SMEs is costly. It is thus necessary to establish a knowledge space for collaborative efforts to achieve coordinated innovation.

In addition to the triple helix model, the literature on university-industry-government relations has explored the relationship between these stakeholders. They have also identified two distinct modes of scientific knowledge production: national systems and regional networks. By incorporating these three elements, the triple helix model can provide an analytical window into the complex relationships between universities, SMEs, and governments.

2.13.1 Case Studies of The Triple Helix Model Innovation Universities Enterprises

The Triple Helix is an emerging model for innovation and university entrepreneurship (Sachs, 2018). It is a collaborative model where universities are not the only stakeholders but also work as agents in the ecosystem. The role of the university in this model depends on the region. A university should provide conditions to encourage innovation and encourage creative thinking (Yun & Liu, 2019). According to Jose-Maria (2020), this can be achieved through the art department, which is not necessarily associated with the business.

The Triple Helix model is sufficiently complex represents different perspectives of participants-observers and guides an analytical search for alternatives (Rypestøl, 2020). It distinguishes between two distinct dynamics and the specific configuration of university-industry-government relations, and the transformation of infrastructure in the knowledge-intensive economy. Further discussed by Dolores (2021), it reflects differences among the systems of reference and aims to provide participants with windows into the model's possibilities.

The Triple Helix model can be formulated to incorporate these four elements. In addition, universities can perform various functions in the government, while the latter plays the role of a quasi-governmental innovation organizer. The concept of the triple helix model has more theoretical foundations than most other models. The concept's theoretical

foundations are strengthened by the inclusion of multiple disciplinary perspectives (Cai & Ahmad, 2021). Several disciplinary perspectives have contributed to the development of the model, including social network theory, institutional logic, and a new evolutionary theory (Wu et al., 2022).

The Triple Helix model's three components depend on one another. For the model to work effectively, these three components' roles need to be adjusted. For example, for the university to work with the government and business, its role needs to change. The three Organisations will work together to develop a common vision to bring about this change (Budwig, 2015). Understanding these three entities' roles in the innovation process and realizing their interdependence is crucial.

The innovation SME University Triple-Helix approach's case studies highlight the model's recursive structure and complexity. A Triple-Helix model's three pillars are market support, the knowledge and technology that SMEs require, and the influence of the external environment. In Thailand, the Industrial Technology Assistance Programme (ITAP) serves as a crucial middleman. This initiative matches university knowledge with the knowledge that small and medium-sized enterprises (SMEs) need to help identify their needs. In Thailand's innovation ecosystem, the ITAP is actively involved.

According to Sautter et al. (2019), the triple helix concept provides a framework for SMEs to be integrated into innovation ecosystems. Large Organisations are typically linked to it, but SMEs can also become members of the triple helix. SMEs must have access to important market and industry stakeholders to succeed (Bernardi et al., 2020). Furthermore, by including SMEs in innovation ecosystems, SMEs can gain access to knowledge spaces for reciprocal learning. To put it another way, SMEs can give governments and academic institutions information.

The triple helix theory has several effects on how new ideas and creative business models are developed. With the help of this framework, SMEs can actively understand the meaning of their business models and gain from group learning (Fernandes & Ferreira, 2021). These SMEs are participating in an Organisational learning process that is both intra- and inter-reciprocal. These elements may facilitate SMEs' complete utilization of the triple helix framework. Universities, businesses, and governmental Organisations must consider the implications of this idea (Alexis, 2021).

The Triple-Helix theory proposes an innovation studies network mode. This indicates that there are various, unpredictable settings within innovation networks, which are defined by a complex web of interactions (Alunurm et al., 2020). Networks of actors determine the processes involved in innovation based on their dynamic interactions and exchange of meaning codes. Knowledge-intensive industries may eventually become institutionalized because of these interactions (Elias et al., 2021). Innovative people can better understand their local environments by using the Triple-Helix model.

The Triple-Helix model is sophisticated enough to consider various viewpoints from participant observers and direct the search for solutions through analysis. It highlights the blurred lines between functions and focuses on the interdependence of the government, business, and university systems. Universities, SMEs, and government agencies are all included in the Triple-Helix model's definition of innovation. Moreover, creativity emerges at these communities' interfaces.

2.13.2 Enablers and Barriers of Triple Helix Model

Numerous contexts can benefit from the application of the Triple Helix Model's Enablers and Barriers concept. In addition, this study addresses the institutional sphere, social media, the University-industry-government (U-I-G) sphere, and misconceptions about actor and element concepts. It also explains the advantages of applying the Triple Helix model to comprehend the intricate interactions among these domains.

2.13.3 University-Industry-Government

A paradigm for promoting collaboration between academic institutions, businesses, and government is the Triple Helix Model of innovation and economic development (Pan & Guo, 2021). It looks at the obstacles and facilitators that stand in the way of these three sectors working together effectively. It also considers the various ways in which these industries can promote innovations more successfully. There is a lot of interest in national innovation systems now that the triple helix concept has been introduced. It might improve the country's capacity for innovation and competitiveness. The knowledge economy, the entrepreneurial-innovative model, and the statist model are the three typologies of innovation systems that are integrated by the idea of the triple helix. Every typology has distinct features, one of which is the interaction between industry and academia. There was little cooperation between universities and private businesses, despite the latter being perceived as the vanguard of innovation (Ribeiro et al., 2020). Rather, the government was promoting innovation and strengthening its role

as an educator in tandem with universities. Rather than enabling innovation and entrepreneurship, the government's R&D institutes largely served to provide technical assistance to farmers.

2.13.4 Institutional Spheres

The Triple Helix Model recognises that the interaction between institutions is critical to innovation. Despite the importance of collaboration, institutional spheres have their own specific goals and must remain independent to enable interactions between them. As such, it is important to understand where innovations occur so that they can be promoted. Similarly, studies on innovation models focus on different perspectives of innovation. The open innovation model focuses on the external research process of firms (Stua, 2013). Likewise, the Triple Helix model acknowledges the importance of industry-university relations to innovation. To achieve the optimum triple helix model, an independent institutional sphere should take the initiative. In many countries, however, the government controls both industry and academia. Such a situation leads to government-pulled social development and party-oriented economic growth. The majority of large-scale industrial enterprises reference national strategy and rely on the government rather than the market (Trencher, Terada & Yarime, 2015). The government and key actors work together as satellites. Another key to creating balanced helices in the Triple Helix Model is to ensure that each institution has a unique role in achieving its mission (Rouxle & Pretorius, (2016). The function of the university is unique. The university has many shared functions such as teaching, research, social service, and technology transfer. Governments also have a role to play, including training programs and state-owned enterprise.

2.13.5 Social Media: A New Dimension in Triple Helix Model

The Triple Helix Model combines university-industry-government collaboration with a new dimension: social media. The triple helix is a dynamic collaboration that can spur a new cluster to emerge faster. The public's role is critical during the early instigation stage of an innovation and before economic activity begins (Hansen & Ockwell, (2014). It is important to remember that this model works at both the macro level of a region and the micro level of specific topics.

The triple helix model is the result of interaction between three different institutional spheres. Each contributes unique resources to a common problem and creates a hybrid entity with capabilities that no single sphere can match (Sachs, (2018). These three

spheres reinforce the unique contributions of the other two. The three spheres are interacting together to address the challenge of globalization. The triple helix model can also be used to improve the quality of public services.

The Triple Helix indicator is the most widely used and provides valuable conclusions to policymakers. Regardless of which metric is used, the Triple Helix model provides valuable conclusions to policymakers and stakeholders (Smart et al., 2019). The Triple Helix indicator can be improved through a new efficiency approach.

2.13.6 Impacts of Social Media on the Sustainable Development GOALS (SDGS)

The social media platform Facebook has 1.4 billion active monthly users around the world. Twitter has 316 million active monthly users. In terms of size, this social media space is a decent crowd-sourcing platform for ideas. But what impact does social media have on the Sustainable Development Goals? This research looks at some of the specific ways in which social media can affect the Sustainable Development Goals. As was previously mentioned, social media's widespread use is altering how we communicate. Because these platforms give people a platform to voice their opinions and give political parties access to a worldwide audience, they have become essential tools for political parties. In recent decades, several contemporary issues have gained prominence, including happiness, social equality, employment, and education. International authorities met at a global summit in response to these issues to develop the 2030 Agenda and Sustainable Development Goals.

Social media additionally adds to the public conversation regarding the SDGs. Therefore, decision-makers must consider the views of the public and use these resources to make choices that are consistent with their priorities and values. Social media is one tool for gathering and documenting public opinion. Researchers have also benefited from the use of IT in the field of social media by gaining a more comprehensive understanding of public issues and determining the key players.

2.13.7 Misconception of Actor and Element Concepts

The Triple Helix model promotes partnerships among consolidated structures, which excludes smaller actors. As a result, smaller actors have less opportunity to promote themselves. Researchers such as Rouxle & Pretorius, (2016) have studied the impact of small businesses near large institutions. In the study, they discovered that scientists working near prestigious companies perform better and gain publicity at an earlier stage

of their careers. Furthermore, they received economic messages from the environment more rapidly.

Although the Triple Helix model can be applied to non-Western contexts, it has yet to be validated in those settings. This may be due to different institutional logic in the Western and non-Western countries Fischer et al., 2019). However, these differences may create opportunities for social change and innovation. For example, in China, institutions may not be as developed as in the United States. But in countries like the United States, where intellectual property protection is weak, universities may form spin-off enterprises or firms in science parks.

Although the concept of civil society is a Western concept, other countries like China have been evolving differently. The lack of functional mechanisms in the Triple Helix model may explain the differences (Diniz et al., 2019).

2.14 Impact of the Model on Economic Growth in United Kingdom

Numerous countries have established science parks, which have raised living standards and generated new businesses and products (Lo & Theodoraki, 2021). Universities have benefited from the establishment of these parks as they now have consistent funding for research and can better prepare their students for careers in industry (Lopes, Farinha & Ferreira, 2019). Additionally, they have made it possible for colleges to carry out research and development in response to national needs, aiding in the expansion of the economy (Lopes et al., 2020). But these parks will eventually hurt the nation's economy if they are not placed correctly (López-Rubio, Roig-Tierno & Mas-Tur, 2021).

A multi-sector approach to development that promotes collaboration between various actors is known as the quadra helix model (Lozano, 2006). Another goal of this strategy is to develop nonlinear roles that promote internal transformation. By establishing the proper frameworks and conditions for growth, the government promotes economic development (Lozano, 2018). Companies then make investments in scalable, sustainable, and replicable solutions (Ma et al., 2018).

It has been understated how much these universities have contributed to the UK's economic expansion (Majeed et al., 2017). Most of the country has a tropical climate, but because of its arid interior, natural disasters frequently have a devastating effect on the local economy. Rural families will continue to be food insecure and impoverished if appropriate investments are not made (Majeed et al., 2016).

The traditional roles of academia, business, and government have become hazier because of the triple helix model (Manioudis, 2021). Universities are becoming less focused on producing basic research and more involved in business endeavours. The creation of middlemen between these three components comes next. They then undergo additional hybridization and integration (Manuelli & Sheshadri, 2003). In their respective domains of competence, the three entities are still able to maintain their dominance. Universities play a more crucial role than ever in this increasingly globalized world. By forming wide connections and working with a variety of stakeholders, universities should be more actively involved in influencing the direction of society (Marques et al., 2019). It is recommended that universities encourage a collaborative environment among all four helices to further advance their social role. It is in this dynamic environment that new concepts will arise and flourish. They ought to make it their mission to spur innovation, particularly when it comes to finding solutions to societal problems (Martinidis, Komninos & Carayannis, 2021).

2.14.1 Influence on SME's

Businesses in the modern era understand the value of knowledge capture in the SME sector (Maruccia et al., 2020). However, how would it be applied in a way that the SME could understand? The Triple-Helix method provides an answer. It entails actively interpreting meaning within the framework of a complex educational process. The Triple-Helix method involves three distinct actors in the process. Stated differently, there are three domains: the public, business, and government. These three spheres intersect to create the best environments for innovations (Mehari et al., 2022). The Triple-Helix model has many advantages, but before applying it, certain disadvantages must be considered. These are an innovation ecosystem's three main constituents (Meissner, Gokhberg & Saritas, 2019).

The Triple-Helix model integrates the roles of government, business, and academia; this is the foundation of the Triple-Helix approach (Meyer, 2022). This model is predicated on the idea that universities organize innovation locally or regionally in a quasi-governmental capacity. The triple-helix model can be conceptualized historically. An illustration of Organisational complexity is the industrial R&D laboratory. A "post-modern" research system is typified by its intermediate level of agencies (Lo & Theodoraki, 2021).

The wind energy sector will be greatly impacted by SMEs and universities working together. The triple-helix idea offers a helpful framework to facilitate access to these

capabilities, even though SMEs frequently encounter obstacles when attempting to utilize these innovation resources (Lopes et al., 2020). As a result, this strategy advances knowledge creation in society, the offshore wind industry, and the political objective of renewable energy. There are numerous additional advantages to triple-helix cooperation (López-Rubio, Roig-Tierno & Mas-Tur, 2021).

2.14.2 Universities as Actors of Regional Development

Universities are generally thought of as players in regional development, but many academics are still unclear about what part they can play in this context (Lozano, 2006). There is a widespread political belief that universities can have a significant impact on regional development, but this belief is not always supported by empirical research (Lozano, 2018). Only a small portion of this type of engagement is covered by the pipeline-dominated approach that is typically the focus of the literature on university-industry relations. The larger processes of knowledge sharing and cooperation between university staff and local stakeholders are not considered by this strategy (Ma et al., 2018).

The 2000 Kaiserslautern case study provides an example of how a multilevel environment affects student engagement (Majeed et al., 2016). Systemic factors like a multilevel institutional framework can explain a large portion of the variation, even though individual indicators might not fully explain the whole picture. This research suggests a more comprehensive approach to university-region interactions by adopting a systemic approach (Majeed et al., 2017). It not only takes the university-region interaction into account but also highlights significant elements that are typically overlooked in the literature.

Moreover, the personal goals of the university representatives play a major role in non-commercial regional engagement activities (Manioudis, 2021). Without the involvement of regional stakeholders, these initiatives might not succeed. As such, it is essential to take these stakeholders' goals into account. In other words, there is a need for university leadership to ensure that these regional engagement efforts do not fall flat and instead achieve their purpose (Maruccia et al., 2020).

In addition to research, university-industry partnerships are also crucial to regional development (Mehari et al., 2022). In recent decades, universities have increasingly diversified their roles in regional development, ranging from a traditional educational role

to the complex infrastructural development of a region. The latter includes research and problem-solving. Developing these connections, in turn, involves the involvement of local companies and researchers (Meissner, Gokhberg & Saritas, 2019).

Teaching activities can play a critical role in regional development (Meyer, 2022). They can also lead to long-term institutional change in the region. After all, graduates represent multipliers in the region and are capable of meeting complex challenges. Further, the integration of sustainability-related topics into university curricula and teaching activities can be accelerated through additional vocational training courses or tailored education programs. This is vital for achieving sustainable regional development (Lo & Theodoraki, 2021).

2.15 Importance of Assembling a Workforce with the Right Skills and Knowledge

The lack of skills in a workforce is detrimental to the vitality of a region and nation. Without skilled labour, organisations struggle to innovate, deliver value to citizens, and grow their businesses. Similarly, the lack of skilled labour hinders regions from recruiting high-paying jobs. However, there are ways to address the problem. Here are some of the steps that can help. The skills gap is the discrepancy between demand and supply of talent. Creating a better match between demand and supply can boost business. To avoid the skills gap, businesses must provide thorough onboarding and ongoing training programs for their workforce. Moreover, these training programs can help them adapt their workforce to changing demands and consult with industry experts.

2.15.1 Case Studies of Various Universities

A case study is a story that demonstrates a particular problem or process, typically involving a dilemma, conflict, or problem (Rosenberg, Trencher & Petersen, 2015). While case studies have been used extensively in the teaching of business, law, and medicine, they are equally effective in other disciplines (Rouxle & Pretorius, 2016). Case studies are an excellent way to bridge the gap between theory and practice by giving students practice articulating positions and evaluating courses of action (Rypestøl, 2020).

Innovating at universities requires more than just offering courses on innovation (Santos, Zen & Bittencourt, 2021). The right environment encourages professional innovators (Rouxle & Pretorius, 2016). The university should target promising students and provide them with an environment that encourages their creativity and innovation (Robaeyst et

al., 2021). Some interventions include promoting interdisciplinary connections, offering project-based learning, building mentor networks, and providing social and business-support services (Rush et al., 2021). This research will review various university innovations that are driving the future of education (Rypestøl, 2020).

First, the model for SI is based on the university hub, which has been developed for HIC settings (Sachs, 2018). The key goal was to develop a case study model that could be contextually relevant for LMICs (Santos, Zen & Bittencourt, 2021). Second, because resource constraints remained consistent in all the institutions studied, the informal hub structure was developed within an existing department, which helped leverage the existing resources of the institution (Santos, Zen & Bittencourt, 2021). Third, case studies were created to help institutions understand how to implement SI (Rosenberg, Trencher & Petersen, 2015).

Even though university-based SI hubs are designed as temporary structures, they are meant to catalyse SI within the local healthcare system (Rouxle & Pretorius, 2016). They also adhere to university-level values of inclusion, assets, and co-creation (Robaeyst et al., 2021). These universities also receive a robust capacity-building package (Rush et al., 2021). These efforts have a variety of challenges, however, including internal institutional resistance, the bureaucracy of universities, and the annual funding cycle (Rypestøl, 2020).

2.15.2 Alternatives to Lecture

There are several alternatives to the lecture in university settings. A lecture online is unlikely to be an effective learning tool. A good lecture delivers information, engages students, and keeps them focused. Face-to-face lectures are more likely to result in effective learning. Here are some tips on how to make an online lecture substitute effective:

A flipped classroom model involves having students prepare material outside of class by researching the topics in advance. Professors facilitate discussion of material outside of class. Flipped classrooms are a good way to integrate more interactive and active learning modalities in the classroom. They also promote critical thinking, cooperative learning, and personal responsibility. By implementing these changes, students will be better able to retain the information they learned.

2.15.3 Blended Innovation

While liberal arts and technical education may have their distinctive strengths and weaknesses, both are necessary for innovation. Blended innovation connects academic research with commercial objectives and social goals (Dechezleprêtr, Glachant & Ménière, 2008). Students in liberal arts and technical disciplines would collaborate on projects and serve as guides. Technical innovators would develop new products and services, and the responsibility for strategy and operations would be shared across the various disciplines (Hansen & Ockwell, 2014). Blended innovation has great potential for higher education. For example, e-Marin's lab is a blended course design project involving 12 university teachers. Two educational engineers accompanied teachers during the course transformation process, helping them redefine the learning objectives and choose appropriate media formats. The engineers also created interactive multimedia storyboards using video and animation. After the course launch, they provided personalized coaching and advice to teachers. The web designer elaborated satisfaction surveys to gauge students' satisfaction levels. While some institutions baulk at commercialization, others advocate for purist forms of learning. Hasche, Höglund & Linton (2019) claim that direct industry engagement corrupts academic life, as material incentives and concerns trump contemplative research. However, research conducted by universities yielded nearly 30% of publicly funded R&D (Hong et al., 2019). The universities can take advantage of this by structuring their tech-transfer offices around a business mindset. They could also reformulate their promotion and tenure criteria to incorporate business creation in their programs (Hou et al., 2019). They could also pursue more structured long-term relationships with industry and seek better compensation for their products (Heidkamp, Garland & Krak, 2021).

2.15.3.1 Stanford GSB

Courses offered by Stanford GSB include the Centre of social innovation and Entrepreneurialism is an exceptional program that allows students to be a part of the world. The programs offered include specialized courses as well and it also has the Stanford GSB Impact Fund. Students are also able to participate in programs like the Stanford GSB Innovation Case Study as well as The Social Entrepreneurship Program. By participating in these programmes, the students will be able to come up with and implement ideas for business. This is a possibility for Stanford GSB to lead in this area due to its focus on social innovation.

The school is a great choice for those who are enthusiastic about the ecosystem of innovation particularly those who live in Silicon Valley because it focuses on general management, as well as the diversity of its students. The school also stresses the importance of collaboration across disciplines between pupils, which is crucial for the success of the innovation ecosystem. The school views technology as an instrument for shaping the future of work and encourages collaboration at work. It also stresses the importance of encouraging an environment of sharing and empathy. It also highlights the importance of cultivating empathy and sharing. Stanford GSB profile, which offers resources for further research and important details about the school, might be interesting for prospective students.

The Stanford GSB Innovation Case Study provides a variety of cutting-edge strategies to train future leaders. The student body and faculty of the school demonstrate its focus on teamwork and innovation. The school encourages students to lead from the heart and integrate their studies with cutting-edge technology and business ideas. It encourages professors to explore various teaching methods and theories. This is why Stanford GSB continuously develops and expands its curriculum and programs.

2.15.3.2 Texas A&M University

Innovation is something that many Texas A&M University students take very seriously. A group of students from the University of Biomedical Engineering is a good example. A newly discovered material that transforms ultrasonic waves into optical signals has been created by Vladislav Yakovlev and his colleagues. This substance, referred to as a metamaterial, generates images with significantly greater resolution and detail than traditional ultrasonography technology. Medical imaging quality has been said to have improved because of these innovations.

The creative research being done at Texas A&M University might pique the interest of other students. A few Aggie-owned businesses, some of which were founded based on research, are tracked by the university. The companies with the highest levels of success are then identified using this data. The university also organizes the Aggie 100, an annual competition to identify the Aggie businesses with the fastest rate of growth. Aggie-owned businesses and university staff are both recognised in this competition.

Texas A&M University's iTP3 project is an additional illustration of innovation in action. Innovative methods to lower adolescent pregnancies have been created and tested by the iTP3 project. Texas A&M has created a model to address traditionally underserved

populations' issues in novel ways by identifying these populations. The project's innovators collaborate to create interventions by applying systems thinking and human-centred design.

2.16 Birmingham City University (BCU) Campus: Living Lab as Innovation Catalyst

Birmingham City University's Living Lab is an innovative environment where individuals from diverse backgrounds collaborate to address various challenges. This approach provides communities with the resources needed to develop and implement their innovative solutions (Evans et al., 2015). The recent establishment of the Living Lab at Birmingham City University has shown promising preliminary results in community development. The concept of living labs offers significant benefits to a wide range of communities and institutions. The campus serves as a microcosm of society, leveraging its resources and active participants to achieve community-wide objectives. The integration of these elements within Birmingham's urban setting is facilitated by the living laboratory concept. The campus transforms into a dynamic laboratory, developing connections among its members by integrating the university's operational and physical assets. Understanding the systemic nature of innovation is crucial for developing living labs as catalysts for innovation, involving phases of modifying collaborative networks, tools, methods, and processes for idea creation (Turkama, 2012; Rosenberg Daneri, Trencher, & Petersen, 2015; Schaffers &; Evans et al., 2015).

Community-based transition arenas that mirror living labs function as open-innovation loops, helping organizations overcome stagnation. Everyone involved benefits from user-driven innovation, including product testing and knowledge gained from living labs' holistic platforms. While the objectives for living laboratories are clear and measurable, from user acceptance and system interoperability to infrastructure investment and technology advancement, the results of pilot projects can be obscure and difficult to quantify (König & Evans, 2013; Waheed, 2017; Findler et al., 2019).

Universities excel in establishing open, real-world laboratories for developing new technologies (Trencher, Terada, & Yarime, 2015; Evans et al., 2015; Purcell, Henriksen, & Spengler, 2019). A team of researchers, students, educators, and engineers at Birmingham City University created the "XploR" cane to assist visually impaired and blind individuals. Potential features of the cane include facial recognition technology, GPS navigation, obstacle detection up to 10 meters, and five distinct haptic feedback

pulses. The concept was tested and refined within a Living Lab, involving developers, researchers, users, and professors from BCU. As part of the Interreg NWE Living Lab Application (LILA) project, participants engaged with various users, exploring different approaches, and balancing competing expectations regarding the globalization of business in interactions with people from France and Luxembourg.

Feedback from these sessions highlighted differing regional priorities: Luxembourg participants emphasized the importance of 10-meter obstacle detection, while French participants valued facial recognition technology over GPS navigation, which was most desired by English users. Throughout the project, it became evident that globalizing entrepreneurship relies on discussions involving all partners, stakeholders, and end users. The ongoing development of the project through "living laboratories" facilitated innovative business strategies, shifts in user behaviour, and crowdsourcing. Living labs provide a low-risk environment to simulate viable business concepts, helping to overcome cultural barriers and streamline the internationalization of entrepreneurial ventures. The "XploR" project underscored the need to clearly define obligations and relationships among all stakeholders, highlighting the Living Lab's role as a catalyst for societal and industrial change on the BCU campus.

2.16.1 Technology Transfer Through Networks of Living Labs (BCU, France and Luxemburg)

The core challenge of the "XploR" project has been the transfer of technology, given that users from different domains have varied requirements. This leads to a range of issues when attempting to internationalize entrepreneurship through market formation. The LILA initiative facilitates cross-border collaboration by establishing living labs, which is essential for developing products with regional themes. This approach enables anticipation of consumer demand and strategic planning for product availability. Creating a product that satisfies users in multiple countries involves more than just spreading innovative technologies within a single nation; it requires consideration of cultural, contextual, and legal factors, as well as service and product innovation.

In the "XploR" project, the cross-border challenges are addressed by defining user stories to better understand their requirements in terms of collaboration, preparation, setup, and development. Engaging with international living laboratories is the initial step in expanding the living lab network. The living lab initiates partnerships with international

counterparts and collaborators, establishing partnership agreements to define market growth and product innovation strategies.

The table on the next page represents the five dimensions of a framework model for cross-border collaboration issues.

Table 2.1: Framework of Cross-Border Collaboration Issues

Analyzing	• **Finding the gap in the market.** • **How would it help the users?** • **What barriers are there?**
Planning	Finalizing the contracts and agreements, planning, and building a network and defining responsibilities and roles. • Business model design • Organization of cross border living lab planning and development process • Contracting frameworks and partnership structuring • Elaboration of the common plan • Defining roles and responsibilities • Details of processes, procedures, and planning • Methods or tools used for collaborating (e.g., shared workspace, etc.)
Connecting	Identifying collaborative innovation opportunities, market development and potential market and partners selection. • Potential partners finding and their requirements. • Agreement on approaches and common goals • Principles of intellectual property • Negotiation support and dialogue building • Collaboration procedures • Tools for communication among cross-networks
Support	Conducting collaborative testing, innovation, and market-development activities. • Structuring living labs operations • Governance models • Support for collaboration in the network • Defining the project management and co-ordination tools • Co-ordination among cross-border living labs during support phase (e.g., web conferencing etc.)
Testing	The product should be tested through pilot testing to ensure it has transferred the technology through internationalizing entrepreneurship. • Facial recognition is required in France product model. • 5-zones obstacle detection is required in Luxemburg product model.

(Adapted from: Schaffer's and Turkama, 2012)

Schaffers & Turkama's (2012) framework for internationalizing a project emphasizes three key elements: establishing connections, forming an approach, and providing ongoing support. However, this framework lacks an analysis phase to assess market needs through a demand curve and evaluate the product's potential. Additionally,

Sthlbrost (2015) points out that their approach does not include a testing procedure to ensure that the final product meets customer expectations before distribution. Similarly, the "XploR" project necessitates the involvement of various stakeholders to develop processes for creating, evaluating, and implementing technology to meet customer needs.

The objective of the "XploR" initiative is to pilot cutting-edge technology and promote innovative products. Originating from Birmingham City University students, the smart cane concept required direct interaction with real-world users to validate technology transfer. The criteria outlined in Table 1 were used to guide the co-innovation process. Numerous challenges have arisen in designing and executing new initiatives due to collaboration efforts aimed at expanding existing markets and disseminating relevant technologies.

2.16.2 “Xplor” Project: A Proposed Systematic Innovation Framework

While the "XploR" intelligent cane boasts a GPS navigation system designed to enhance user mobility and commuting, it has prompted various questions from users. These questions span topics such as technology adoption, route selection, obstacle detection, and avoidance. Upon the technology's initial release in France and Luxembourg, there was significant curiosity regarding its potential for global expansion. French users showed a greater interest in the facial recognition system compared to the 10-meter obstacle detection feature with haptic feedback during the "XploR" internationalization phase. Conversely, users in Luxembourg found the 10-meter obstacle detection and haptic feedback more appealing than facial recognition. This indicates that the technology requires further refinement and development to fully meet the diverse needs and preferences of its users.

Participants in the international entrepreneurship assessment have found the "XploR" cane, equipped with GPS navigation and facial recognition, beneficial for both daily and extraordinary situations. The integration of ultrasonic sensors and signal processing capabilities with traditional navigation tools offers a comprehensive solution. This new framework effectively communicates the urgency and uncertainty of any situation to the user. The cane's integrated tracking system and adaptable route re-routing capabilities ensure safe arrival at the destination. Additionally, the computer-human interface is designed to assist visually impaired and blind individuals in their daily activities,

providing a significant enhancement to their quality of life. A model is presented in the below figure, used to base the “XploR” project.

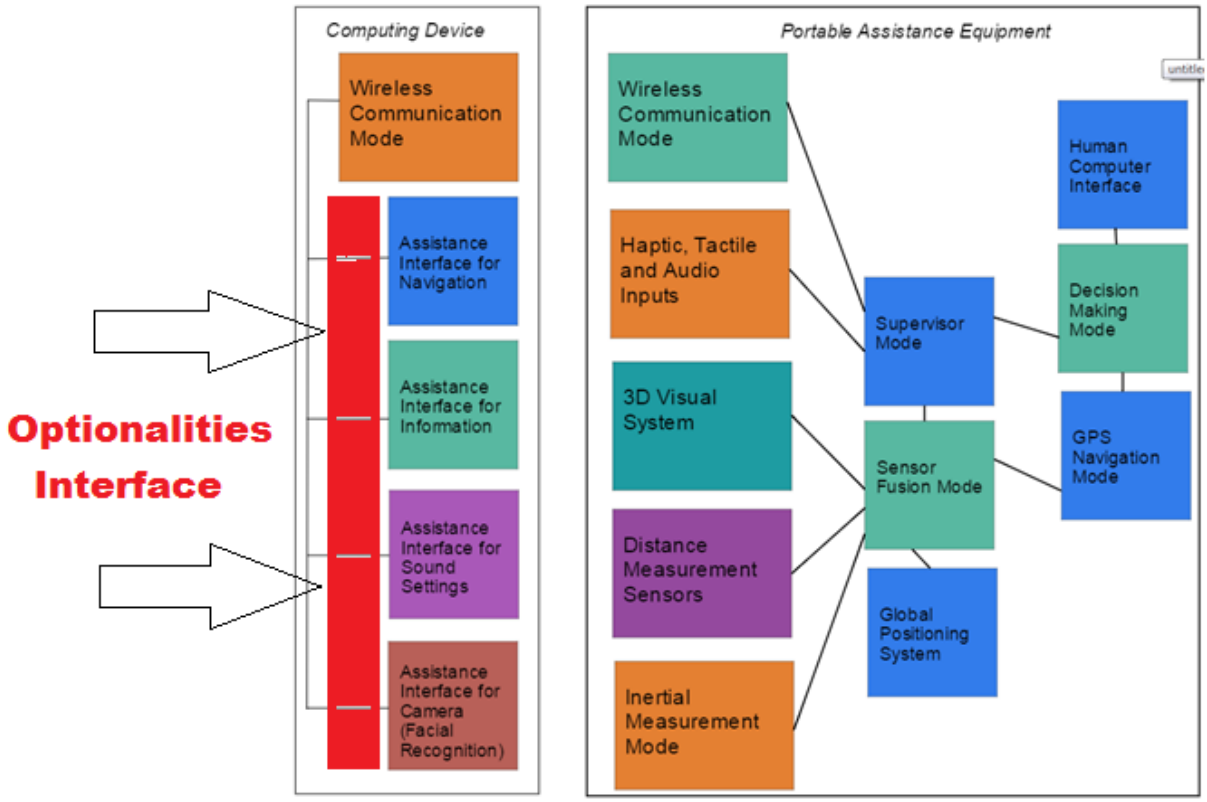


Figure 2.6: The Proposed System Block Diagram

(Adapted From: Assistive Technologies for Visually Impaired People, Liu et al., 2011)

It illustrates the proposed model, detailing the integration of various functionalities through the communication interface. This smart cane features navigation aids, information updates, volume control, and facial recognition capabilities. Each mode provides distinct controls and support functions. The facial recognition software identifies familiar faces by comparing them to stored images, notifying the user via Bluetooth headphones when a match is detected. The navigation interface helps users plan routes, recalculating the optimal path to avoid obstacles.

To meet the needs of globally mobile users, the "Optionalities Interface" layer has been introduced. In response to differing preferences, such as the positive reception of facial recognition in France compared to Luxembourg, the interface allows users to enable or disable the camera feature. Similarly, Luxembourgish users can adjust obstacle detection settings from 10 meters to 4 meters in the menu. This customization aims to

facilitate the global adoption of the smart cane's technology by addressing user-specific needs. Motion sensors integrated with the GPS navigation system help locate and track the user's path, enhanced by the new interface layer. Although the smart cane aids in determining the user's position, slight inaccuracies in distance measurement may occur due to low frame rate sampling of the sensors. The inclusion of magnetic compasses within accelerometers and gyroscopes enhances accuracy. This integration minimizes location pinpointing issues, making the smart cane useful for both outdoor and indoor navigation. Constructed with various sensors, the smart cane relies on advanced computing programming techniques. The sensor fusion module ensures that the cane's additional sensors and interfaces operate cohesively, providing a seamless user experience.

2.16.2.1 Proposed System Design

The purpose of this study is to develop a novel smart cane that is capable of automatic facial recognition, long-range obstacle detection (up to 10 meters), haptic touch, and GPS positioning. There are a lot of canes on the market, but none of them provide the benefits. The sensing capabilities of the cane of up to 10 meters was separated into 5 zones employing various pulses. The Mowat sensor motor and Nottingham Obstacle Detector (NOD) would be used in each zone to identify obstacles and sound an alarm. The "XploR" smart cane is revolutionary because it allows the visually impaired and the blind to navigate their environments more easily. The proposed structure is presented through the below figure.

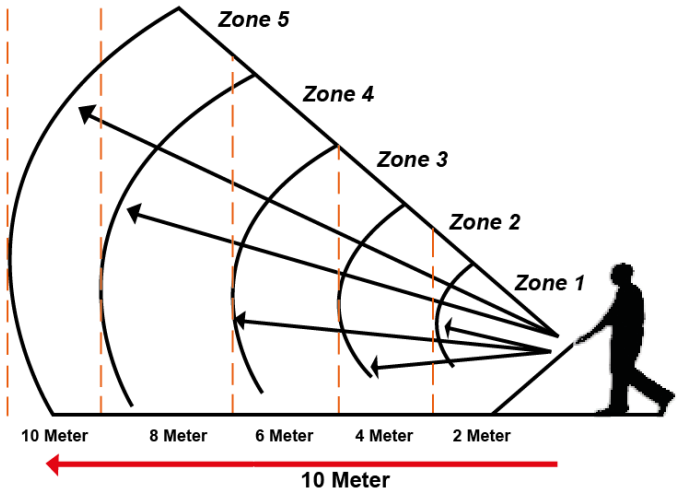


Figure 2.7: Detection Zone and Angular Coverage

(Adapted From: "Xplor" Cane Assisted Mobility for the Visually Impaired, Sakhardande et al., 2012)

This initiative at Birmingham City University Campus (BCU) involves collaboration among students, academics, electronics engineers, and community users. Various criteria emerged during discussions with international partners from France and Luxembourg, aimed at internationalizing this co-innovative product. In France, a survey was conducted to gauge the reception of this new technology among blind or visually impaired residents. The results indicated that while the facial recognition feature was highly appreciated, the 5-zone sensing capabilities were not favored. Similarly, feedback from the Luxembourg partners revealed a strong preference for facial recognition, but the 5-zone obstacle detection was not well received by their users. The project is currently in the experimental phase of technology transfer, requiring the integration of features essential for the internationalization of the concept.

2.16.2.2 Sustainable Product: “Xplor” Smart Cane

Sustainable innovation is a crucial consideration in the invention and development of cutting-edge technology, alongside minimizing potential harm to the economy, society, and the environment. Product innovation plays a vital role in achieving economic success by ensuring sustainability. The "XploR" project operates on the principle that a sustainable and innovative approach to problem-solving can provide a competitive advantage. By engaging various levels of innovation in both developing and developed countries, the "XploR" cane has been designed with a wide range of functionalities tailored to enhance system efficiency, service quality, and the social value of products.

The "XploR" project has integrated both radical and incremental innovation strategies to create a product that significantly improves upon traditional cane designs. The development process was reimagined with the end-user in mind, aiming to provide a viable solution in diverse settings by involving existing user groups.

This study thoroughly examines the inner workings and capabilities of the "XploR" cane, including features such as facial recognition, haptic touch, sensor capabilities, and built-in GPS navigation. An "Options Interface" usability feature has been incorporated to meet international market demands, allowing users to select or omit specific functionalities according to their preferences. The cane's length is adjustable by removing the handle, and it operates on rechargeable batteries, eliminating the need for visually impaired or blind users to handle battery replacements.

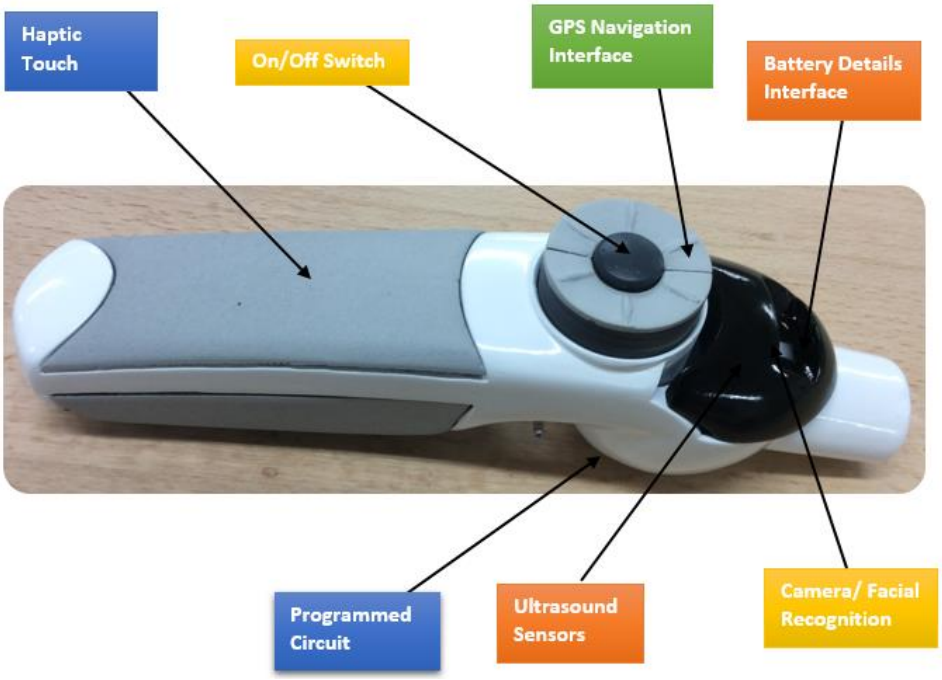


Figure 2.8: "XploR" Cane (Real Design)

(Source: Living Labs (LILA) & BCU Project, 2015)

In the "XploR" project, an innovative cane was developed featuring two receivers, one for each ear. The ultrasonic sensor detects background noise, while the camera captures images of individuals within a 10-meter range, comparing them to a database for identification. The haptic touch feature provides users with various vibrations, and the built-in GPS guides them around obstacles. The objective of "XploR" was to create a navigation system based on pathfinding to assist visually impaired individuals with daily mobility. Utilizing a Nottingham Obstacle Detector (NOD), the cane detects obstacles, calculates their distance, and alerts the user through Bluetooth and haptic touch.

The high cost of technology, lack of digital navigation support, and limited detection features make assistive technologies from different countries inaccessible to the blind and visually impaired. Blind individuals often struggle with locating obstacles, navigating accurately, and recognizing faces. While existing assistive devices like the EyeCane and WhiteCane are useful, they lack advanced features such as facial recognition and environmental awareness through sound. The "XploR" cane aims to address these gaps, providing a comprehensive solution for enhanced mobility and safety.

2.17 Sustainable Innovation Framework and Future of Innovation

The Sustainable Innovation Framework has integrated four key enablers to achieve a more sustainable future for the world's industries. Mass customization, customer-driven design, and mass production are two examples of these. The fourth is sustainability, which requires companies to understand their impacts and create new products and services to address them. Using a holistic approach is necessary to develop products and services that will meet the needs of the customers.

Incorporating sustainability into the business model is an increasingly popular strategy for many organisations. The company can implement multiple sustainability strategies to achieve its goals, including resource efficiency, closing resource loops, and substituting renewable resources and natural processes (Kumar, 2008). Sustainability efforts also boost revenue while also generating positive social and environmental impacts. For example, a fashion brand, Vitsoe, commits to paying its workers above-average wages and has a strict hiring policy. In the fashion industry, companies are increasingly focusing on delivering functionality and satisfying consumers.

Public limited companies with publicly traded shares may find it difficult to convince analysts of the need for a long-term strategy, which requires a more long-term perspective (Lewis, 2013). A new business model can facilitate the adoption of emerging technologies for a diverse range of markets, including consumers. Modern business models seek to reduce absolute material throughput while encouraging end-user consumption (König & Evans, 2013). Sufficiency includes the three environmentally preferable waste hierarchy options: avoidance, reduction, and reuse. Sufficient design is the foundation of a sufficiency-driven business model innovation strategy (Liyanage & Netswera, 2021). The product's lifespan is extended to meet the needs of the end-user and prolongs the business model's life cycle.

According to Jonker & Pennink (2010), the goal of sustainable innovation is to deliver novel products and services that improve the quality of life and help the environment. The company can pursue this goal by changing the processes used in its business. The change can happen in any number of areas, such as product design and manufacturing. Another example of sustainable innovation is the modular design of smartphones. Using modularity, for example, helps companies make repairs easier and reduces e-waste.

To achieve a successful sustainable innovation strategy, the business model should incorporate social, environmental, and future generations' needs (Kang, Li & Kraus, 2019). The pressures of sustainability development often create new opportunities and challenges for incumbent businesses. In the current climate, incremental innovation is not enough. Companies must seek radical innovation to create new capabilities and overcome unsustainable industrial patterns (Kang & Jiang, 2019). It is also essential to innovate in ways that are both disruptive and beneficial. It is imperative to address environmental challenges as well as social pressures.

Consumers perceive a higher level of performance in sustainable products than in conventional ones. Sustainability information also influences the evaluation of companies, which translates into purchase intent. These shifts are being driven by post-recession consumers who are increasingly looking for brands that promote social responsibility and sustainability (Kim et al., 2020). Unilever, for example, claims that its "brands with purpose" are growing twice as fast as others. The company's business model has two roles: it helps to develop sustainable products and services while aligning the interests of customers, employees, and stakeholders.

2.17.1 Impact of Sustainability Innovations to Impactful Patents

The relationship between impactful patents and sustainability is not completely understood. The sustainability transition is often associated with incremental eco-improvements that are difficult for traditional businesses to adopt (Lozano, 2006). In this scenario, patents can provide a measure of the success of sustainable innovations. Patents are a trade-off between complete disclosure and monopoly for a limited period. But in other areas, a sustainability transition is associated with radical eco-improvements that require new technologies.

Several research and development activities are taking place in the context of sustainability. These efforts result in patent applications that feature sustainable characteristics. Once these inventions are granted a patent, they are likely to have a positive impact on society (Ma et al., 2018). This is especially true for authorities that implement sustainable policies. Moreover, patents awarded to entities that implement sustainable policies are a confirmation of the know-how they possess to achieve this change.

In addition to sustainability-related patents, IP on green technologies can help in the diffusion of sustainable manufacturing technologies. By developing a cross-industry IP transfer, sustainable technologies can transform intangible goods into tradable ones. Patent applications published by patent-active firms are open to public access, making them a public repository of technology-related knowledge (Lopes et al., 2020). In the end, the research of these inventions in patents will help identify the innovator and encourage further development.

While cross-industry collaborations have been proven fruitful in the past, there are still some challenges in facilitating such collaborations. Cross-industry collaboration is complicated by cultural and institutional differences. For this reason, research must expand beyond single-country studies to cover multinational value chains (López-Rubio et al., 2021). The impact of cross-industry collaborations on innovation diffusion is essential to meet the goals of the global climate change crisis (Lozano, 2018).

While environmental sustainability merits special attention, it is important to note that it does not necessarily correlate with patenting activity. The economics of a firm's financial strength are crucial to the introduction of new patents (Dhruba & Paul, 2022). It is possible to link environmental and financial performance by looking at the firm's R&D intensity. Investments in research and development are a proxy for the firm's financial strength, which we measure through net income growth and revenue growth (Fischer et al., 2022). Moreover, firms with high levels of R&D spending do not necessarily engage in a more inventive process.

While the current debates on IP rights and sustainability are vital for the transition to a sustainable economy, this research provides some insights into the relevant debates. In particular, the research aims to facilitate cooperation between new entrants and incumbents by facilitating IP transfer across industries. It outlines the need for specific mechanisms to facilitate such IP transfer and identifies key issues for circular economy implementation.

2.17.2 Impact of Sustainability Innovations to Production Performance

Incorporating sustainability innovations into production processes can lead to significant monetary benefits (Prokop et al., 2021). By bringing sustainability principles into the design phase of a product, companies can cut costs while meeting regulatory mandates. The consumer-packaged goods industry can achieve higher profits by cutting waste and

enhancing worker and environmental health (Provenzano, Seminara & Arnone, 2020). The effective execution of sustainability initiatives depends on the identification of opportunities for sectoral collaboration (Purcell, Henriksen & Spengler, 2019).

Businesses are dealing with environmental issues more proactively. Many are reducing their use of non-renewable resources and energy. The entire value chain is involved in this drive for efficiency. Businesses collaborate with suppliers to create sustainable raw materials and cut down on waste. Although improving corporate image is typically the primary goal of these initiatives, most businesses also see immediate cost savings and new business opportunities (Quinlan, 2011). Therefore, businesses that adopt sustainable initiatives might have an easier time finding and keeping top talent.

The adoption of new technologies can enhance an Organisation's business practices as it grows more environmentally conscious. The World Wide Web, for instance, was a relatively new technology. Businesses implemented a plan to incorporate web technology into their operations (Ribeiro & Bao, 2021). This tactic aids businesses in promoting teamwork, increasing productivity, and developing fresh goods and services. Organisations can also affect the performance of their suppliers and the preferences of their customers. It is imperative to acknowledge the significant influence that sustainability innovations have on production performance (Ribeiro, Varum & Daniel, 2020).

According to a recent study done in China in 2020, green innovation helps Chinese businesses become more sustainable (Abbate, 2021). This study demonstrates that green innovation is a significant global trend in sustainable development that can boost employee satisfaction and provide competitive advantages. Businesses should incorporate green innovation practices into their operations to increase corporate sustainability (O'Kane et al., 2020). This research could offer insightful information about corporate sustainability. In later research, the implications of these results will be examined. However, production performance will continue to be impacted by sustainability innovations in the interim.

Environmental pollution, carbon emissions, and energy consumption can all be decreased through green manufacturing innovation. In addition to investing in waste recycling, businesses that use green technologies should also recycle all of the raw materials they use in their operations. Green innovation can boost operational efficiency and lower a company's need for raw materials (Nguyen & Marques, 2021).

Companies are always concerned with reducing waste and reusing products. Returns cost the average corporation around 4% of its total revenue each year (Nguyen & Marques, 2021). Companies can increase profits by reusing products, thereby turning a cost centre into a profitable one. By reducing waste and generating revenue, green innovation is also an effective means to increase profits. This approach is especially useful in the UK, which is the largest emitter of carbon emissions.

2.18 Theoretical Framework & Open Innovation

A theoretical framework to support open innovation activities from the university's platforms has only been sporadically connected to existing models of corporate strategy and business strategy (Stephen et al., 2008). The knowledge-based view examines relations with external partners in terms of value creation and transaction costs. A relational view introduces knowledge-sharing routines and effective inter-organisational governance as sources of competitive advantage (Ståhlbröst et al., 2015). Although the concept of open innovation is new, the concept has been used as an exemplar in several industries, including health care, finance, and manufacturing.

The Open Innovation framework and its dynamics are based on the implicit assumptions that a market-oriented innovation model must incorporate (Smith et al., 2014). These assumptions may not be compatible with the assumptions that underlie this model. The assumptions underlying this framework are the following: The open innovation principle allows for the penetration of novel landscapes that are difficult for individual organisations to discover (Soleas, 2021). According to Majeed et al. (2017), it is the phenomenon of including inbound and outbound innovation, as well as internal and external innovation. In short, open innovation models divide the work of innovation among diverse groups, which, in turn, moulds the pattern of interactions between the various organisations. By promoting open innovation, companies can explore new markets and new business models (Smart et al., 2019).

Besides the inflow and outflow of knowledge and ideas, the open innovation model also requires companies to incorporate new sources of innovation. This includes external sources such as partners and customers, as well as internal ones, including their employees. To be truly effective, open innovation must combine internal and external sources of innovation, including licensing and selling IPRs (Stake, 2013). The framework should allow for both. As a result, it can increase the amount of innovation and enhance the profitability of companies.

2.18.1 Complex Adaptive Systems (CAS)

Complex systems are very difficult to understand. According to Yuzhuo (2020), their complexities stem from multiple levels and perspectives, making them difficult to analyse and predict. But they also provide an important set of concepts for innovation professionals. Here are some key concepts from the framework. Adaptive: This concept refers to the ability of a system to change its configuration and response to changing conditions (Jose-Maria, 2020). Further discussed by Hernández (2020), a complex adaptive system tends to change its configuration in response to changing conditions.

Complex adaptive systems require a different approach than simple systems. In complex systems, it is possible to break down each component into smaller parts and formulate detailed plans to implement an innovation (Zabala-Iturriagagoitia et al., 2021). However, in CAS, it is not possible to follow a purely mechanistic approach because the system's dynamics are so diverse. Emergent behaviours may be crucial for the success of CAS innovations. However a complex adaptive system can be modelled using a multilevel approach, and this means that it must be understood at the system level.

In the context of innovation, complex systems have multiple elements and are composed of highly interdependent parts (Santos et al., 2021). While simple systems can be designed to optimize professional functioning and patient well-being, complex systems have many more components and respond to changes in other elements of the system. According to Manioudis (2021), these systems are often non-linear and unpredictable, and they have several components and interactions with each other and the environment. If the system is complex enough, it is likely to exhibit unexpected behaviours.

2.18.2 Evolutionary Change

An evolutionary change model is a theory of innovation that emphasizes incremental changes in existing processes, structures, and products (Yoon, Vonortas & Han, 2020). Compared to revolutionary innovation, evolutionary change is cheaper and less disruptive (Yun & Liu, 2019). If an incremental change fails, it can be easily repaired. It also requires fewer risks than revolutionary innovation. If executed properly, an evolutionary change can transform a marketplace. But it cannot solve all problems in each industry.

According to Acosta (2019), to qualify as an innovation, a trait must exhibit a qualitative departure from the ancestral trait. The new trait must be associated with increased performance or use of a novel niche, and it must confer positive fitness on its bearer (Arranz et al., 2020). However, the novelty of the trait itself is not sufficient; it must also be associated with a phylogenetic pattern. Once an innovation becomes common, it may also trigger adaptive radiations.

The role of competition in the innovation process is also crucial. However, policymakers are expecting a direct relationship between innovation and commercial success. Although an evolutionary theory of innovation is unlikely to influence the development of policy, it has similar implications for managers. It illustrates that innovation is not a homogeneous phenomenon and a variety of processes can lead to success. There is still a need for more research in this area.

2.18.3 Business Models and Innovation

The business model of an organisation describes the architecture of its business unit, the mechanisms by which it captures value, and the flows of costs, revenues, and profits (Wojnicka-Sycz, 2020). The design of the business model, as well as the selection and operation of tangible assets, are critical to its success. The framework describes the interdependencies between the various elements of the business model (Lewis, 2013). In business models, interdependencies include a company's ability to sell bespoke cars at affordable prices or provide fancy stores for low prices.

When companies wish to enter new markets, they must redesign their business models. Developing and refining new business models requires a fundamental rethinking of the Organisation's processes, resources, and profit formula (Rouxle & Pretorius, 2016). The process of business model innovation can lead to a real competitive advantage for companies. The McKinsey Award-winning research in 2020 on business model innovation discusses how to create innovative strategies in white spaces. Managers can classify innovation opportunities into distinct stages of the process by employing this framework.

Business models and dynamic capabilities are intertwined; they impact one another and strategies' viability (Sachs, 2018). Subsequent empirical research will elucidate these correlations and offer valuable perspectives on how business models impact dynamic capabilities. It's crucial to think about how Organisational design affects business model

innovation in the interim. It will offer insights into the innovation framework's business model as well as how it is put into practice. It's critical to comprehend these capabilities' functions as well as the variables that affect how an Organisation's architecture is designed and how dynamic capabilities are created.

2.18.4 Opportunities and Threats

Adaptability can be significantly improved by innovation. According to Rosenberg, Trencher, & Petersen (2015), it can involve the launch of a new product, a change in production techniques, the creation of a new market, the acquisition of new raw materials, or the restructuring of an existing industry. Roig, Sun-Wang, & Manfredi-Sánchez (2020) carried on Schumpeter's thinking by defining innovation as a particular tool for entrepreneurs, an action that creates new avenues for generating wealth from resources. According to Rush et al. (2021), innovation is a concept, idea, or service that is seen as novel. Though the concept may not be new, how someone perceives it is what matters. Žemaitis et al. (2019) presented a compelling interdisciplinary approach to the concept and nature of innovation, highlighting the need for organisations to innovate in response to shifting consumer expectations, lifestyles, and market, technological, and structural changes.

According to Smart et al. (2019), innovation is essential to a company's operation, survival, and expansion. Santos, Zen & Bittencourt (2021) explored a range of innovation types in their work, including new products, services, processes, and Organisational solutions. They also covered the different forms, interests, and interpretations of innovation across different disciplines. With a diagram of six attributes, they proposed a universal definition of innovation: nature (new, improved, changed); type (product, service, process, technique); and objective (success, rivalry). Social (Organisation, enterprise, customers, social system, employees, software developers); means (technology, idea, invention, creativity, market).

From the classical doctrine to the present, there has been a significant shift in society's mindset toward innovation. Technological innovation (process and product), non-technological innovation (Organisation and marketing), and management innovation are now highly valued (Gallardo-Vázquez et al., 2019). The conversation around technological innovation in today's world must recognize the significance of what happened during the COVID-19 pandemic, which led to a sharp increase in the need for expensive IT solutions, medications, and essential medical equipment. Zhou and Wang

(2020) emphasized the critical role that Industry 4.0 technology plays in managing and controlling the pandemic. According to several writers, society 5.0, or the fifth industrial revolution, may result from the COVID-19 pandemic (Farinha, 2020). The pandemic advances through various stages, and as a result, Industry 4.0's role and impact expand.

The disruption of every enterprise is evident in the declining global economic activity and the dearth of intelligent production technologies. Disasters and infectious disease outbreaks were the driving forces behind significant technological changes. Hence, the enormous technological advancements of today (Hernández, 2020). Attitudes that are supportive of innovation can be seen in goods, services, quality, manufacturing procedures, or managerial techniques. The Wang group, 2021. They must be integrated into the enterprise culture and management system since they are increasingly the main creative force within every Organisation. The first step in characterizing management innovation as a break from conventional managerial concepts, procedures, and practices was to identify it in the literature. Polt & Unger (2021). Stated differently, management innovations refer to novel approaches to procedures, principles and techniques of operation, and managerial frameworks that substantially alter how the Organisation achieves its objectives (Trivellas et al.,2021).

They consist of novel approaches to increase effectiveness in management practices, procedures, structures, or methods. Trivellas et al. (2021). Innovations in management are essential because they guarantee more innovation, which enables prompt and adaptable reactions to market cues and obstacles, culminating in the strategy's execution. According to analysis and research by Sybrith et al. (2021), every large business needs to overcome two significant barriers to be able to innovate. The first is to create the "eureka moment," which is a colourful representation of the importance of innovative activities and a no-doubt example of senior management's role. The second is the move toward an innovation culture. Managers who took part in the Deloitte CFO Survey 2020 spring edition Recognised that the coronavirus would hurt projected investment projects, revenue, and employment. The unexpected coronavirus pandemic, which is occurring in most countries almost simultaneously, serves as the foundation for company managers' frames of reference. They revised their worries and made new arrangements (Pan & Geo, 2021).

2.19 Shortcomings in The Literature

The concept of entrepreneurial universities has gained significant attention in recent years, particularly in the context of sustainable innovation and regional development. However, despite the increasing recognition of their potential, several research gaps (mentioned below) remain that need to be addressed to fully understand and harness their role as catalysts for sustainable regional development:

- A critical gap is the measurement of the impact of entrepreneurial universities on regional development. While qualitative case studies abound, there is a dearth of quantitative analyses that systematically assess how these institutions contribute to regional economic growth, social inclusion, and environmental sustainability (Audretsch, 2014). Developing robust metrics and methodologies to evaluate these impacts is essential for policymakers and university administrators to make informed decisions.
- Sustainable innovation is a relatively new area within the entrepreneurial university discourse. Most existing studies focus on traditional innovation metrics such as patents and spin-offs, often neglecting the sustainability aspect (Guerrero & Urbano, 2012). Sustainable innovation encompasses not only economic benefits but also environmental and social dimensions, aligning with the broader goals of sustainable development (Schaltegger & Wagner, 2011). There is a pressing need for research that explores how entrepreneurial universities can drive innovations that are environmentally friendly, socially responsible, and economically viable.
- The Triple Helix model (Etzkowitz & Leydesdorff, 2000) emphasizes the importance of collaboration among universities, industry, and government for innovation and regional development. While this model is widely acknowledged, there is limited empirical research on the mechanisms and outcomes of such collaborations in the context of sustainable innovation. Investigating how these actors can effectively co-create sustainable innovations and the challenges they face in this process remains an open research area.
- Most studies on entrepreneurial universities and regional development are cross-sectional, providing a snapshot of the situation at a particular point in time. Longitudinal studies that track the evolution of entrepreneurial universities and their regional impact over time are scarce. Such studies are crucial for

understanding the long-term effects and sustainability of initiatives undertaken by these institutions (Audretsch, 2014). They can also reveal the dynamic interplay between universities and their regional ecosystems.

- The role of policy and institutional support in developing entrepreneurial universities is another underexplored area. While some studies highlight the importance of supportive policies and institutional frameworks (Rothaermel, Agung, & Jiang, 2007), there is a need for more detailed investigations into which specific policies and institutional arrangements are most effective. This includes examining the role of funding mechanisms, regulatory environments, and university governance structures in promoting sustainable innovation.

2.20 Conceptual Framework

An effective conceptual framework is an indispensable component of any research journey, providing structure that ensures systematic and coherent exploration of research objectives (Creswell & Creswell, 2017). In a research project, conceptual frameworks function as roadmaps allowing for systematic investigation of complex phenomena and relationships. So, in this research, the researcher has designed a conceptual framework which serves two primary roles for the researcher. First, it acts as the intellectual basis upon which the entire study rests, offering a structured set of concepts, theories, and variables that inform and frame research questions (Creswell, 2014). By grounding the study in established theories or conceptual models, the researcher gains a greater insight into the subject matter while positioning it within the wider academic discourse, seeking not only to contribute new knowledge but also to engage with existing scholarly dialogues (Bryman & Bell, 2015).

Furthermore, this conceptual framework offers an efficient and logical structure. By defining key variables and their relationships, a conceptual framework helps the researcher to align theoretical underpinnings with empirical observations precisely (Miles, Huberman, & Saldana, 2013). This alignment is crucial for ensuring that the research findings are both valid and reliable, facilitating a deeper understanding of the research problem (Neuman, 2014). Conceptual frameworks also assist in identifying gaps in the current literature, guiding the researcher in the formulation of hypotheses and research questions that are both innovative and grounded in theory (Creswell & Creswell, 2017).

The conceptual framework in this research is directly shaped by several critical gaps identified in the literature surrounding entrepreneurial universities, regional development, and sustainable innovation. These gaps highlight underexplored areas and provide the foundation for the structure, focus, and direction of the framework.

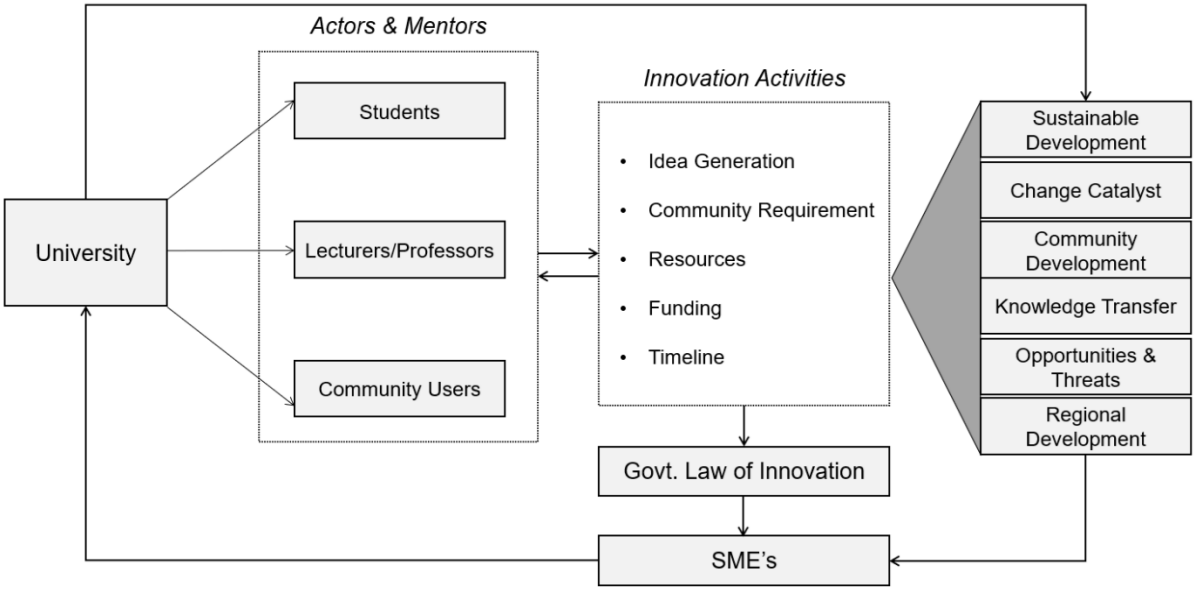


Figure 2.9: Conceptual Framework

(Created by Researcher, 2023)"

The above conceptual framework plays an essential role in this research by providing an essential tool for design and methodology. It helps the researcher to select research methods, data sources, and analytical techniques that fit with the theoretical framework in relation to research project, while at the same time synthesizing existing knowledge, which allows for identification of gaps, inconsistencies or areas that warrant further exploration as outlined below:

Impact Measurement of Entrepreneurial Universities	The absence of robust quantitative metrics to assess how entrepreneurial universities influence regional economic, social, and environmental outcomes (Audretsch, 2014) has informed the need for a structured conceptual framework. The framework guides the integration of

	measurable variables that connect university actions to tangible regional development outcomes, thereby enhancing the empirical rigour of this research.
Neglect of Sustainable Innovation	The conceptual framework addresses the deficiency in existing studies that overly emphasize traditional innovation (e.g., patents, spin-offs) by incorporating sustainability-driven innovation and social innovation as central components. These inclusions reflect a multidimensional understanding of innovation that goes beyond economic metrics to include environmental and social impact.
Limited Empirical Analysis of Triple Helix Collaboration	The framework draws on the Triple Helix model but goes further by embedding collaborative dynamics into areas like regional partnership development and knowledge exchange for social innovation. This reflects the need for more granular investigation into how universities, industry, and government co-create sustainable outcomes.
Lack of Longitudinal Perspectives	To compensate for the predominance of cross-sectional analyses, the conceptual framework supports a dynamic view of university-regional ecosystems. This enables the research to track the evolution and long-term sustainability of

	university-led initiatives and their ripple effects across time.
Policy and Institutional Support	Recognising the underexplored role of institutional frameworks (Rothaermel et al., 2007), the framework integrates considerations of governance, funding mechanisms, and performance-based standards. This ensures a systemic perspective that ties institutional strategies with sustainable regional transformation.

Table 2.2: Gaps Identification and Conceptual Framework

(Created by Researcher, 2023)"

In essence, the conceptual framework developed in this study is a response to and a synthesis of these critical gaps. It is designed not only to bridge theoretical and empirical shortcomings but also to provide a strategic tool for evaluating the multi-dimensional role of entrepreneurial universities in fostering inclusive and sustainable regional development.

2.20.1 How Universities Play a Role in Innovation

University leaders are facing many challenges: changing student demographics, financial burden, stakeholder demands, and rapid technological change. The COVID-19 pandemic has further accelerated existing trends, forcing universities to innovate and adapt. This research thesis highlights three areas for universities to focus on:

2.20.2 Creating a Sustainable Vision of Development

Sustainability is an essential part of higher education, as universities shape the minds of tomorrow's leaders and contribute to the achievement of the SDGs. However, universities and universities have a unique role to play in this regard. As the key providers of higher education, they must develop a sustainable vision and promote a culture of sustainability throughout the institution (Cobben et al., 2022). Sustainability

goals must be a central part of the curriculum at universities and other universities, and sustainability-minded communication is necessary to engage students at different levels (Leite et al., 2022).

According to Mehari et al. (2022), sustainability can be addressed through multiple pillars, each with its objectives. For example, some institutions pursue sustainability to differentiate themselves from the competition in the global market, while others pursue sustainability to meet the demands of clients channelled through business sector associations. Regardless of the approach adopted, a shared narrative of SDGs can provide a coherent framework to link projects and encourage collaboration. A central theme of a strategic framework is a shared narrative that is both compelling and credible (Trisetyarso & Hastiadi, 2022).

Several universities are embracing this common vision. The University of Pretoria, for example, is using research to address societal issues across the UK, including food security. The Ahfad University for Women, on the other hand, provides a holistic experience aimed at developing future leaders and change agents. These examples are just a few examples of how universities are creating a sustainable vision of development for universities.

The importance of sustainability in higher education cannot be stressed enough. As a facilitator between stakeholder groups, universities have a responsibility to create tomorrow's leaders and implement their knowledge and ideas. The Talloires Declaration (Canada) and the Copernicus Declaration (Association of European Rectors) in 2021 boosted the adoption of sustainability principles in universities. However, the implementation of sustainability principles in universities is not uniform, with some regions progressing faster than others.

In UK universities, for example, a public university adopted enterprise and sustainability as its academic mission. As a result, it became a catalyst for change in local communities and regional businesses. A private university in Bulgaria worked with business sector leaders to implement sustainability initiatives and catalysed social innovation and economic regeneration in that region. In the UK, a major research university established an office for sustainability. Through its engagement program, it connected faculty to sustainability projects.

2.20.3 Identifying a Region or a City as a Key Partner for Universities

Innovators can increase the chances of innovation by developing collaborations with universities. Many multinational companies are cooperating with universities to develop new products. Others seek to find ways to leverage the university's expertise to solve complex problems. In some cases, universities can play a central role in regional innovation ecosystems. These relationships can also encourage new knowledge. Listed below are some of the reasons why universities should consider collaborating with regional partners.

To attract innovation, universities should focus on improving their geographical location. Innovation districts are emerging in dozens of cities. These districts reflect distinct typologies and levels of formal planning. In some cases, innovation districts are emerging around a large anchor institution, such as a university, research institute, or teaching hospital. The universities can benefit from these innovations through shared research infrastructure. A thriving innovation ecosystem can draw high-tech companies to a specific city. Moreover, major institutions can have significant marketing value, especially in the life sciences space. For instance, Cambridge, Massachusetts, has MIT and Harvard within its boundaries. It also has excellent transport connectivity. A metro stop is also nearby. The University has helped the development of a thriving innovation ecosystem.

Besides university-industry partnerships, regional innovation ecosystems have other benefits as well (Correa, 2007). In addition to providing jobs, universities also help develop the local economy. Research and innovation in the United States have a rich history of partnerships with universities. Silicon Valley, Route 128, and the Research Triangle of North Carolina are examples of innovation clusters in the United States. Regional universities have a dual mission of developing regional economic development, transferring technology to local industry, and stimulating the development of new businesses in start-up incubators. Technology-intensive companies typically locate their operations near universities where the top talent is located (Comin, Hobijn & Rovito, 2008). In addition to this, they seek to recruit talented students and star scientists.

Smart cities and regions are a vital part of regional innovation ecosystems (Costa, Neves & Reis, 2021). By leveraging the university's research and innovation base, regional governments can make their regions smarter. Universities can improve the efficiency of

development processes and the quality of societal services by collaborating with universities. This collaboration opens avenues for co-creation, collaboration, and innovation (Wu et al., 2022). They are increasingly active in regional innovation ecosystems and play a pivotal role in promoting regional growth.

2.20.4 Providing Knowledge to the Creation of Social Innovation

Social innovation brings radical change to address societal challenges. The field is becoming increasingly popular and has a global impact, but there are still many areas that need attention (Buabeng-Andoh, 2012). One area where social innovation may be of particular interest is the challenges related to poverty, globalization, inequality, and climate change. By providing new ideas, it provides the opportunity to take a step back and consider the interconnectedness of many factors (Lozano, 2018).

Many challenges that social innovation must solve are systemic. Institutional structures often fail the people they were designed to serve. Institutional voids prevent participation in communities and contribute to social and economic inequalities. Social innovation may be an answer to this challenge. One important feature of social innovation is its inclusion of everyone (Sachs, 2018). While large industrial enterprises are essential, European countries should also prioritize smaller social enterprises that replicate true European society, which values people, communities, and social structures. Policymakers are now focusing on developing social innovation in European countries as it can lead to triple triumphs: better services for users, sustainable government services, and new business opportunities (Ribeiro et al., 2020). Its goal is to make health and well-being a reality for everyone.

In addition to the interdisciplinary and intersectoral nature of social innovation, researchers are now looking at the intersections of these fields. This means that innovations can integrate knowledge from various fields to improve social systems and solve complex systemic challenges (Secundo et al., 2019). For example, social innovation can involve collaboration across sectors, including health systems and healthcare practices. These studies help enhance social innovation in health and healthcare systems. However, there are still gaps in knowledge about social innovation in the health sector.

Social innovation can be defined as a product, service, or a combination of social practices that addresses an unmet need in society (Findler et al., 2019). Examples of

social innovation range from car-sharing to social housing. Providing knowledge to the creation of social innovation shows the importance of addressing voids in society and providing the opportunity for all actors to move forward. The concepts of social innovation can also be applied to the management of existing institutions and systems.

Managing relations with university stakeholders in innovation requires careful consideration of both the power and influence of different parties. In the case of HEIs, stakeholder power can result from pressure exerted by one party to achieve a particular outcome (Aloulou et al., 2019). On the other hand, stakeholder legitimacy refers to the general perception that the relationship is appropriate. Traditional stakeholders include students, governments, local industry, growth coalitions, and property developers.

In higher education, the community is more pronounced than in the business world. As a result, there are more decision-making centres and layers of external parties involved. This research has focused on the role of these entities in the university's innovation process. The potential of an organisation is the configuration of resources, abilities, attitudes, and experiences (Cai, 2022; Cai & Lattue, 2021; Cai & Ahmad, 2021; Cai, Ferrer & Lastra, 2019; Cai, Ma & Chen, 2020; Calignano & Jøsendal, 2018).

2.20.5 Sustainability-Driven Innovation

The growing number of people on the globe is driving the need for innovative methods of producing goods, services, and processes (Fischer et al., 2019; Fischer et al., 2022; Foray, 2009; Gallardo-Vázquez et al., 2021; Gallardo-Vázquez et al., 2019). Global population growth will exacerbate social and environmental problems and lead to significant transformations in the global economy. Additionally, it will become harder to grow profitably, and many businesses are currently searching for innovative ways to produce goods that still benefit the environment and save money. By designing products and processes that are more sustainable, these companies are also helping the environment and society while also improving their brand image and ensuring that their employees are engaged.

In the past, organisations focused on energy conservation and green products but did not make sustainability a strategic priority (Fischer et al., 2019). But as sustainability has become a key part of business strategy, more business leaders are seeing the value of sustainability in boosting revenue, margins, and brand value. Companies that integrate sustainability into their business practices will benefit from innovation across the

enterprise and influence the preferences of customers and suppliers (Gallardo-Vázquez et al., 2019). And the more sustainable they are, the more profitable they will be. In addition to developing products that do not degrade the environment, sustainable innovation also includes process improvements and efficiencies. New technologies are often developed in response to challenges that can be solved by making the processes better (Gallardo-Vázquez et al., 2021).

2.20.6 Performance-Based Pricing

Although performance-based standards and sustainability are relatively new fields, a lot of research has already been conducted in them (Elsamny & Gianoli, 2022; Espinoza-Sánchez, Peña-Casillas & Cornejo-Ortega, 2022; Etzkowitz & Leydesdorff, 2000; Evans et al., 2015; Farinha et al., 2020; Fayolle, Gailly & Lassas-Clerc, 2006; Fernandes & Ferreira, 2021; Ferrer-Balas et al., 2008; Findler et al., 2019). Although these standards have many advantages, there may be drawbacks. While metrics offer benefits that go beyond best practices, this strategy entails a significant investment in the acquisition of pertinent knowledge and abilities. Nike, for instance, has spent $6 million on open-source metrics (Elsamny & Gianoli, 2022). It has made investments in the development and application of metrics to ensure the sustainability of these standards.

A metric for a particular technology cannot be developed without a technical understanding of the market and the associated manufacturing procedures (Ferrer-Balas et al., 2008). Performance-based standards come in a variety of forms, each with specific specifications. Selecting the one that is pertinent to the industry and business is a challenge. Single-commodity initiatives cover more aspects of production but don't extend to multiple goods and services. The standards must be coherent and equally rigorous and must recognize heterogeneity.

Sustainability-based pricing can be beneficial for organisations (Evans et al., 2015). The methodical analysis of the data can help identify areas that need attention. Furthermore, it should be sustainable for all parties, including the organisations that supply these services, suppliers, and alliance partners (Farinha et al., 2020). Such changes in the supply chain can improve everything upstream and downstream and can benefit the entire industry. It is important to consider the sustainability of such a system in determining the financial rewards of a technology (Fayolle, Gailly & Lassas-Clerc, 2006).

2.20.7 Unintended Social and Environmental Impacts

New technology adoption frequently has unforeseen social and environmental effects. The need for cobalt, a crucial component of lithium-ion batteries, is one such instance (Bertrand, 2010). Growing costs for cobalt have made societal issues like child labour, pollution, and corruption worse (Borah & Ellwood, 2022). Additional inadvertent social and environmental consequences of novel technologies encompass the decline in biodiversity and the augmented utilization of resources like electricity and water (Braun, Cai & Shen, 2022).

Rapid changes are occurring in our society as we embrace new digital technologies (Brundiers & Wiek, 2011). A complex interplay between multiple forces is responsible for both environmental degradation and "the Great Acceleration" in human consumption (Bruton, Ahstrom & Obloj, 2008). Because of the widespread adoption of cutting-edge products and the mainstreaming of technology-driven culture, these forces are only growing faster. Nowadays, almost every aspect of the economy is impacted by digitalization, including the daily lives of most people.

Policies aimed at lowering these risks are being implemented by developing nations more frequently. Governments are mandating environmental impact studies for new technologies more and more. The impact of technological innovation can be even greater if unintended social and environmental consequences are ignored, even though public pressure is the main source of social and environmental impacts (Bertrand, 2010). This is especially true when social structures incorporate technology. Without a thorough grasp of how new technologies will affect society, the government will not be able to regulate their dissemination.

New technologies may occasionally advance general social and environmental goals. Certain innovations have the potential to drastically alter ecosystems or lifestyles. However, these innovations frequently have unintended and unpredictable effects (Borah & Ellwood, 2022). For instance, the production of biofuels may result in indirect changes to land use, a decline in biodiversity, and more competition for available land. A systemic approach is required in this situation (Bruton, Ahstrom & Obloj, 2008). Furthermore, considering the long-term effects of new technologies is just as important as analysing their social impact (Braun, Cai & Shen, 2022).

2.20.8 Uncertainty in Technological Innovation

Uncertainty is one of the key drivers behind technological innovation. Uncertainty may arise from a lack of market demand, competitive behaviour, or price development of substitute products; additionally, it may also stem from environmental conditions; for instance, weather changes could impact the production of raw materials, leading to unpredictable price changes that make future forecasting impossible for companies. Success among innovators and entrepreneurs' hinges upon their ability to find certainty amid uncertainty - it's an invaluable skill that allows companies to prepare for new challenges while seizing opportunities. Unfortunately, many people often conflate uncertainty with risk; there are distinct differences between the two concepts.

Businesses looking to implement innovative technologies must be open-minded enough to experiment and take risks when it comes to experimenting with them, especially disruptive innovations that significantly alter existing products and services (Bencke et al., 2019). When this occurs, managers need to understand factors affecting uncertainty so they can minimize unnecessary risks while making more informed decisions. Technological innovation is a complex process. Companies must overcome uncertainty at every step, from invention through diffusion. Invention is the hardest stage; when finished successfully, diffusion allows consumers to adopt it and assess its efficacy before evaluation comes next - with consumers giving feedback as to its effectiveness or not.

Although technological innovation can be challenging, companies can find several effective strategies for managing uncertainty (Hou et al., 2019). One is incremental innovation - building upon existing technology and knowledge - as this type of innovation tends to be less risky and more cost-effective as it requires less research and development costs than radical innovations. Additionally, incremental innovations usually cost less due to fewer R&D needs being required than radical ones. Another way of dealing with uncertainty in technological innovation is to develop a clear vision of what the final product should look like. This can help businesses reduce uncertainty by giving them insight into how the technology will ultimately be applied and will also assist with making strategic decisions more effectively.

Uncertainty can be overcome through strategic planning, which involves identifying a desired outcome of a project and devising a plan to reach it. This process may include scenario analysis or the creating of a decision tree as a tool. Likewise, prioritizing

projects to ensure resources are being spent on the most productive efforts; and creating clear vision can motivate employees and inspire them to pursue challenging ventures.

Summary

This chapter explores the concept of innovation in depth, particularly within the context of universities as enablers of sustainable regional development. It begins by defining innovation as the creative implementation of ideas to address change, encompassing the development of new products, processes, services, and systems. The chapter categorizes innovation into multiple types, entrepreneurial, radical, incremental, sustainable, business model, product, organisational, process, social, transformative, systematic, open, and disruptive, each playing a distinct role in organisational and societal advancement.

These types of innovation reflect a spectrum from minor improvements to groundbreaking transformations that redefine industries. A significant focus is placed on Living Labs, described as open innovation ecosystems where stakeholders collaborate in real-life settings to co-create solutions. Living Labs facilitate design thinking and are exemplified through initiatives at Birmingham City University, where students and local authorities co-develop sustainable urban projects. The chapter introduces the Desirability, Feasibility, and Viability (DFV) model as a framework for evaluating innovation outcomes. Universities are framed as innovation catalysts, with their roles outlined through mechanisms such as university hubs, science and technology parks, and industrial innovation campuses. These entities enable knowledge exchange, commercialisation, and talent development while fostering university-industry-government collaboration.

The chapter also delves into academic entrepreneurship, emphasizing its contribution to technological advancement, start-up growth, and knowledge transfer. Challenges related to collaborative research, intellectual property, and institutional alignment are also addressed. Furthermore, the chapter discusses the impact of innovation on regional development, focusing on the influence of university-firm collaboration, social entrepreneurship, and sustainability. It highlights how universities can shape policy, reduce inequality, and enhance local economies through research and innovation. The chapter concludes by emphasizing the importance of formal and informal university interactions, community-led innovation, and cultural factors that influence innovation

outcomes. Overall, it positions universities as vital drivers of inclusive, sustainable, and transformative innovation in a rapidly evolving global context.

Chapter 3: Context

3.1 Overview

Traditionally universities were seen as strongholds of knowledge and learning, however, in today's rapidly changing era of 21st century, their obligations are far beyond of just providing learning. Now universities are being perceived as the pivotal institutions that can instigate innovation process and act as change catalyst in ways that are multiple in nature. It refers to how university becomes a driver of innovative changes by influencing academic spheres or broader socio-economic environments.

The world has turned to universities as preeminent avenues of learning, scientific research, and knowledge production. Moreover, higher education institutions have also in recent decades become the critical agents of some of the most important and system-shifting innovation, economic viability and positive social outcomes developed across many regions around the world. Universities, as major conduits for cutting edge research in a diverse range of fields are driving myriad breakthrough innovations and technologies that have the potential to help solve the world's most challenging problems. Additionally, they are also supporting the best talent to become innovators, entrepreneurs, policymakers, artists, and activists of both today and tomorrow. Therefore, universities are highly respected not only for extending the edges of academic frontiers but also as platforms, where innovative ideas stemming from these explorations are turned into action and have far beyond-sectoral impact.

In the upcoming sections of this chapter, it will discuss the role of the country's government and universities promoting such innovations. This will start by looking at how universities are a key platform for driving innovation propelling technological edge and regional competitiveness. It will also examine the government's vital function in promoting collaboration between universities as well as community, generating a setting where academic research is available to business. It will also present how indirect knowledge transfer works, and it will address the issue of how scientific information and innovations developed in universities are transferred outside these institutions. Finally, this research will consider and discuss the significance of relational involvement and institutional backdrop by examining how strong relationships and supportiveness of institutions can increase the efficiency of university-led innovation.

3.1.1 Innovation Activities in Universities

In the present context, university players (e.g., students, lecturers, and support staff etc.) have put research and teaching first over innovation activities to improve the quality of education. As per Draca, (2013) innovation can be classified as process innovation, product innovation or position innovation. These kinds of innovations are not just beneficial to the society at large, but can also create intellectual property (Ma et al., 2018). However, universities should not only focus on the economic benefits since social innovation is essential in certain areas around the globe. For instance, in Latin America, the societal and democratic revolution is also crucial.

According to Hou et al., (2019) research is a key element of innovation. It is often considered innovation in processes and products and the principal role of a university is the education of students that is often ignored. However, as discussed by Maruccia et al., (2020) innovation can be described as an act of changing paradigms and methods of thinking. In many cases, innovation is not assessed or recognised as a creative idea and in this regard, it is essential to know how university stakeholders can boost their innovation processes. In a recent study in 2020, the European University Association (EUA) conducted a survey of universities across Europe. In this study, the results showed that 75 per cent of European universities paid a lot of focus on innovation. Nearly 59 per cent evaluated innovation initiatives (Ribeiro, Varum & Daniel 2020). Lack of recognition by the authorities as well as limited resources for staff have been cited as the reason for the disparities in universities for these kinds of activities (Robaeyst et al., 2021).

As per Purcell, Henriksen & Spengler, (2019) the contributions that academic researchers make must be acknowledged and recognised as achievements. The number of partnerships in innovation and the contributions of researchers as individuals should be considered the standard for the success of innovation. Also discussed by Prokop et al., (2021) entrepreneurship teaching, start-ups, and patent rights might be other indicators of a researcher's contribution to research. Universities should create a culture that encourages collaboration across the four helices in the innovation ecosystem. Universities can provide societal benefits and increase awareness of innovative initiatives.

3.1.2 Academic Staff and Their Role

According to Datta, Saad and Sarpong, (2019) the role of academics at universities as lecturers, experts or consultants is to facilitate students' learning through various tools and services. They can increase and enhance the campus's values to create an exemplary environment. As per De Bernardi & Azucar, (2020), Universities are playing a major part in the process that encourages innovation within the United Kingdom. The absence of funds has led to many of the central research labs going under or repurposed into small innovation centres (Elias 2021). The gap between industry and universities has hindered students from developing the skills and knowledge needed to succeed in the field of innovation. This also hinders institutions' ability to harness their influence over private businesses and profit from external funding streams.

In the research carried out by Kang & Jiang (2019), it was discovered that funding from the government is not the only main factor behind university innovation. However, the absence of funds for research has slowed down the growth of certain companies. As discussed by Aloulou, (2019) the higher educational system currently supports private innovation through research carried out by its faculty and has been proven to boost innovation over the long term. Furthermore, universities could construct more relevant incubators, design their tech transfer offices to reflect the business-oriented approach and alter the tenure and promotion requirements to incorporate entrepreneurial activity (Zhang, Chen & Fu 2019,). Additionally, universities can pursue more funds for their innovation activities.

According to Wojnicka-Sycz (2020), research and development spending at universities differ greatly by region and certain countries receive higher amounts of funding than others. For instance, there is a reason why the United Kingdom (UK) consistently places in the bottom quarter and is ranked 34th in the world which is not enough to maintain its economic growth (Fischer and colleagues. 2022). It is essential to boost R&D investment for the UK to ensure sustainable and dependable economic growth. In this regard, the government must promote innovation through research and development.

3.1.3 Engagement of Students

According to Marques et al., (2019), the involvement of students in universities could be a means of addressing social issues. The study is further discussed by Meyer, (2022) these shifts are related to different modes of learning and entrepreneurial activities as well as distinguishing between the dominant models of knowledge transfer and new

models that are socially responsive. Socially responsive models have the potential for more the future of collective opportunities and systemic change (O'Kane and others. 2020).

The research carried out by Damanpour & Marguerite, (2009) elaborates their belief that the mission of academics needs to be in line with sustainable development. This would be a crucial step in engaging students. By carefully aligning the academic mission of universities to sustainability, "Living Labs" models allow a variety of projects together under one governance structure (Martinidis, Komninos & Carayannis 2021). They also include faculty and students in development and research projects. For instance, a public UK university (Birmingham City University) has been pursuing sustainability as a method to distinguish itself in both national and international markets. In Bulgaria, a private university (Varna University of Management) joined forces with the business community to spur social and economic innovations within Bulgaria.

As outlined by Manioudis, (2021) by getting students involved in this process, they can help them be sustainability experts. And they can utilise this information to steer the university's sustainability agenda. These strategies will enable students to be involved in projects that help the world. As a result, they will be able to create an environment that allows students to excel, and therefore, universities can be great places to get students involved in sustainability.

3.2 Universities & Sustainable Innovation Change

Universities addressing sustainable innovation change are a key part of the sustainability conversation. Their vast range of expertise allows them to analyse the causes and consequences of sustainability problems and produce new knowledge, tools, and practices while specifying the key role of universities and how they can support sustainable innovation. As stated by Zhou & Wang, (2020) the role of universities in achieving sustainable development goals does not only include the collaboration between academic staff and actors of that innovation project but also the broader stakeholder community, such as Small Medium Enterprises (SMEs) and local communities. Universities play a crucial role in societal transformation, helping to form global citizens and deliver knowledge to the world.

3.2.1 Develop University Partnerships with Industry

In addition to taking part in many innovation tasks universities additionally broaden strategic partnerships with industry to grow their impact (Yun & Liu, 2019). Further mentioned by Hou et al., (2019) this collaboration and partnerships between enterprises and universities, enable researchers to collaborate on specific tasks, resulting in brand-new services or products in conjunction with accelerating product improvement and commercialisation.

It leads to creating a strong relationship between faculty from academic research institutions and representatives from industry. By working together on a common problem, faculty members at universities can build and apply their expertise to solve problems in real-world contexts (Vlados & Chatzinikolaou, 2021). According to Sautter, (2019), academic staff can pursue ground-breaking research projects and commercialise their ideas with the help of students and alumni, who can gain valuable experience and contribute to solving real-world problems. Ultimately, university-industry collaboration leads to pioneering solutions to pressing global challenges while establishing realistic timelines, budgets, and goals (Braun et al., 2022).

According to Abdel, (2011), this is central to developing communication with the research partner to recognise what contribution they will make to the research project. They may offer resources, personnel, or materials to conduct the research. Once established, these efforts will become part of a sponsored research agreement and clearly define the expectations of all parties (Buabeng-Andoh, 2012). According to Amitrano et al., (2018), the collaboration between the university and industry may involve the creation of a simulation centre or consumer product. Universities should have a business model that aligns with research and development ideas and should provide the industry with a platform for innovation. The goal is to accelerate innovation and develop new products and services. The collaboration between universities and industry should be as rigorous as the project's internal process, ultimately, leading to mutual success (Damanpour & Marguerite, 2009).

Here are multiple case studies of how universities have delivered sustainable innovation change.

3.2.2 Plymouth University (PU)

One example of a sustainable innovation initiative at a university is Plymouth University's work with sustainability procurement. The university developed an initiative called "Sell-to-Plymouth" that targeted small and medium enterprises in the city and won the Times Higher Education Leadership and Management Award for its efforts (Purcell, Henriksen & Spengler, 2019). Another project was the clinical dental training at Plymouth University, which became a social enterprise that provided dental care to more than 16,000 patients from disadvantaged communities.

The university led the National University Enterprise Network for Social Enterprise and was the first university to receive a social enterprise mark. That case study was based on eight in-depth interviews with the participants. They selected the interviewees using a snowball sampling technique, which allowed them to identify actors and documents related to the RTPS. They also sought to interview members of HEIs who had been actively involved in the transition process. They applied the narrative interview technique to help the interviewees reconstruct the transition process and emphasize specific aspects of it.

While the specific goals of the various sustainability initiatives vary, the overarching theme is that they aim to advance sustainability to differentiate in the global marketplace (Pinto, Ossmane & Carvalho, 2020). Some seek to achieve sustainability through shared delivery while others pursue it through channelling client demands through business sector associations (López-Rubio, Roig-Tierno & Mas-Tur, 2021). Further discussed by Espinoza-Sánchez, Peña-Casillas andrnejo-Ortega, (2022) in either case, a shared narrative of the Sustainable Development Goals (SDGs) can provide a framework for connecting these different projects and ensuring that they are aligned with each other.

Despite the legal framework for sustainability in universities, sustainability is still not a mainstream priority in many areas. The key factors that influence sustainability focus and activity are performance agreements and national funding programmes. In the UK, the Ministry of Higher Education provides a general template for performance agreements but leaves sustainability up to voluntary compliance. It is not yet clear whether universities will voluntarily adopt sustainable practices. However, this is a good sign. Active experiential learning is a necessary part of sustainable innovation. Active experiential learning helps students build the skills needed to solve these challenges.

Sustainability roadmaps are an essential part of such initiatives. Other cross-disciplinary skills students need include life-cycle analyses, systems thinking, and scenario planning. All these are essential for sustainable innovation in our society and economy.

3.2.3 University of Applied Sciences Utrecht (HU)

Innovations in education emerge in a VUCA (Volatile, Uncertain, Complex, and Ambiguous) environment, which is not in a linear and well-planned process (Correa, 2007). University of Applied Science's (HU) innovation project was to guide the innovation process in the proper direction, with the help of academics to possess situational awareness. Understanding the action repertoire innovators employ at pivotal points and how this influences the trajectory of educational innovations was the aim of that study. The goal of the research is to create a desirable action repertoire that will aid in the successful advancement of VUCA educational innovations.

The challenges of HU & sustainable innovation change are often daunting. Rather than focus on individual improvements, the process should instead seek to find a holistic approach to improve systems. This includes taking a systems-oriented approach, which means establishing favourable conditions to encourage innovation. These conditions typically involve long-term and widespread change. In addition, they must be driven by a collective vision and set of values. Hence, HU & sustainable innovation change should be supported by the involvement of citizens. According to Jerzmanowski, (2008), sustainability is an essential component of any business strategy, which means that organisations must be prepared to work in partnership with stakeholders and supply chains. In the past, organisations focusing on green products and energy conservation often made sustainability secondary to their business strategy. Today, business leaders are realizing the potential benefits of a sustainability strategy for their bottom lines. By embracing sustainable innovation, companies can increase their revenue, profits, and brand value (Tawney, Miller & Bazilian, 2013). Furthermore, they will be better positioned in their markets, unlike their competitors.

Innovation aimed at achieving sustainable well-being and social progress is a vital part of economic prosperity (Sachs, 2018). However, this innovation must go beyond achieving competitive advantage and revenue generation. In other words, it must also serve the public good and serve the triple bottom line. Sustainable innovation should permeate the entire organisation. Sustainable innovation aims to create shared value in the long run. This is not an easy task, however; businesses need to realize the benefits

of a socially oriented business. HU & sustainable innovation change is the next generation of economic development thinking. By combining environmental concerns and business innovation, this type of innovation can help businesses reduce costs and waste, improve their brand image, and engage employees. The goal of HU & sustainable innovation change is to create an economy that is sustainable for the future.

3.3 Strategic Development Goals (SDG's)

Sustainability is a major topic in the academic world and universities are at the forefront of innovation and sustainability. Their sustainability agendas have been shaped by their partnerships with businesses and local groups. The strategies should be aligned with SDGs. HU's sustainability plan addresses energy, emissions, campus operations, nature, culture, learning, and social responsibility. HU is experimenting with sustainable solutions and making use of cutting-edge research to tackle real SDG challenges. A public UK university has adopted sustainability and enterprise as its academic mission. Through this, it became an inspiration for local and regional businesses. A major research university in the US forged a connection between faculty and sustainable projects through a faculty engagement program. Its faculty were able to make the connections that led to a more sustainable world.

According to Lozano, (2018) sustainability requires innovation in all sectors and both private and public organisations increasingly depend on the ability to transform and innovate to meet these challenges. During the course, students learn how to apply sustainable innovation processes in the business world and how to collaborate with different disciplines. They also learn how to apply sustainable development principles and practices. In addition to exploring the concepts of sustainability and the steps of innovation, they also learn about interdisciplinary collaboration and how to make the change necessary for sustainability.

HU OFS continues to innovate with students and faculty. Its work has survived the transition to a new CEO of one of the lead companies. However, it must continue to deliver business value for it to survive. However, the project's impact must be carefully assessed. A clear communication strategy should be developed and implemented. There are many opportunities to accelerate the change and make a difference in society. According to Santos, Zen & Bittencourt, (2021) the key to successful change in a university is to embed its strategic objectives and research must produce positive outcomes and change the academic environment. Further discussed by Elias, (2020)

the dynamic transformation of society demands that universities create a unique environment for research and education. Ultimately, this means producing responsible graduates with the skills necessary to make a difference. However, achieving change involves significant changes in people and institutions. Clearly defined objectives, time, and resources are necessary to make a difference.

3.3.1 Cross-Disciplinary Research

According to Costa, Neves & Reis, (2021) a common theme of the symbiotic relationship between universities and sustainability is the alignment of the university community's actions with the sustainable development goals (SDGs). These efforts have catalysed change among students and the wider local and business communities. The first step towards a successful cross-disciplinary collaboration is to understand the specific needs and objectives of the partner institutions (Lopes et al., 2020). Further discussed by Domínguez-Gómez, Pinto & González-Gómez, (2021) the university must establish the necessary conditions to accelerate these types of collaborative projects, which should be feasible within the existing funding. The partners involved in the research projects should also identify opportunities for additional support. Moreover, universities must ensure that they have appropriate specialist funding. As discussed by Elias et al., (2021) cross-disciplinary research needs a specific funding stream, including more support for researchers from the related disciplines.

Several case studies demonstrate the value of partnerships between universities and SDGs. A "living lab" model brings a variety of projects under one governance framework (Fischer et al., 2019). It can also involve the involvement of faculty and students in research and development projects. This approach has several benefits, including the alignment of the academic mission with sustainable development. These benefits extend beyond universities to the global community. It also creates societal engagement through cross-disciplinary research and development.

As discussed by Kim et al., (2020) as an academic, embedding cross-disciplinary research (CDR) within university research and education is a win-win situation leading to establishing the university's relevance to the sector and developing the competencies of its graduates. Success in this area is acknowledged by a variety of sector awards, frameworks, and league tables (Elsamny & Gianoli, 2022). Some of these awards also include measures of CDR, and some are student-led, while others are media-driven.

Ultimately, the impact of university-wide sustainability research and education will be measured over the long term.

3.3.2 Collaboration and Success

According to Arranz, Arroyabe & Schumann, (2020), the key to success in an innovation hub lies in establishing early connections with community stakeholders and the involvement of these stakeholders in the design and development of the innovation. This early engagement shows the university's commitment to the community. These relationships provide an additional source of financing for the university and may also provide the industry with access to the university's resources. Universities must play a crucial role in addressing these challenges and seizing opportunities as the nature of work is changing significantly and they are uniquely positioned to shape this change while ensuring that the benefits of innovation are shared across society (Hasche, Höglund & Linton, 2019). This means, according to Unger & Polt (2021), that they must guarantee that talent from a diverse community can participate in the emerging economy and offer a forum for fresh ideas.

The ability of universities to form new alliances that will bring knowledge from the lab to the real world and supply vital funding for exceptional faculty, students, or alumni is essential to their success. Universities can also facilitate students' idea-sharing connections with the brightest minds outside of the classroom. This will help students get ready for a world that is changing quickly. Universities that offer a venue for innovation have numerous benefits (Hong et al., 2019). Success is defined by creating an environment that is conducive to innovation, and universities are essential to this process. Numerous trailblazers originate from academic institutions, such as Birmingham City University, which has incorporated innovation into its research, teaching, and administrative procedures. For instance, it has included high-performance computing for research and intellectual property commercialisation, digital media, and advanced learning environments in its curriculum. Furthermore, it has created an Xplor cane (for blind and visually impaired individuals) to support regional development and the community (Majeed et al., 2017).

By embracing social issues, universities can improve society in addition to serving as a platform for innovation. Universities can contribute to the solution rather than adding to the issue by working with communities and inviting students to campus (Majeed et al., 2017). This is especially crucial for university research, which frequently focuses on

societal issues. Future social innovations will provide answers to today's and tomorrow's problems. Universities and the Ivory Tower have long been connected. Although this idea is still widely held, new research suggests that universities should play a different role in society as information providers. This is a new role that Bruton, Ahstrom & Obloj, (2008) calls "Open Innovation." Businesses are becoming more and more dependent on knowledge to survive in the global marketplace. This implies that for universities to meet the challenges of a world that is changing quickly, they must offer a platform for innovation.

Universities should concentrate on their areas of strength and seek out businesses that are interested in hiring young entrepreneurs when creating an innovation hub. A university offering a program in chemical or aerospace engineering, for instance, ought to focus on recruiting local graduates for their positions. As an alternative, a corporation with a remote headquarters might wish to collaborate with academic institutions to gain access to state-of-the-art research and attract future employees. The success of the innovation hub will depend on the mix of tenants and the kind of amenities (Moon, 2008). For the innovation hub to succeed, the university must commit to being a major tenant. This will help with construction financing and attract industry tenants (Stua, 2013). University innovation has traditionally been associated with technology transfer, patenting, and licensing. Today, however, organisations are Recognising the value of open systems, which encourage contributions from experts. Ultimately, universities that embrace social innovation can contribute to these initiatives by developing an innovation transfer process and enriching collaboration among students, faculty, and staff. By accelerating open-source development, universities can support this process and contribute to societal progress. Public universities are becoming more and more significant to the nation's economy and essential components of the innovation system. These Organisations frequently offer employment opportunities, access to funding, and crucial market knowledge. Universities thus play a crucial role in promoting innovation, especially in high-tech industries. In the end, British universities will be crucial to the country's economic future. These universities can serve as a platform for innovation and increase the competitiveness of businesses if given the proper assistance.

3.3.3 Partnerships with Stakeholders

University collaboration with stakeholders is a compelling two-way interaction, which transcends academia and conjoins educational institutions to external bodies including

the industries, government departments or community associations. These types of partnerships are key to inspiring innovation, tackling critical societal issues, and ensuring academic research align with the needs of industry. One of the key benefits to university stakeholders' partnerships is the integration of the industry into academia. Business-student collaborations provide exposure application of their studies in practice and connect theory to practical experience, while industry collaborators have an opportunity to work with the latest research and showcase professional development opportunities. Furthermore, these partnerships are ensuring greater employability of graduates by linking the academic curriculum with industry needs which in turn would help all students gain necessary skills and knowledge which is a perfect fit for the work.

The role of government in making partnerships with the university is to continue research and formulate critical and sustainable solutions for the society. Working together, they support strong policy development that benefits the well-being of society in terms of public initiatives and outreach programs, as well as funding models critical to influencing research projects. The collaboration between the government and universities produces a good use of academic expertise and potential for making balanced well-grounded decisions as well as contributing to social transformations.

Another facet of university-stakeholder collaborations is community partnerships. Community partnerships explicitly involve all collaborators as active contributors to their broader local and world communities (ECE, 2014). Universities also work with community organizations through outreach programs or collaborative research activities focusing on issues that directly affect them, and stimulate knowledge sharing, empower local communities, and promote sustainable development (Majeed et al., 2016). Universities contribute to positive social impact beyond their own boundaries by understanding and fulfilling the needs and priorities of communities they are part of. Such partnerships between universities and organisations demonstrate how a symbiotic relationship can be used to harness resources and expertise to meet both local and global challenges including poverty, access to healthcare and environmental sustainability.

University stakeholders' partnerships are, therefore, critical to build the ecosystem to ensure comprehensive and meaningful development that allows students an exciting learning experience, motivates university staff, addresses real-world societal issues and entrenches social responsibility into academia. By making a concerted effort to actively

involve industries, governments, communities, and non-profits as equal partners in the pursuit of positive change, universities can maximize their resources and expertise so that they are effecting real change within their communities.

Summary

This chapter provides a comprehensive context/overview, Innovation Activities in Universities, Academic Staff/Students Roles, Sustainable, Stakeholders & Partnerships through which Universities have evolved from traditional knowledge centres to pivotal institutions driving innovation and regional development. It also discusses how universities play a critical role in advancing scientific research for economic viability and generating positive social outcomes. Through collaborations with industry, government, and community stakeholders, universities facilitate groundbreaking research and technological advancements, addressing global challenges. They also nurture talent, preparing students to become future innovators, entrepreneurs, and leaders, thereby extending their impact beyond academia into broader socio-economic realms.

Chapter 4: Research Methodology

4.1 Overview

This chapter outlines the methodological foundations of the research, elaborating on the philosophical positioning, research design, data collection and analysis strategies, and ethical considerations. The study investigates the dynamic and contextually embedded role of universities as sustainable innovation catalysts. Hence, a nuanced and flexible research methodology is employed that could accommodate institutional complexity, stakeholder diversity, and the multidimensional nature of innovation processes in higher education environments.

The research methodology, in broader terms, is the overall rationale or system that helps a researcher in conducting a scientific study including general principles used to relate and interpret data. “Research methodology is thus the blueprint for the whole research process which, if systematically followed, ensures that each step will be carefully planned and executed, leading to a ‘logical’ explication of how an investigation should unfold” (Bryman, 2016). This requires the choice of research philosophy, which determines the researcher’s stance on reality and knowledge, i.e., whether one is following positivism, interpretivism, pragmatism, or critical realism (Saunders, Lewis, & Thornhill, 2019).

The research designs include inductive, deductive, or abductive reasoning, developing the development and testing of theories (Creswell, 2014). In addition to this, research methodology also includes selecting suitable strategies of research that include experiments, surveys, case studies, and can come under ethnography or focus groups among others based upon the objective of the research as well as the nature of the inquiry (Marshall & Rossman, 2014). The planning even extends to the methods of data collection, and these may include interviews, questionnaires, observations, and document analysis, which must be designed appropriately to collect the required information efficiently (Neuman, 2014).

4.1.1 The Importance of Research Methodology

The importance of research methodology lies in its ability to determine the credibility, reliability, and validity of the results, distinguishing it from other data. Robust methods ensure that all stages of a study are clear and replicable by other researchers, which is

crucial for scientific progress. For science to advance by building on previous research, reliability is essential (Bryman, 2016). A systematic methodology allows researchers to eliminate biases and inconsistencies, as well as potential mistakes that may distort the results into incorrect representations of the studied phenomenon (Neuman, 2014). This is especially important when research findings are used to shape policy, practice, or other forms of research (Creswell & Creswell, 2017). In social sciences, where human and societal trends are involved, having a structured methodology results in trustworthy insights that can be used to create effective interventions or policies (Marshall & Rossman, 2014).

Moreover, research methodology is important for ethical compliance, ensuring that the rights, dignity, and welfare of participants are respected. Research design includes ethical considerations, which are essential in studies involving human subjects. These considerations encompass consent, confidentiality, and harm reduction in all aspects of the study (Saunders, Lewis, & Thornhill, 2019). A comprehensive methodology details how ethical concerns are addressed, including procedures to obtain informed consent, guarantees of anonymity protection, and the right of participants to withdraw from the study at any point. Such ethical strictness safeguards participants and lends the research trustworthiness and integrity (Denzin & Lincoln, 2018). The chosen methodology also contributes to improving decision-making during and after the study. It structures the approach from the formulation of the research question to the methods, allowing researchers to decide which techniques and tools will be useful to reflect their thoughts accurately (Creswell, 2014).

This enabled the research to be focused, coherent and capable of addressing the objectives intended and these might include selecting the most relevant stakeholders to participate in a focus group, preparing good questions that can draw data out of interviewees and analysing the data in such a way as appropriate relations between universities and innovative processes become evident (Eriksson et al. 2016).

4.1.2 Critical Evaluation

Moreover, a clearly outlined research methodology enables peers and other stakeholders to assess and critique critical information contained in the study. Careful documentation of all aspects of the research process not only ensures reproducibility and replicability but also allows others to evaluate whether proper measures were taken. This level of transparency is essential to the academic process, providing transparency

so that others can either replicate the study or expand upon the findings (Bryman, 2016; Neuman, 2014). In fields where it's important to build on prior knowledge and gain new understanding, such as in natural science or medical research, this potential replicability is what makes the findings stand up to serious scrutiny.

From a practical point of view, research methodology is necessary to solve the problems that arise in real life. It is a structured approach to examining problems, obtaining information, and coming up with answers for bringing results into practice and policy. In applied research aimed at improving educational interventions, a well-designed methodology ensures that these interventions are evidence-based, and their impact accurately discerned. In this way, we can see where we should focus on future tasks. This once again reflects the importance of quality research methodology in connecting theory and practice for socio-economic growth (Saunders, Lewis, & Thornhill, 2019; Creswell, 2014).

In conclusion, the research methodology is at the heart of scientific inquiry's ability to establish credibility and reliability in its findings due to offering a framework, procedures, and ethical basis. This guarantees that the research is carried out in a systematic, transparent, and ethical manner, further increasing the validity of the application of results. Indeed, it is research methodology which navigates all these complex activities of data collection and analysis to produce the valuable insights that can lead to policy, practice, or further research. But it does more than that, because in doing so, it serves to help society tackle real-world problems and increase our overall state of knowledge, two things which are profoundly important (Denzin & Lincoln, 2018; Creswell & Creswell, 2017).

This chapter will detail the research methodology using the "Research Onion" model, which provides a comprehensive framework for developing and explaining the various stages of research design (Saunders, Lewis, & Thornhill, 2019). The Research Onion consists of six layers: philosophies, approaches, strategies, choices, time horizons, and techniques and procedures. Each layer will be discussed in detail, and the selection of one element from each layer will be justified in relation to focused group research. The theme of the thesis is to investigate the role of universities as platforms for innovation and as catalysts for regional development.

4.2 Research Philosophy

Research philosophy refers to the set of beliefs concerning the nature of reality (ontology), the nature of knowledge (epistemology), and the methods of acquiring knowledge (methodology) (Creswell & Creswell, 2017; Saunders, Lewis & Thornhill, 2019).

For this study, the interpretivist philosophy is the most appropriate. Interpretivism is concerned with understanding the subjective meanings and experiences of individuals within their social context (Creswell & Poth, 2018). This aligns well with the research objective of investigating the role of universities in innovation and regional development, as it involves exploring the perspectives and experiences of various stakeholders (e.g., academics, administrators, industry partners, policymakers, and community members) (Bryman, 2016; Guest, MacQueen & Namey, 2012).

Interpretivism allows for an in-depth understanding of the complex and dynamic interactions between universities and their regional environments, which is crucial for comprehending how universities can act as platforms for innovation and catalysts for regional development (Guerrero & Urbano, 2012; Etzkowitz, 2003; Carayannis & Campbell, 2019). By adopting an interpretivist stance, the research can capture the rich, detailed insights needed to understand these processes (Lincoln & Guba, 1989; Denzin & Lincoln, 2018).

Whereas positivism focuses on objective, measurable facts, often through statistical or experimental methods, it is unsuitable for this study, which deals with interpretive meanings, not quantifiable variables (Neuman, 2014). It also limits the ability to explore the depth and complexity of stakeholder experiences.

The philosophy of realism seeks to explain underlying structures and mechanisms, mixing qualitative and quantitative approaches. Although it is insightful, it leans toward a more theory-driven and causal explanation model, which is not the aim of this research (Burke, 2007).

The pragmatism philosophy focuses on what works, often blending qualitative and quantitative methods. While useful in applied research, it does not align with the mono-method qualitative design and deep interpretive stance adopted here (Tashakkori & Teddlie, 2010). The goal of this research is not to select methods based on outcomes but on philosophical alignment with the exploratory aim of the study.

4.3 Research Approaches

Research approaches determine the plan and procedures for research design, including the methods of data collection and analysis (Creswell, 2014; Saunders, Lewis & Thornhill, 2019). The inductive approach is selected for this study. Inductive reasoning begins with observations and data collection, and through analysis, it leads to the development of theories (Bryman, 2016; Bernard, 2017). This approach is suitable for the exploratory nature of the research, aiming to understand the roles of universities in innovation and regional development based on stakeholders' experiences and perspectives (Guerrero & Urbano, 2012; Carayannis et al., 2021).

Given the lack of a single, comprehensive theory that explains the multifaceted roles of universities in regional development, an inductive approach allows for the emergence of new insights and theories grounded in the data (Guest, MacQueen & Namey, 2012; Denzin & Lincoln, 2018). This approach aligns with the interpretivist philosophy, emphasizing understanding the subjective experiences and meanings that stakeholders attribute to universities' roles (Creswell & Poth, 2018; Lincoln & Guba, 1989).

Deductive reasoning tests existing theories through hypothesis-driven research. It typically relies on structured, often quantitative data collection methods (Neuman, 2014). Since the current study is not testing a predefined theory, but instead aiming to develop new insights based on participants' perspectives, deduction would be too rigid and unsuitable.

Abduction combines both induction and deduction by moving back and forth between data and theory. While useful in some mixed-methods studies, this research is firmly grounded in qualitative inquiry (Tashakkori & Teddlie, 2010; Johnson & Onwuegbuzie, 2016). Since this research is not refining or testing existing theories but building fresh understanding from stakeholder dialogue, the inductive route is more aligned with the aims and methodology.

4.4 Focused Group Research Strategy

Focus group research is chosen as the primary strategy for this study. Focus groups involve guided discussions with selected participants to explore their views, experiences, and insights on specific topics (Krueger & Casey, 2015). This strategy is particularly effective for understanding the complex and multifaceted roles of universities in regional development.

This study employs focus groups as the main research strategy to collect data from a diverse set of stakeholders, including university staff, industry partners, and policymakers. Focus groups enable participants to engage in interactive discussion, allowing for the co-construction of knowledge and a deeper understanding of complex social phenomena (Krueger & Casey, 2015).

The group format encourages participants to reflect on each other's views, often revealing shared values, disagreements, and nuanced interpretations that might not emerge in isolated interviews (Creswell & Creswell, 2017; Guest, MacQueen & Namey, 2012). This makes them especially suitable for exploring the socially embedded roles of universities in regional innovation systems.

Surveys, though widely used in empirical research, were not chosen because they typically capture surface-level data and limit opportunities for participants to explain the reasoning behind their responses. The lack of interaction also prevents the discovery of emerging themes that arise during group discussions (Neuman, 2014).

One-to-one interviews, while rich in detail, do not offer the same level of dynamic exchange among participants. Focus groups, on the other hand, generate collective insight and stimulate discussion that often leads to new understandings (Denzin & Lincoln, 2018). They also enhance participant involvement, which supports the credibility and trustworthiness of qualitative research (Miles, Huberman & Saldana, 2013). Additionally, focus groups align well with the interpretivist paradigm of the research by enabling participants to express their values, language, and interpretations in a social setting. This facilitates deeper access to cultural and contextual knowledge relevant to the research questions (Silverman, 2016). The focus groups were conducted online via Microsoft Teams, accommodating participants from multiple universities and allowing for geographic diversity. Although group discussions require careful moderation to manage dynamics and avoid dominance effects (Cohen, Manion & Morrison, 2018), the strategy proved effective in capturing rich, detailed data across stakeholder groups.

4.5 Sampling Strategy and Ethical Considerations

The sampling process followed a purposive sampling logic, selecting participants based on their roles, experiences, and relevance to the research aims (Palys & Atchison, 2018; Onwuegbuzie & Leech, 2007). Participants were drawn from both computing and business disciplines to reflect the interdisciplinary nature of innovation within the

institutional context. A total of 6 focus groups were conducted, comprising students and staff members. This number was informed by qualitative research conventions, which suggest that data saturation where no new themes emerge is often achieved with 6 to 12 interviews or 3 to 5 focus groups, depending on the study's scope and heterogeneity of the sample (Guest, Bunce & Johnson, 2006; Hennink, Kaiser & Marconi, 2017). Thus, the sample size was deemed sufficient to generate rich, situated insights without seeking statistical generalisability (Stake, 2013; Guest, MacQueen & Namey, 2012).

Ethical considerations were embedded throughout the research process and adhered to the principles of informed consent, confidentiality, and autonomy (Creswell & Poth, 2018; Denzin & Lincoln, 2018). All participants received detailed information sheets and signed consent forms outlining the study's purpose, their voluntary involvement, and their right to withdraw at any time without consequences. In line with institutional ethical approval, all data were anonymised, and identifiers were removed during transcription and analysis to ensure the protection of individuals and institutions (Silverman, 2016; Lincoln & Guba, 1989).

Special ethical sensitivity was applied during sampling and data collection, especially because the participant pool included both students and teaching staff. Focus group facilitation was designed to encourage open, honest dialogue while minimising power imbalances and social desirability bias (Bryman & Bell, 2015). Group composition was intentionally structured to avoid hierarchical pressure and to protect minority voices. The researcher remained reflexively engaged throughout the process, continuously evaluating their positionality and its influence on the research encounter and interpretation of data (Miles, Huberman & Saldaña, 2013).

All data were securely stored on encrypted drives and analysed using NVIVO software, ensuring traceability, systematic coding, and auditability, in full compliance with GDPR and institutional data governance protocols (Bryman & Burgess, 2019; Guest, MacQueen & Namey, 2012).

4.6 Data Analysis: Thematic Approach

Thematic analysis is chosen as the analytical framework due to its suitability in identifying patterns, themes, and meaning across qualitative data. Following Braun and Clarke's (2006) six-phase model, the researcher engaged in familiarisation with the data, generated initial codes, searched for and reviewed themes, and defined them with

reference to the research questions and theoretical framework. NVIVO software was used to manage data and facilitate the organisation and visualisation of thematic relationships. The themes were later cross-referenced with relevant literature, allowing for deeper theoretical integration and model development.

Summary

This chapter presents the methodological foundation of the study, designed to explore how universities act as catalysts for sustainable innovation and regional development. A structured yet flexible research design was developed using Saunders et al.'s (2019) Research Onion model, covering research philosophy, approach, strategy, method, time horizon, and procedures. The research adopts an interpretivist philosophy, recognising that social realities are constructed through subjective experiences. This stance supports the study's aim of understanding diverse stakeholder perspectives academics, administrators, and industry partners on universities' evolving roles in innovation ecosystems (Creswell & Poth, 2017). Other philosophical paradigms such as positivism, realism, and pragmatism were deemed unsuitable due to their emphasis on objectivity, causal mechanisms, or mixed methods, which do not align with the study's qualitative and exploratory nature. An inductive approach was selected to allow theories and insights to emerge from stakeholder narratives (Thomas, 2006). This approach fits the study's aim to explore, rather than test, theory, particularly in an under-theorised area like universities' impact on regional innovation (Gioia et al., 2013). Deductive and abductive methods were excluded due to their reliance on pre-existing frameworks or back-and-forth movement between data and theory, which were not applicable here.

The chosen research strategy is focus group discussions, which provided rich, interactive data from participants across different institutions. Focus groups encouraged shared reflection and group dynamics that generated deeper insights into socially embedded practices (Krueger & Casey, 2015). Compared to surveys or individual interviews, this method better captured the complexity of stakeholder experiences (Denzin & Lincoln, 2018; Neuman, 2014). Purposive sampling is used to select participants knowledgeable about the subject, including academic and student stakeholders from computing and business faculties. Ethical safeguards were rigorously applied, ensuring informed consent, anonymity, and voluntary participation.

Chapter 5: Data Collection & Analysis

5.1 Overview

The aim of the research is to analyse the role of universities acting as a platform for innovation providing change catalyst for the regional development. This chapter explores and analyse the collected data through focused groups. The researcher has conducted and collected various focused groups which includes two groups of Birmingham City University computer sciences students who participated in the innovation festivals, two groups from QA Higher Education who are business management students, and the final two groups are from the Ulster University business management programmes who are passionate about developing new ideas and products. Thematic analysis approach is used to analyse the collected data using NVIVO software in which some distinctive as well as common themes have emerged and discussed thoroughly.

Focus group research makes use of themes as an essential part of data analysis (Creswell, 2014). A theme is defined as any recurring pattern that appears repeatedly within the data and serves as an umbrella term to summarize sections of it (Bryman & Bell, 2015). When creating themes, it's essential that they align with both the research questions and goals as well as participants' views, making sure any themes created reflect these factors as effectively as possible (Creswell & Creswell, 2017).

Focus groups can be an invaluable way of getting to know your target audience better and understanding their attitudes toward products or services (Bryman & Burgess, 2019). Focus groups provide invaluable insight into the effectiveness of marketing campaigns or help create future products more likely to meet consumer needs (Creswell & Poth, 2018). It is essential that the goal of the focus group be clearly defined prior to recruiting participants to select an audience representative sample and ensure accurate, meaningful results from your focus group (Cohen, Manion & Morrison, 2018).

Focus groups offer several advantages over individual interviews or surveys in terms of gathering the ideas and views of participants (Denzin & Lincoln, 2018). Furthermore, focus groups are time-efficient; rather than conducting individual interviews for every participant in your focus group, multiple focus groups can take place during that same

amount of time (Bryman & Cramer, 2018). Furthermore, online focus groups allow for reaching a greater number of people (Bryman & Bell, 2015).

Focus group discussions aim to provide participants with an atmosphere in which they feel free to express their thoughts and opinions freely, creating an open forum in which everyone feels at ease sharing their insights and perspectives (Creswell, 2014). You can achieve this by setting ground rules such as respecting each other's opinions without interruption and refraining from making direct remarks that might bias results (Creswell & Creswell, 2017). You should ask open-ended questions during discussions while actively listening for responses - leading questions may skew results too far in one direction (Creswell & Poth, 2018).

One drawback of focus groups is their difficulty when used for studying sensitive topics, especially when conducted face-to-face (Denzin & Lincoln, 2018). Employing online methodologies as research methodologies may overcome this limitation by making participation more anonymous (Bryman & Burgess, 2019). Focus groups may be difficult and time-consuming to organize in remote or isolated locations, requiring transportation services or incentives to attract and keep participants (Cohen, Manion & Morrison, 2018).

Group discussions provide a valuable method for gathering qualitative information, exploring participants' attitudes, beliefs, and opinions on a specific topic, with a moderator typically leading the conversation (Guest, MacQueen & Namey, 2012; Marshall & Rossman, 2014). Participants are encouraged to share their perspectives about an issue rather than merely filling out a survey form. Compared to individual interviews, discussions are often more engaging and informative, facilitating the collection of a wide variety of data related to feelings and emotions. To ensure data completeness and accuracy, discussions are recorded and transcribed for further analysis, despite the challenges of the time-consuming and expensive transcription process (Johnson & Onwuegbuzie, 2016).

Focus group discussions offer an effective means of investigating various research questions, ranging from evaluating consumer satisfaction to analysing audience reactions in radio programs (Marshall & Rossman, 2014; Miles, Huberman & Saldana, 2013). However, it is essential to recognize the limitations and avoid biases that could skew the data, such as the dominance effect, halo effect, and groupthink, where individuals conform to views shared by others to maintain group.

When planning a focus group discussion, clarity about the specific questions posed to participants, selecting a suitable venue, and choosing an effective moderator are crucial (Huberman & Saldana, 2013). To prevent participant fatigue and ensure sufficient time for everyone's contributions, the discussion should not exceed two hours. Additionally, budgeting for all research-related expenses, including the moderator's salary, recording/transcription fees, participant travel/retention fees, and venue rental charges, is essential for successful implementation.

The Word Cloud option is used within NVIVO to better and quickly identify key themes and recurring areas within the collected data. The size of the words in the tree corresponds to their frequency and allow the researcher to visually assess which terms are most prevalent.

Figure 5.1: Recurring Keywords in the Data

(Source: Created by Researcher, 2023)

In this study, the researcher employed the Word Tree option, drawing upon its capability to visualize how a specific word is utilized within a corpus by displaying all its instances in various contexts. Each node in the tree represents one instance of the keyword, and each branch indicates the frequency of instances within it. The interactive nature of Word Trees allows users to click on a node to reveal additional branches and contexts for that keyword, while double-clicking enables access to the full word tree (Palys & Atchison, 2018).

Word trees offer several advantages over other text-based visualizations, such as word clouds that only display the most frequent words. Their structured format enhances intuitiveness compared to lists of keywords, and the interactive feature allows users to expand or collapse branches as needed. NVIVO's Word Tree feature employs various heuristics to identify the most relevant contexts for a selected keyword in its tree view. This includes displaying common words and phrases related to the keyword while filtering out less frequently used words, contributing to a more focused and meaningful representation (Patton, 2015).

The Word Tree functionality in NVIVO not only presents recent instances of keywords within text but also illustrates how these words and phrases interact in context. This feature proves particularly helpful when aiming to identify trends or uncover insights that may not have been apparent during initial analysis.

5.2 Data Exploration of Computer Science Discipline Focused Groups

5.2.1 Theme C1

After coding the data in NVIVO as well as thoroughly performing the analysis on the data, the following theme emerged along with the responses of the participants:

(Theme C1) Community Development Through Knowledge Transfers
• The university have played a good role in letting us conduct research. • University ensured the sustainability goals of the innovation. • Contribute to the creation of new knowledge, theories, and technologies through research activities.

- It provides an environment for intellectual exploration, developing the creation of new ideas and knowledge.
- Various modules are taught educating students about innovation.
- Through academic settings to practical applications in society, contributing to technological advancements.
- The academic environment encourages innovative thinking.
- Focus on addressing real-world problems, leading to practical solutions.
- These served as hubs for continuous learning.

Table 5.1: (Theme C1) Community Development Through Knowledge Transfers

(Source: Created by Researcher, 2023)

The option of Word trees in NVIVO serve as a powerful tool in this analysis and provide a visually intuitive way to explore, understand, and communicate patterns and themes within large sets of textual information. In the current research, researcher has performed Word Search (Community, Development, Knowledge) on the collected data from focused groups Community and the following results are generated:

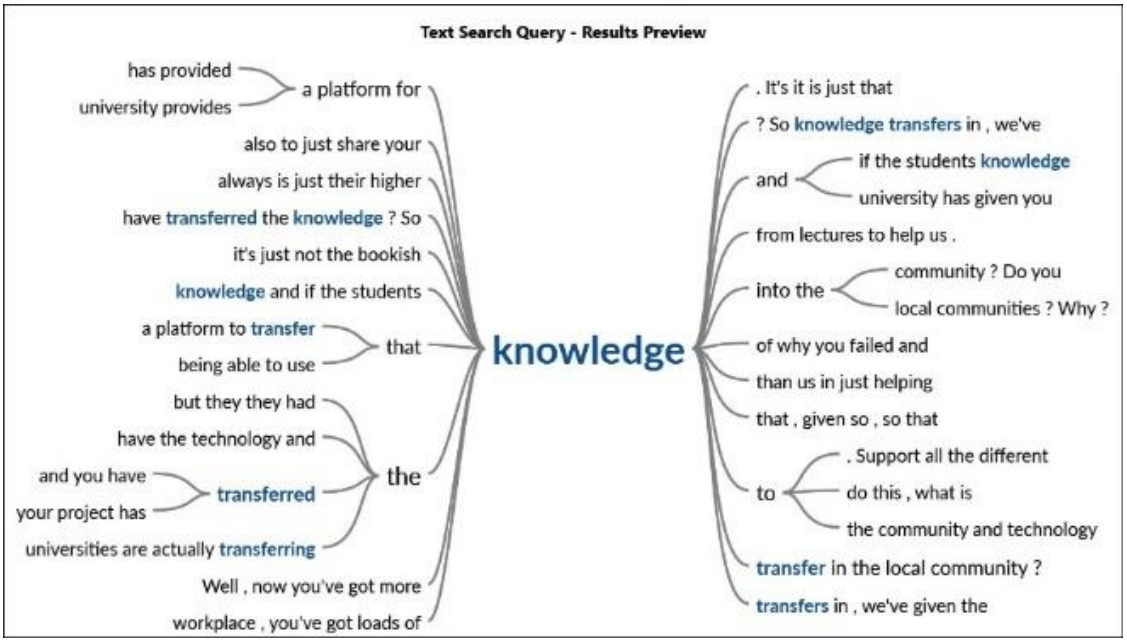


Figure 5.2: Results Review for Knowledge

(Source: Created by Researcher, 2023)

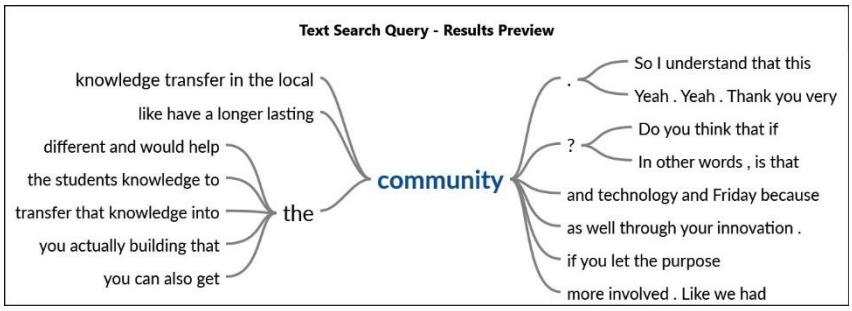


Figure 5.3: Results Review for Community

(Source: Created by Researcher, 2023)

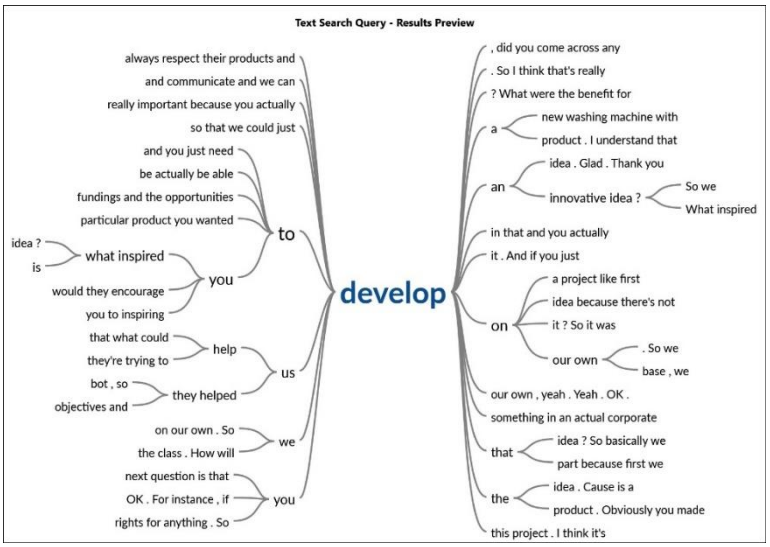


Figure 5.4: Results Review for Develop

(Source: Created by Researcher, 2023)

5.2.2 Analysis of Theme C1

5.2.2.1 University's Role as Knowledge Generator in Innovation Activities

The collected data depicts that the increasing importance of higher education as a driver of change and social transformation has led to a shift in higher education's role from knowledge producers to co-creators of solutions. Students are increasingly demanding hands-on learning and involvement in real-world issues, and the University is stepping up to serve as a catalyst for societal change. There are several recent examples university-based discussed in alliance to developing community through the knowledge

transfer. The first step in understanding the role of university in community development is to understand the value of knowledge and recognise the value of that knowledge. Once knowledge is valued by its seeker, it becomes easier to transform and assimilate into local knowledge. Most scientists and local farmers do not have any prior knowledge of what university researchers produce. As a result, integrating university research and knowledge into community development activities is a vitally important aspect of community development.

Birmingham City University (BCU) assists universities with their technological innovation. They support technology transfer offices through educational opportunities, advocacy, and networking. The university's intellectual property (IP) is protected, and technology transfer professionals make sure the technology is successfully developed and licensed to a commercial firm. These commercialization partnerships lead to greater innovation in universities and economic activity beyond their borders. In addition to these benefits, technology transfer is one of the four pillars of the new global economy.

5.2.2.2 Identifying Knowledge Gaps

Education's main challenge lies in its gap between research, practice, and policy. Third party agencies and intermediaries have emerged to strengthen connections between these three domains through knowledge brokers - often known as intermediaries or third-party agencies (Hansen & Ockwell, 2014). One of the participants from focused groups mentioned that “we kept on focusing on the main sustainability goals we had in mind, like sustainable cities and communities, and to others like just one renewal energy and cause for one of our review meetings, we had to do like research on it on the product and market research” and this stresses on identifying the knowledge gap and then perform the research. This can investigate further of knowledge brokers in regional innovation systems by exploring four of their key themes of functioning: cluster building, decision making/control processes, the social dimension of networks and exchange elements. Universities provide universities a rare opportunity to act as knowledge brokers. Their regional mandate makes them ideal partners in supporting various forms of local innovation activities and filling any knowledge gaps between research and business; creating links between researchers and entrepreneurs while offering training in specific skills is another benefit they offer (Hasche, Höglund & Linton, 2019). However, it is essential to recognise that universities as knowledge brokers are constantly shifting. Universities need to adapt quickly in response to ever-evolving community needs by

identifying gaps and devising interventions to fill them (Heidkamp, Garland & Krak, 2021).

5.2.2.3 Identifying Knowledge Brokers

Knowledge brokers in HEIs are professionals who act as intermediaries between researchers and policymakers or stakeholders, and research itself. Knowledge brokers promote integration of research findings into policy-making processes while supporting the implementation of research-based solutions in practice and policy - with specific tasks including translation, tailoring information to specific contexts, networking, and mediation (Hong et al., 2019). Administrators are also accountable for administrative tasks like organizing events, creating documentation, filing emails, and maintaining websites. Their role spans organisational boundaries bridging between academia and non-academic organisations while building trustworthy and positive relationships with end-users by encouraging the exchange of ideas and using research in decision-making processes (Hou et al., 2019). Knowledge brokering activities should be implemented across the academic landscape, beyond research institutions to include boundary organisations. This will ensure relevant information reaches all parties involved while encouraging a culture of knowledge sharing that encourages innovation (Kang, Li & Kraus, 2019).

5.2.2.4 Developing a Knowledge Transfer Strategy

Establishing a knowledge transfer strategy is vital to ensure your team members receive all the information they require. To develop one, start by identifying your key areas of expertise and then considering any gaps you need to fill (Kang & Jiang, 2019). Once identified, set up a system for collecting and sharing information to fill those voids. Universities can utilize sensing capabilities to identify opportunities within the UIC ecosystem (Kim et al., 2020). Sensing capabilities are the underlying management routines that allow universities to allocate resources towards perceived opportunities strategically and create sustainable partnerships between academia, industrial partners, and governments. During the focused group discussion, one of the participants said, “This is the market to search, and this is the thing that's so cool and we should do this” and this depicts that the universities can serve as knowledge brokers in cultural ecosystems by offering entrepreneurial education, mentoring potential cultural entrepreneurs, and offering incubation and acceleration to students' cultural start-ups. By acting as knowledge brokers in this way, universities will help translate the vast

amount of knowledge present in cultural ecosystems into projects that create actionable projects with new business opportunities and boost regional growth - further strengthening HEIs' roles as knowledge brokers with smart specialization and creating more sustainable modes of operation.

5.2.2.5 Developing a Knowledge Management Strategy

Implementing a knowledge management strategy involves developing systems and business processes to collect and share information, including creating a knowledge repository, encouraging a culture of knowledge sharing and using appropriate technology tools to support it (Hansen & Ockwell, 2014). This approach allows organisations to apply collective knowledge in organisational processes to improve decision making, encourage innovation, and meet business goals more easily. Companies often lose valuable information when employees leave, due to either no documented knowledge management system in place or poor understanding about its significance and benefits (Hasche, Höglund & Linton, 2019). By developing and educating staff about knowledge management systems, businesses can prevent this problem from arising. Building a knowledge management strategy can be complex. To be effective, it requires commitment from senior leaders to encourage a culture of knowledge sharing as well as the deployment of various tools and technologies (Heidkamp, Garland & Krak, 2021). Once in place, it should be regularly evaluated to ensure it meets organisational needs, integrated into business processes and culture for optimal knowledge sharing across departments as well as stakeholders (Hong et al., 2019).

5.2.2.6 Developing a Knowledge Management Plan

Knowledge management strategies must include more than simply having a clear business model and structure; to be truly effective they must also identify specific knowledge gaps your company wishes to fill to focus on activities with maximum value and impact that enable employees to do their work more efficiently and effectively.

5.2.3 Theme C2

This theme discusses that there are some important concerns when using technology in communities. First, it is important to ensure that technology is used in the service of the community, otherwise it may have unintended consequences. As such, universities can help communities to access the latest technologies and equipment to improve their quality of life. While analysing the data, the following theme has emerged:

(Theme C2) Emerging Technologies & Research Excellence
• University arranges various talks by industry leaders, and they discuss the new trends of the technology. • Our university research on emerging technologies is thrilling. • Our motivation is high due to the potential to contribution of innovation festivals. • It's a dynamic field that continually challenges and inspires us. • It opens new markets, enhances efficiency, and drives innovation. • Performing a through research is the foundation for creating products or services that meet the evolving needs of the market, developing growth and success.

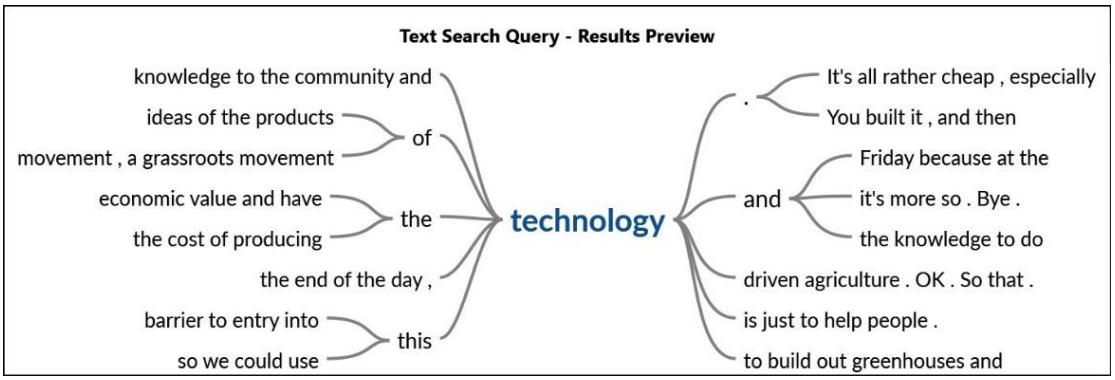
Table 5.2: (Theme C2) Emerging Technologies & Research Excellence

(Source: Created by Researcher, 2023)

This theme suggests that, using technology has its many positive purposes, it also contributes to the social development of communities. Besides advancing the economic and social development of communities, technology is transforming the way people interact and work with one another.

Aside from these benefits, the use of technology has affected the way of life. Technology has improved communication by creating new methods for people to communicate, including various research platforms. It has also changed everyone’s daily lives by allowing them to research and access information from anywhere. During the focused group discussion, a participant mentioned that “For this, basically we are so happy that we were guided by the university, so every class had predefined structure that will would go on with the class” and this theme further suggests that there should be more talks arranged by the university delivered by the industry leaders. They will not only bring the modern research but also the future developments along with challenges and how to

overcome them. The impact of emerging technologies has a very wider role on the community. The developments are not just facilitating the small budget projects of students but also lead to further research and excellence. The researcher has searched the



word “Technology”, and the below word tree is produced:

Figure 5.5: Results Review for Technology

(Source: Created by Researcher, 2023)

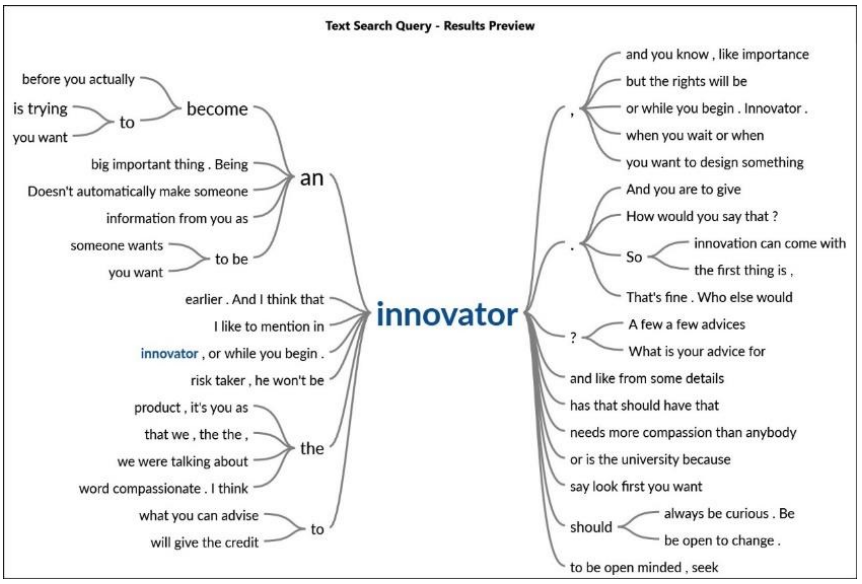


Figure 5.6: Results Review for Innovator

(Source: Created by Researcher, 2023)

The word tree depicts that there are many ways in which technology is being used to advance the cause of community development. While it is an excellent enabler of this endeavour, it is also hindering it. For example, one of the branches expresses barrier to entry in some communities typically where there are low literacy levels, making it difficult

for them to utilise technology. Poor connectivity is another significant problem in rural areas, making it difficult for them to connect with others. Excessive power shortages also make it difficult for rural communities to purchase and charge technology.

5.2.4 Analysis of Theme C2

This theme is analysed with the understanding that the researchers can take advantage of emerging technologies to create immersive, augmented, or virtual environments for teaching and research purposes, including simulation environments, photogrammetry, and motion capture. These tools can also be misused to promote bias and discrimination, disseminate falsehoods, disregard intellectual property rights, violate privacy and even arm autonomous lethal weapons - so the challenge lies in finding ways to balance technology's strength with human values.

5.2.4.1 Research and Development

Universities provide platform to researchers to create new knowledge to solve problems, answer questions, and make breakthroughs, as well as discover how it can be applied in various contexts (known as applied research) (Liyanage & Netswera, 2021). At BCU interdisciplinary research centres and institutes, they specialise in all areas of emerging technology from space cybersecurity to photonics. Research is often funded by both government agencies and private companies, contributing to economic development while creating jobs (Lo & Theodoraki, 2021). BCU serve as innovation hub through the creation and advancement of emerging technologies. BCU recently unveiled the European PhD hub an initiative that seeks to deepen their understanding of technological breakthroughs that impact societies and economies while creating independent labs, centre in Birmingham. It features research from across ten pivotal technology domains with authors that include leading science and engineering faculty members.

5.2.4.2 Commercialization

University researchers and scientists are often Recognised for developing revolutionary technologies, from autonomous vehicles to encryption algorithms (Lopes, Farinha & Ferreira, 2019). Many views these discoveries as transformational; acting as catalysts for positive societal change. Universities serve as innovation hubs by forging partnerships between business communities, government agencies, and technology-based industries. Universities also act as training centres that prepare future professionals to use emerging technologies. The School of Emerging Technologies at

TU will advance interdisciplinary education and research on emerging technologies by offering engaging research opportunities for postsecondary students from baccalaureate through applied doctoral levels. These programs address workforce and societal needs such as artificial intelligence (AI), Quantum Information Science (QIS), and Advanced Air Mobility.

Universities provide academics with the resources to commercialize their research through accelerators and incubators that assist them with building out and scaling their companies, thus providing the income necessary for further exploration and development of frontier technologies (Liyanage & Netswera, 2021).

5.2.4.3 Innovation Hubs & Entrepreneurship

Universities serve as innovation hubs for emerging technologies and help entrepreneurs establish businesses. They do so by creating an environment where creativity and brainstorming can flourish, producing new ideas while networking potential partners or customers for businesses (Lo & Theodoraki, 2021). Universities are being encouraged to contribute more actively to regional and national economic development by engaging in activities known as their 'third mission'; such as entrepreneurialism and industrialization. This could boost the economy. Goal of this initiative: creating an interdependent cycle between research, innovation, and economic growth (Lopes, Farinha & Ferreira, 2019).

Incorporating this strategy requires providing students at universities, and in their surrounding community, with various learning and entrepreneurship opportunities - from elementary school coding classes through drone workshops for teens or career change courses for adults looking to make a career shift into technology-based startups (Liyanage & Netswera, 2021). Furthermore, creating networks of business incubators which link universities with businesses. These incubators can facilitate networking while also offering funding and services that small businesses may require.

5.2.5 Theme C3

In addition to addressing these challenges, students must also consider the larger public environment in which they live. Because every community is different, it will need to consider the specific characteristics of a community to develop a model that will serve different business models. Ultimately, this is how transformational community development will take place. The researcher emphasizes the need for university to

consider the larger public environment when designing and implementing innovative community development programs. While analysing the focused group data, the researcher has come up with the following theme:

(Theme C3) Industry Relevant Curriculum for Sustainable Products Developments
• We have a module at level 3 which prepares us for the innovation. • There should be industry related modules just like we meet organisations and their bosses on innovation festivals. • It would be great to have a curriculum that focuses on sustainable product development

Table 5.3: (Theme C3) Industry Relevant Curriculum for Sustainable Products Developments

(Source: Created by Researcher, 2023)

Despite its wide-ranging influence, how can curriculum adoption by the university help in developing community, it is crucial to understand that there is a very strong link between both. By providing social and economic infrastructure and technology, the curriculum alliance to industry developments can help develop communities. It provides a voice to the community within a larger ecosystem, enabling students to build a better future for themselves and their community. Though the use of technology has changed nearly every aspect of human life, the situation of digital literacy among women is dire. Nonetheless, digital literacy programmes are showing promise in overcoming these challenges and integrating technology into community life.

Many people are unaware that disruptive innovation technologies can also help in developing communities. Disruptive innovations begin in low-end markets. Many incumbents, however, prioritise their highest-demanding and most profitable customers while ignoring less-demanding customers. Thus, their offerings often overshoot the performance requirements of low-end consumers. Thankfully, the use of disruptive technologies has radically changed this industry. Disruptive innovations usually happen during innovation festivals where students perform thorough research on what is

happening in the market and what features could be added to improve the existing products.

While performing a word search on “Innovation”. The below word tree is produced:

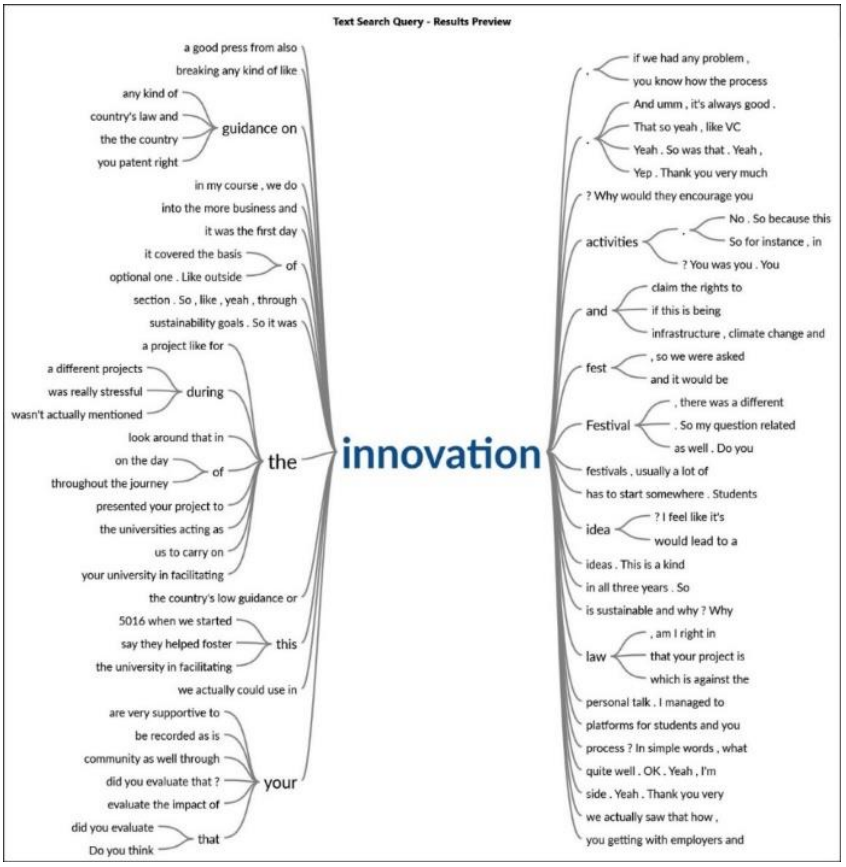


Figure 5.7: Results Review for Innovation

(Source: Created by Researcher, 2023)

As per the above tree and while analysing the data, it is evident that developing a sustainable innovation ecosystem is essential to local economic development. Innovation festivals are an important source of innovative activity and can be a critical input to government and other development institutions. They can also act as change agents for the society. An appropriate balance of government, business, and entrepreneurial support can yield positive results for local economies. The below word tree encourages the importance of challenges by the actors, mentors as well as the universities when act as innovative platform for community development.

5.2.6 Analysis of Theme C3

5.2.6.1 University Curriculum

Many traditional universities as well as organisations are under fire these days and on the verge of transformation. Among those Organisations are universities, corporations, chambers of commerce, nonprofit foundations, and schools. But online learning can offer something new: a way for these universities to collaborate in the development of a community. To make this kind of collaboration work, the partners must be good learners. The community will need these partners in the development of its community and the programs they offer.

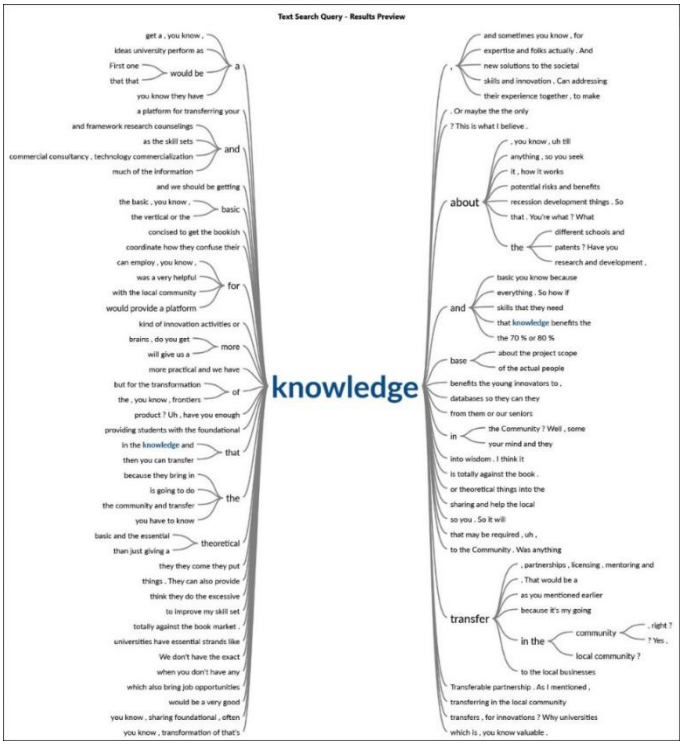


Figure 5.8: Results Review for Knowledge

(Source: Created by Researcher, 2023)

The benefits of practical learning and knowledge extend far beyond the students who benefit. According to Gallardo-Vázquez et al. (2021), universities have recognised its benefits by earning the Catalyst Awards in the three categories of student success, faculty training, and institutional effectiveness. It also provided robust faculty training, including online faculty mentoring and enrichment series. And the university has made significant use of Blackboard Analytics to help facilitate the transition. Its work is Recognised in a worldwide community of practice.

For example, business students might study sustainable business practices that consider environmental impact, social responsibility, and long-term economic viability. Similarly, engineering students might explore sustainable design principles that minimize resource consumption and environmental degradation (Lozano et al., 2017). According to Wiek et al. (2011), interdisciplinary collaboration is a key feature of sustainable development, and universities can facilitate this by offering interdisciplinary courses and collaborative projects that bring together students from various disciplines. This approach not only mirrors the real-world complexity of sustainability challenges but also nurtures a collaborative mindset essential for addressing these challenges. Through interdisciplinary coursework, students gain exposure to diverse perspectives, learn to appreciate the complexity of real-world problems, and develop the skills to work collaboratively across disciplines.

Practical and experiential learning opportunities form a cornerstone of a sustainable development-focused curriculum. According to Stibbe (2015), universities can provide internships, service-learning projects, and research opportunities that allow students to apply theoretical knowledge to real-world sustainability challenges. This hands-on experience not only enhances students' problem-solving skills but also instils a sense of responsibility and agency in contributing to positive change. For instance, students studying environmental science might engage in fieldwork to assess local ecosystems, while those in social sciences might participate in community development projects (Gallardo-Vázquez et al., 2019). The global nature of sustainability challenges necessitates a global perspective in university curricula. According to Leal Filho et al. (2019), internationalization of the curriculum, through global partnerships, study abroad programs, and exposure to diverse cultural perspectives, equips students with a nuanced understanding of how sustainable development is shaped by different contexts. Exposing students to global sustainability issues encourages a sense of global citizenship and prepares them to navigate the complexities of an interconnected world.

Moreover, the integration of sustainability into university curricula extends beyond specific courses; it requires a systemic approach that permeates the entire educational experience. According to Barth & Michelsen (2013), universities can establish sustainability offices or committees tasked with promoting and overseeing sustainability initiatives across campus. Additionally, the physical campus infrastructure can serve as

a living laboratory for sustainable practices, from energy-efficient buildings to waste reduction and recycling programs.

5.2.6.2 Sustainable Developments

In the realm of research along with the focused groups findings, universities play a crucial role in advancing knowledge and innovation for sustainable development. According to Leal Filho et al. (2018), research-intensive universities can prioritize sustainability research across disciplines, encouraging faculty and students to investigate pressing sustainability challenges. The outcomes of such research can inform both curricular development and practical solutions for sustainability issues. Universities can also establish research centres or institutes dedicated to sustainability, developing a collaborative and cross-disciplinary approach to addressing complex challenges. Challenges in integrating sustainability into university curricula include the need for faculty development, the identification of relevant and up-to-date content, and overcoming disciplinary silos. According to Jones & Selby (2016), faculty development programs can equip educators with the knowledge and tools to integrate sustainability into their courses effectively. Additionally, creating spaces for faculty collaboration and interdisciplinary dialogue can break down disciplinary barriers and encourage a culture of innovation in curriculum development. The role of assessment and accreditation processes cannot be overlooked in ensuring the effectiveness of sustainability-focused curricula. According to Lozano et al. (2016), assessment strategies should align with the intended learning outcomes related to sustainability, and accreditation bodies can play a role in incentivizing and Recognising institutions that prioritize sustainability in their educational programs. This ensures accountability and encourages universities to continuously improve their efforts in embedding sustainability into their curricula.

The researcher has performed a word search for sustainable, the following word trees are found:

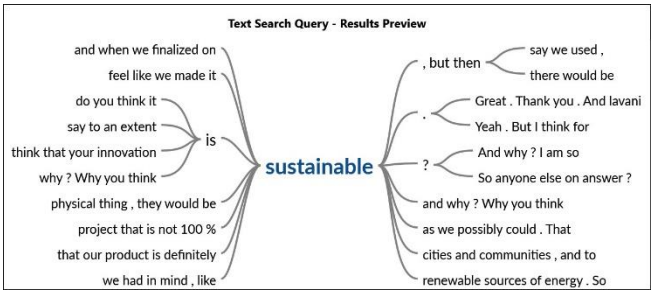


Figure 5.9: Results Review for Sustainable

(Source: Created by Researcher, 2023)

The community serves as a forum for questions, resources, and best practices. Birmingham City University (BCU) Studies has also developed a private online learning community in Moodle that facilitates collaboration between faculty members. Similarly, other institutions are using online learning to support the development of local communities and institutions.

If a university wants to be truly sustainable, its education must encompass sustainability principles. However, universities often find it challenging to implement such changes when faced with demanding tasks like teaching, administration work, and research projects. According to Gallardo-Vázquez et al. (2021), to effectively integrate sustainability in universities requires restructuring their education model to produce an educational program aligned with long-term market requirements. Student entrepreneurship and company interactions must be encouraged to encourage innovation. According to Goddard, Hazelkorn & Vallance (2016), this can be accomplished by strengthening relationships between academic environments and business environments to co-create knowledge, host workshops, lectures, practice communities etc. Additionally, increasing students' involvement in projects at companies is crucial in creating an open atmosphere where their knowledge can be shared amongst the wider community. The obtained demonstrated that most participants supported reframing of a university's approach to sustainability as a strategic one, viewing it as part of governance, strategy, education, and campus life. Furthermore, the findings also revealed common themes and leadership insights useful for those engaging in reframing sustainability as a transformational agenda specifically emphasizing multi-stakeholder approaches which involve not only university stakeholders but also local businesses and community members.

5.2.6.3 Learning Through Projects

The discussion data provides in depth understand about learning through projects, however sustainable development issues present unique and different approaches in higher education that empower students for collective action. According to Haites, Duan & Seres, (2006) universities must incorporate sustainability into their curricula, cultivating new generations of sustainability leaders. This paper highlights one innovative course designed to integrate sustainability in higher education by engaging students to collaborate on real-world sustainability projects partnered with communities

- adaptable and responsive to local needs of community partners. This course's project-based learning approach is founded on the belief that sustainability's challenges require strong collaboration, so developing collaborative action competencies is paramount for students. Students identify a social or ecological issue important to local community members, then employ procedures from a methodology to create a project tailored specifically towards meeting those needs; students then work alongside community groups on this effort over an extended period.

Students engaged in this process learn to identify and work with local community partners such as social enterprises or innovators to promote sustainability solutions and meet the sustainability goals of these organisations. Furthermore, they engage with other stakeholders such as informal citizens' groups or local government to gain an insight into how different actors frame issues in different ways, what resources exist locally as well as any barriers or opportunities present themselves in their area. Once their project has been created, students use their design skills to devise solutions to address the selected problem. After testing and verifying that their solution works as intended, students conduct a 'pop-up hub' event where they present their project to wider communities while inviting them to take part in workshops; these may take place either at university or a different location within their community. Additionally, this course includes an interdisciplinary examination of key human rights issues and institutions. According to Garcia-Alvarez-Coque et al. (2020), students learn about how international treaties and institutions have been utilized to establish fundamental dignity for both humans and nonhuman animals alike and how these structures may change due to emerging threats.

5.2.7 Theme C4

Social innovations offer the potential to overcome these obstacles, particularly when developed with the participation of local stakeholders. The Social Innovation in Health Initiative was launched in 2014 to advance social innovations in health and community-based delivery of health services. Social innovation in health refers to a process that links social change to health improvement. Social innovations use the diverse strengths of communities and local institutions to come up with innovative solutions to common challenges in healthcare delivery.

The researcher has thoroughly analysed the data and the following theme has emerged:

(Theme C4) Social Projects Through Innovation Festivals & Overcoming Challenges
• Participating in innovation festivals for social projects is a chance to showcase our solutions and make a real impact. • Limited resources and time constraints can be hurdles. • Different kinds of challenges of funding, development, team working, allocation of tasks, timeline etc. • Working together as a team have helped to overcome the challenges. • Innovation festivals can positively transform our community. • Community involvement is mandatory. • Innovation festivals provide practical learning stage. • Our energy project has impacted the community.

Table 5.4: (Theme C4) Social Projects Through Innovation Festivals & Overcoming Challenges

(Source: Created by Researcher, 2023)

Social innovations can address multiple SDGs and achieve several outcomes. Some social innovations involve community engagement throughout various phases of the process. For example, one social innovation that incorporated community partners in building boats for women's midwives in village health stations was a case where community partners provided the materials and expertise to build the boats. In contrast, another social innovation that involved community involvement was a case where the innovators directly distributed information about the benefits of the project and sought feedback. The application process for this award is rigorous and competitive. To apply, an Organisation must demonstrate that it has a commitment to social innovation in health. The Organisation should have a capacity to advance social innovation in health in its country, be able to work with other institutions, and be committed to embed social innovation into the health systems of the host countries. Furthermore, the applicant

Organisation should have an interest in research on infectious diseases in poor countries.

In the current research, researcher has performed Word Search (challenges) on the collected data from focused groups Community and the following results are generated:

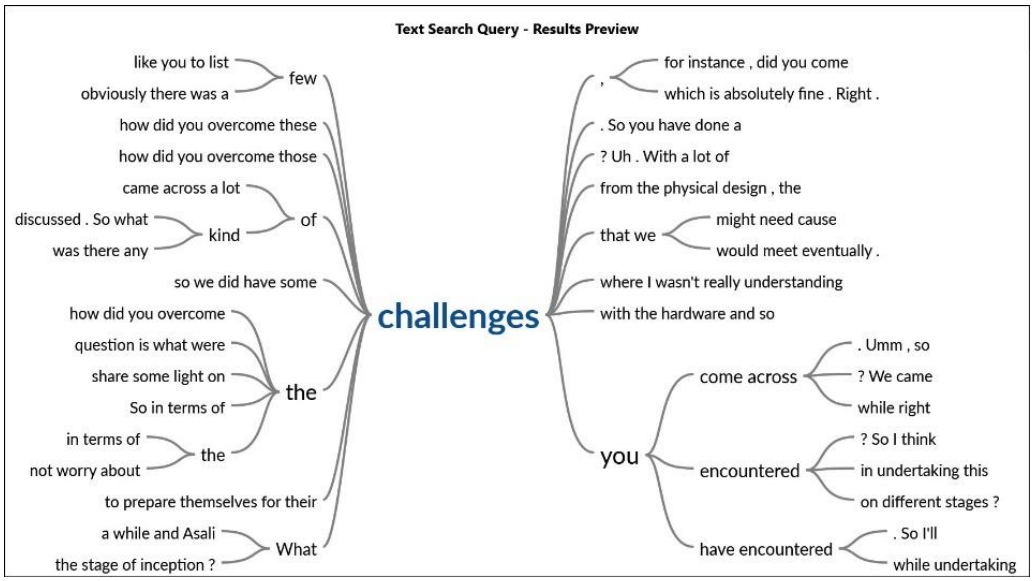


Figure 5.10: Results Review for Challenge

(Source: Created by Researcher, 2023)

5.2.8 Analysis of Theme C4

An innovation challenge is a program in which participants are invited to suggest innovative solutions to specific problems, and their proposals are then chosen for a showcase event during which teams present their projects and receive expert feedback from professionals. Businesses, universities, and other organisations often organize innovation challenges as a way of encouraging creativity and collaboration in the workplace. Social innovations are multidisciplinary projects designed to generate social value and contribute to societal transformation. They may take the form of cooperative networks, Living Lab concepts, or other social enterprises (Evans et al., 2015). They operate despite existing formal and informal institutional voids, while implying new roles for universities in contemporary regional innovation systems (Bernard, 2017). Universities are turning to social tools for student recruitment, building relationships with current students and alumni engagement. BCU is creating its own social networks to enhance peer-learning opportunities and project collaboration opportunities within communities.

Sustainable development has been a top priority for governments and businesses. It is an ambitious goal that requires collaboration and innovation to overcome challenges, such as economic disparities, climate change, environmental degradation, and poverty. To reach these goals, the United Nations has defined 17 Sustainable Development Goals (SDGs) (Gallardo-Vázquez, Hourneaux Junior, Gabriel, & Valdez-Juárez, 2021). While progress on achieving these targets remains challenging, many organisations have developed a culture of boldness and innovation. These companies have been able to develop new products, processes, and services that can help to improve sustainability performance and create wealth without negatively impacting the environment (Nidumolu, Prahalad, & Rangaswami, 2009).

However, not all organisations have been able to implement this cultural shift. Some organisations struggle with a lack of internal resources and a shortage of external expertise. This can lead to difficulties in creating an innovation culture and implementing innovations that achieve their desired outcomes. One way to overcome this challenge is by leveraging existing platforms, such as a competition for student projects (Budwig, 2015).

5.2.8.1 Identifying Challenges

Festivals offer the potential for social innovation; however, there may be challenges involved. Festivals may lack the resources to identify and support social projects effectively or face difficulty measuring their impact. One challenge facing them is their limited understanding of social innovation, making it hard for them to identify and support relevant initiatives (Budwig, 2015). Festivals offer university students an invaluable opportunity to address social issues in creative ways, while inspiring others to continue the work outside the festival context (Evans et al., 2015). Furthermore, festivals promote inclusiveness. Innovation Festivals work as Social Innovation Incubators, helping address challenges by offering community involvement for regional development (Rush et al., 2021).

BCU's innovation festivals provide an ideal venue for exploring cutting-edge tools and gadgets. Investors, engineers, and even those simply curious about new tech can find innovation festivals useful for getting hands-on with cutting-edge tools and gadgets like virtual reality and AI (Schaltegger & Wagner, 2011). Innovation festivals focus on eye-catching technologies while remaining engaging and approachable compared to conferences, making these events ideal for non-techies too. Innovation festivals provide

a fantastic way to network with individuals from various industries and fields of interest, offering panel discussions, workshops, and lectures from experts aimed at increasing their understanding of current innovations being developed while learning about challenges they are encountering, potentially providing inspiration for their own innovations (Clark, 1998).

These innovative festivals are an effective way to form relationships with companies and other organisations who can assist students with developing ideas and innovations of their own or offering solutions to any problems their business might be encountering (Costa et al., 2021). Held across universities worldwide, these events provide students with a great way to network. Innovation festivals provide the ideal setting to stay abreast of current technology trends, learning about tools and techniques as well as networking with fellow innovators, helping your company to remain more innovative and competitive than its counterparts (Kim et al., 2020). It provides a fantastic platform for keeping up with programming trends. Some innovations can be profound and revolutionary; others can be incremental and lead to new products and services. Innovation can take many forms: simple designs or complex solutions may lead to product or service development; sometimes new businesses or industries even emerge out of these innovations; the most successful innovation festivals typically focus on this latter form.

5.2.8.2 Overcoming Challenges and Scaling Up

One key challenge to scaling up for any social enterprise is financial sustainability; therefore, it is critical to identify potential funding sources and partnerships to meet this goal. Furthermore, monitoring performance allows for informed decisions about new initiatives or expanding existing ones. Measuring social impact can be challenging. A social enterprise providing vocational training to marginalized individuals must measure how many participants completed the program and were ultimately employed, as well as ensure its employees receive fair treatment and are paid living wages (Schaltegger & Wagner, 2011).

Birmingham City University's innovation festival has taken steps to address this challenge by adapting its festivals into living labs for testing ideas, prototypes, and solutions that might improve city living (Majeed et al., 2016). Projects might involve trailing mobility applications among festival visitors or creating participatory artworks that collect climate data which the Met Office would otherwise struggle to collect on its own. Festivals can transform cities into pop-up labs for new ideas. Creative communities use

festivals as platforms for open innovation and to encourage R&D within art, culture, and city development (Rothwell, 2020). Festivals act as intermediaries between global creative communities, stakeholders, and local citizens.

Festival sites provide an ideal testing ground for innovations, making them the perfect arena to develop new solutions and establish networks of partners that can ensure their success and sustainability once they have left their temporary home at a festival site (Clark, 1998). The Scale Up Framework provides guidance for BCU students when designing interventions with scaling in mind, assessing prototypes/pilot programs that have potential for scaling up, and taking specific projects forward towards scale up. Furthermore, this framework suggests ways of building capacity within countries ready to implement scaling up strategies (Costa et al., 2021).

5.2.9 Theme C5

Regional development and legal compliance are intricately linked, forming the backbone of sustainable growth and responsible governance within a specific geographic area. At the heart of regional development lies the aspiration to enhance the economic, social, and environmental fabric of a community. This multifaceted endeavour involves a spectrum of stakeholders, ranging from government bodies and investors to local businesses, community members, legal experts, and environmental advocates. The complex landscape of legal compliance serves as the regulatory framework that guides and governs various aspects of development projects, ensuring they align with existing laws, regulations, and policies. As regions strive to evolve and progress, the delicate balance between advancing development goals and adhering to legal requirements becomes increasingly paramount.

After coding the data in NVIVO as well as thoroughly performing the analysis on the data, the following theme is emerged along with the responses of the participants:

(Theme 5) Regional Development & Legal Compliance
• Community stakeholders on university-led innovations. • Community users' involvement in the decision-making process.

• Challenges and concerns raised on legal frameworks about university-led innovations. • Exploring legal barriers • Involving the users into the ethical considerations when universities doing innovations. • Engaging participants in environmental sustainability of university innovations.

Table 5.5: (Theme 5) Regional Development & Legal Compliance

(Source: Created by Researcher, 2023)

Globalisation forces development officials to focus on regional competitiveness, placing an increased importance on innovation as the source of transformational impact for firms and regions alike - universities are key players here. At BCU's CEBE, the Innovation Fest showcased student projects designed to address real business issues. Businesses could discuss their requirements with students before setting briefs and judging projects. There has been much talk of how universities contribute to regional development; however, less attention has been paid as to why. Studies indicate that universities may play an integral part in creating grassroots change agents that might not be visible to strategic managers (Alpaydin et al, 2015; Rutten and Van den Broek, 2019).

BCU students demonstrate this concept through Innovation Fest, where their work is showcased with live projects designed to address industry or societal challenges. Numerous businesses also act as partners by providing briefs for student teams as they compete against one another for awards and engagement from judges. However, these organic activities may be challenged by pressures to internationalize. According to Cinar, (2019) such tensions may lead to mismatches between universities' strategies and academic collaborations regarding social innovation: regional social innovation may become institutionally invisible, which has serious ramifications on sustainability of regional innovation. Key challenge remains in maintaining relevant university-business interactions within an ever-evolving global economic landscape characterized by disruptive technologies and economic globalization.

Students across higher education are being increasingly encouraged to develop entrepreneurial mindsets. This trend stems from an emerging recognition that

universities are the keystones of economic development for struggling regions; an idea underscored by Joe Biden's $1 billion program recently unveiled to restore manufacturing to America's heartland regions. Universities are becoming an integral component of the knowledge economy, with researchers being instrumental in producing innovative economic ideas and commercial innovations. But it is important to remember that simplistic views of universities as mere "engines" that spew out new concepts is counterproductive for understanding their role in regional development more holistically. Academic excellence pressures may encourage universities to focus their research on global issues, which could hamper their ability to connect with local innovation networks and staff mobility may prevent them from forging long-term connections with industry (Alpaydin et al, 2015; Rutten and Van den Broek, 2019). This is a matter that needs further exploration.

In the current research, researcher has performed Word Search (Law and Patent) on the collected data from focused groups Community and the following results are generated:

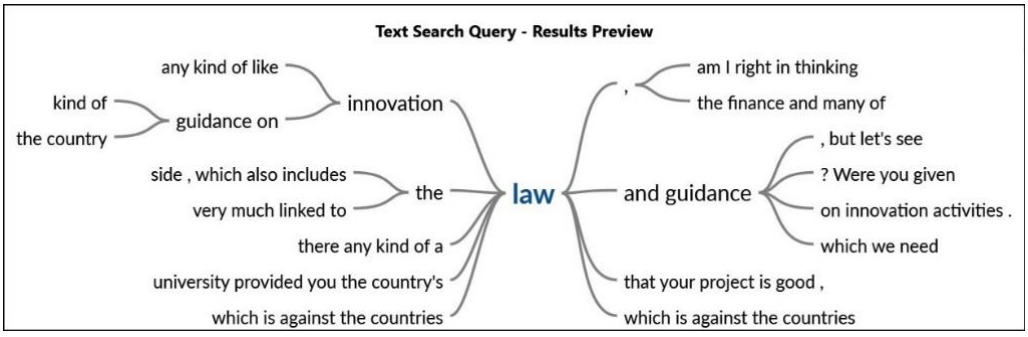


Figure 5.11: Results Review for Law

(Source: Created by Researcher, 2023)

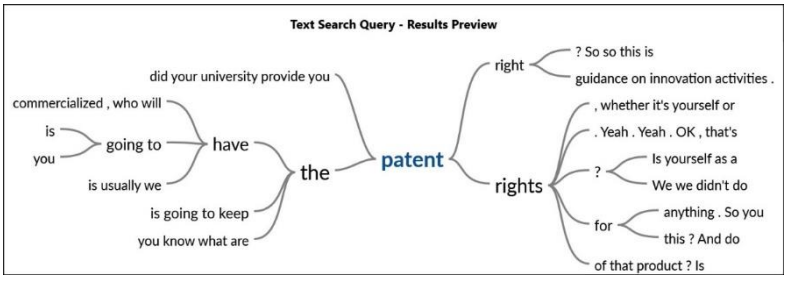


Figure 5.12: Results Review for Patent

(Source: Created by Researcher, 2023)

5.2.10 Analysis of Theme C5

5.2.10.1 Country's Guidance on Law of Innovation & Legal Issues

Government representatives view regional development as a strategic imperative, one that requires a meticulous approach to legal compliance for the effective translation of developmental goals into actionable policies. According to Marques et al. (2019), legal frameworks provide the structure necessary for responsible project implementation, safeguarding public interests and maintaining the integrity of the region. Investors and financial institutions recognize the value of investing in regions committed to legal compliance, as it not only reduces risks but also ensures that investments contribute to sustainable development. The local business community sees regional development as an avenue for growth and innovation, with legal compliance acting as a framework that ensures fair competition, protects business interests, and contributes to the overall stability of the local business ecosystem (Cai, 2022).

Community members, as the ultimate beneficiaries of regional development, perceive it as an opportunity to improve their quality of life. According to Manioudis (2021), legal compliance is instrumental in safeguarding their rights, health, and well-being, and the engagement of the community in legal processes encourages transparency, trust, and shared responsibility. Legal experts and compliance officers play a pivotal role in ensuring that regional development projects adhere to legal standards. According to Martinidis, Komninos & Carayannis (2021), their perspective revolves around interpreting and enforcing laws, collaborating with stakeholders, and creating strategies that balance development goals with legal requirements. Environmental advocates view legal compliance as an essential component of responsible regional development, ensuring that projects align with environmental regulations and contribute to biodiversity conservation, sustainable resource management, and the overall health of ecosystems (Nidumolu et al., 2009).

However, navigating legal compliance in regional development is not without its challenges. The legal landscape governing regional development is often intricate, involving multiple layers of regulations at the local, regional, and national levels. Navigating through diverse and sometimes conflicting laws can be a daunting task for project developers and legal experts alike. Small businesses and local entrepreneurs may face resource constraints when trying to comply with extensive legal requirements, hindering their participation in development projects (Bryman & Bell, 2007). Ensuring

meaningful community engagement in the legal compliance process can be challenging, requiring concerted efforts to bridge information gaps and empower residents (Lozano, 2018). The regulatory environment is dynamic and subject to change, posing challenges for project developers, legal experts, and compliance officers in maintaining up-to-date knowledge (Gallardo-Vázquez et al., 2021). Striking a balance between ambitious development goals and stringent legal requirements can be a delicate task, where unchecked development may lead to legal violations or legal compliance becoming a hindrance to progress (Farinha et al., 2020).

Despite these challenges, synergies between regional development and legal compliance can contribute to the overall success of both endeavours. According to Maruccia et al. (2020), legal compliance ensures that regional development aligns with principles of sustainability, contributing to ecological conservation and mitigating potential harm to ecosystems. Regions with a strong commitment to legal compliance instil confidence in investors, attracting responsible investments and contributing to economic stability. Legal frameworks that promote community engagement and protect the rights of all stakeholders contribute to inclusive regional development, ensuring that the benefits are distributed equitably. Moreover, legal compliance acts as a guide for businesses, encouraging ethical practices and developing a business environment built on transparency and accountability (Clark, 1998).

5.2.10.2 Ethical considerations and Universities Innovations

Creating an environment of innovation at your university can take significant effort, time, and resources. According to Thomakis & Daskalopoulou (2021), key strategies include outlining an innovation strategy, eliminating unnecessary bureaucracy, and encouraging cross-functional collaboration. Allowing employees to experiment with new ideas and technologies is crucial in creating an innovative culture, promoting creative thinking outside the box and empowering workers. Tiekstra & Smink (2021) further discuss that supporting workers during experimentation helps them learn from failure as well. The Culture of Entrepreneurship, as discussed by Trencher, Terada & Yarime (2015), refers to an organisation-wide set of values and beliefs shared among its members that supports innovation and decision-making. Two-year colleges need strong entrepreneurial cultures to compete effectively against larger institutions in the business world. University organisational culture, as discussed by Thomakis & Daskalopoulou (2021), plays a critical role in both enhancing and constraining research collaborations,

especially among universities with higher reputations that compete for funding against other prestigious institutions.

Current university ethics committee models do not meet the demands for ethical governance of data-driven research involving human participants, as highlighted by Winfield and Jirotka (2018). To address this gap, they advocate including lay participants in the process. An outside expert perspective can provide a more rounded, technical review that considers all potential impacts rather than only risks, helping review panels to fully appreciate ethical considerations of innovation. Establishing a culture of collaboration, as emphasized by Trencher, Terada & Yarime (2015), can be challenging in an office that prioritizes the individual and rewards individual successes. The companies that prioritise collaborative environments can unlock their full potential, improving employee satisfaction and performance while more quickly meeting goals because collaborative environments promote teamwork and encourage employees to be open to new ideas.

5.3 Data Exploration of Business Management Discipline Focused Groups

The Word Cloud option is used within NVIVO to better and quickly identify key themes and recurring areas within the collected data. The size of the words in the tree corresponds to their frequency and allow the researcher to visually assess which terms are most prevalent.

Figure 5.13: Word Tree for Recurring Words

(Source: Created by Researcher, 2023)

5.3.1 Theme B1

(Theme B1) Entrepreneurial Education & Support System for Startups
• Design and integrate entrepreneurial education into academic curriculum. • Establishing a mentorship programme. • Organise regular networking events and pitch competitions. • Building connections with government funding schemes, SME's etc.

Table 5.6: (Theme B1) Entrepreneurial Education & Support System for Startups

(Source: Created by Researcher, 2023)

The responses of various participants with the focused group expresses that the ever-evolving landscape of the global economy, universities should increasingly recognise the need to go beyond traditional academic offerings and embrace a more dynamic role in developing innovation and entrepreneurship. One pivotal avenue for achieving this transformation is the establishment of robust Entrepreneurial Education & Support Systems geared towards startups and new business ideas within university settings. Such systems not only empower aspiring entrepreneurs but also position universities as entrepreneurial leaders in the education sector. Along with this word tree, the below theme is emerged after collecting various thoughts of different participants:

Entrepreneurial education for university students is an inspiring experience that empowers individuals with the skills, mindset and knowledge needed to navigate the exciting landscape of entrepreneurship. Recognising that traditional academic curricula may not fully equip students for all the challenges associated with starting and running a business, entrepreneurial education seeks to inculcate a spirit of innovation and risk-taking among its participants. University programs that integrate entrepreneurial education enable students to think creatively, identify opportunities, and take an aggressive approach to problem-solving. Courses often cover key entrepreneurial topics like business planning, market research, financial management and leadership skills.

Beyond this theoretical knowledge, hands-on experiences like business simulations, internships or mentorship programs provide practical knowledge while encouraging an entrepreneurial mindset in students.

Entrepreneurial education (EE) has become increasingly crucial for business students seeking to develop the necessary skills and strategies necessary to thrive in an ever-evolving labour market. Entrepreneurs play an essential role in society as they are responsible for creating jobs and economic development as well as increasing productivity and sustainability (Amatucci et al. 2013). Although entrepreneurship has traditionally been associated with new venture creation, a growing appreciation of what constitutes an entrepreneurial mindset has surfaced (Leitch, Hazlett and Pittaway 2012; Mustar 2009). Thus, it may be appropriate for us to move away from seeing entrepreneurs solely as those capable of starting businesses successfully and towards accepting an expansive definition of entrepreneurship as such.

In this section, data collected using focused groups from the business management students of two different universities is analysed using NVIVO. After loading the data, word search (Business, Entrepreneurship, New Idea) is performed, and the following word trees are generated.

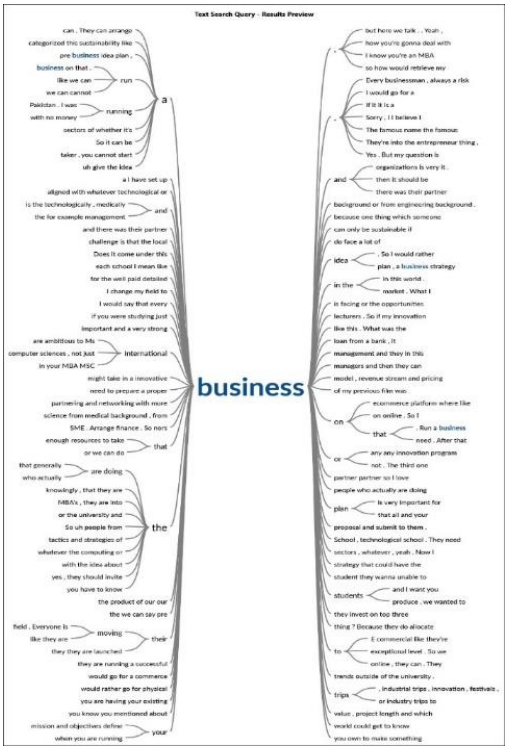


Figure 5.14: Result Review for Business

(Source: Created by Researcher, 2023)

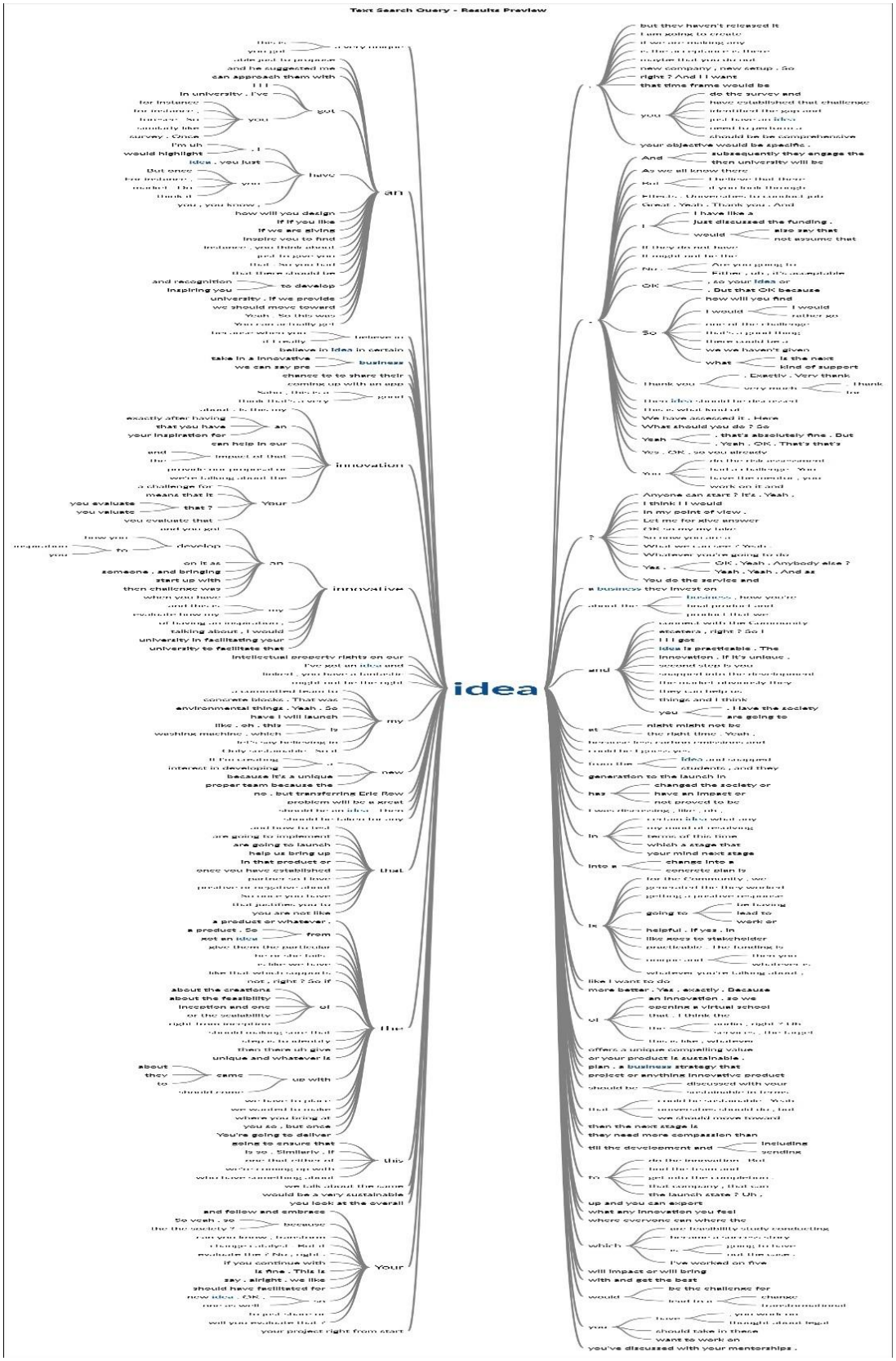


Figure 5.15: Result Review for Idea

(Source: Created by Researcher, 2023)

The word Tree expresses that many of the participants have various thoughts on creating new ideas and how those ideas could be transformed into an entrepreneurship or business idea which could ultimately have impact on the community in various ways.

5.3.2 Analysis of Theme B1

Entrepreneurial education within universities serves as a catalyst for cultivating a mindset that values innovation, risk-taking, and problem-solving. By integrating entrepreneurship into the academic curriculum, students gain practical insights into the intricacies of starting and managing a business. This hands-on approach provides a unique learning experience that goes beyond theoretical knowledge, preparing students to navigate the challenges of the real business world. Additionally, exposure to entrepreneurial education sparks creativity and nurtures an entrepreneurial spirit among students, encouraging them to explore unconventional paths and transform ideas into viable ventures.

EE has been shown to have an impact on students' entrepreneurial intentions, which may be partially attributed to students learning how to connect course content and practical knowledge through entrepreneurship education (Gielnik et al., 2015). Furthermore, students gain the chance to practice entrepreneurship via university-wide entrepreneurship initiatives; this hands-on approach to education helps overcome any hurdles associated with starting new businesses such as lack of space, funds, or resources.

Furthermore, the implementation of a robust support system for startups and new business ideas would enhance the university's role as an entrepreneurial hub. Universities can also establish incubators and accelerators that provide physical space, mentorship, and funding opportunities for fledgling ventures (Audretsch, 2014). These support systems would bridge the gap between academic knowledge and practical application, offering students a conducive environment to test their ideas, refine their business models, and scale their enterprises. The collaboration between academia and industry experts within these incubators would excel a rich ecosystem that propels startups towards success (Etzkowitz & Leydesdorff, 2000). Students interested in entrepreneurship need exposure to multiple areas. Let's create an educational system where these students can tailor their studies toward topics that spark their interests and passions (Fayolle et al., 2006).

Universities provide knowledge for building businesses through entrepreneurship courses and incubators. However, most of this learning primarily focuses on Organisational and product development (Etzkowitz 2003), rather than market development.

5.3.2.1 Entrepreneurship Courses Product Development

Discovering problems and creating solutions is the foundation of becoming an entrepreneur, and students can gain the necessary skills by conducting customer discovery interviews and collecting market feedback. By learning this way, they will have more insight into turning their ideas into innovative products. Starting and growing a startup requires creativity, risk-taking and the ability to solve problems unconventionally, unfortunately university education systems do not promote these characteristics in students, which may explain why many top entrepreneurs (Audretsch, 2014). No matter their eventual career path, aspiring entrepreneurs need to understand how technology can disrupt existing industry hierarchies - which makes entrepreneurship education so essential.

Students learn to identify unmet needs, create the optimal team, and establish a high-impact, scalable business model. Furthermore, they gain an appreciation of the language and techniques utilized within entrepreneurship. Entrepreneurship students gain knowledge in financing and risk management to optimize their chances of success with any new ventures they undertake. Furthermore, they develop the necessary skills for successfully running a business and anticipating issues before they arise. University entrepreneurship programs often employ an integrative approach that encompasses subjects as diverse as design, computer science, business, and literature - this allows interdisciplinary teams to form ideas for potential new startups while building them from scratch.

5.3.2.2 Mentoring

Entrepreneurship education gives students hands-on experiences that allow them to discover who they are and develop themselves. Students can explore their tolerance for risk and uncertainty, experiment with business ideas and learn how to cope with failure within a supportive environment with a mentor. If something they thought attractive in theory doesn't turn out to be right, perhaps early enough so they can switch degrees altogether.

Entrepreneurship education also equips students to identify entrepreneurial ideas and opportunities, while equipping them with the necessary knowledge and skills needed to launch new ventures (Kossmann et al., 2010). This knowledge may be lacking from non-business faculties so entrepreneurship education may provide essential assistance in filling it (Kossmann et al., 2010). This is essential as students from these areas may require further specialized guidance, another reason specialized entrepreneurship education may be beneficial.

5.3.2.3 Licensing

Entrepreneurship education equips aspiring entrepreneurs with the tools needed to transform their ideas into successful businesses. While management education teaches individuals how to best run existing hierarchies, entrepreneurship education equips students with skills necessary for creating new ventures and opportunities (Fayolle et al., 2006). Entrepreneurship courses also help students develop an understanding of the business landscape, which is vital for successful startups. Being familiar with this environment enables entrepreneurs to anticipate challenges and identify opportunities more readily. Universities should provide their students with the freedom and flexibility to create their own majors and take classes from a range of fields, including design, computer science, literature, and business (Audretsch, 2014). Entrepreneurs desire learning about various topics including design, computer science, literature, and business - this allows them to embrace creativity and failure to build innovative new startups that could revolutionize business today.

5.3.2.4 Piloting

Success of startups is an engine of economic growth. Startups create jobs and fuel innovation while benefiting their local economies and contributing to job creation and creation of wealth in local communities. For this reason, universities must offer more entrepreneurial opportunities for their students. Entrepreneurship education helps aspiring business owners understand the business environment and develop ideas for businesses they want to start or develop. Furthermore, it equips them with skills necessary for running their enterprises successfully, such as writing business plans, accessing resources, and creating networks of support. Universities supporting higher education entrepreneurship by creating an online community called Connect that will bring teachers together and share best practices. Membership of Connect is free;

educators who join this community will have access to top-of-the-line entrepreneurship teaching materials, training sessions, and support available right at their fingertips.

5.3.3 Theme B2

According to the analysis of the data, another theme has emerged exploring the strategic partnerships and initiatives established between universities and industries could enhance the skill sets of students, and that aligns educational programs with industry needs, and enriches a mutually beneficial relationship between academia and the business world. The responses from the focused groups, a new theme has emerged as below:

(Theme B2) Industry Collaboration & Skills Development
• Collaborative research projects and partnerships between academic faculty and industry experts should be facilitated. • Universities should arrange regular workshops, seminars, and training sessions led by industry experts. • Industry experts should be involved when designing the courses. • Industry expectations align with the product developments.

Table 5.7: (Theme B2) Industry Collaboration & Skills Development

(Source: Created by Researcher, 2023)

This theme explores the role of universities in shaping the future workforce should undergoing a profound transformation, and a key aspect of this evolution would be the strategic collaboration between universities and industries. Industry Collaboration & Skills Development initiatives within universities not only equips students with practical, industry-relevant skills but also position universities and the higher education institutes as entrepreneurial leaders, actively contributing to the development of a skilled and adaptive workforce before even they get into the market for jobs.

The below word Tress is produced from the collected data:

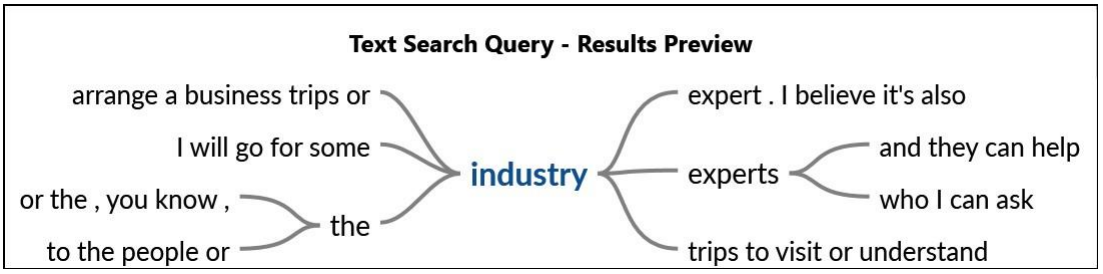


Figure 5.16: Result Review for Industry

(Source: Created by Researcher, 2023)

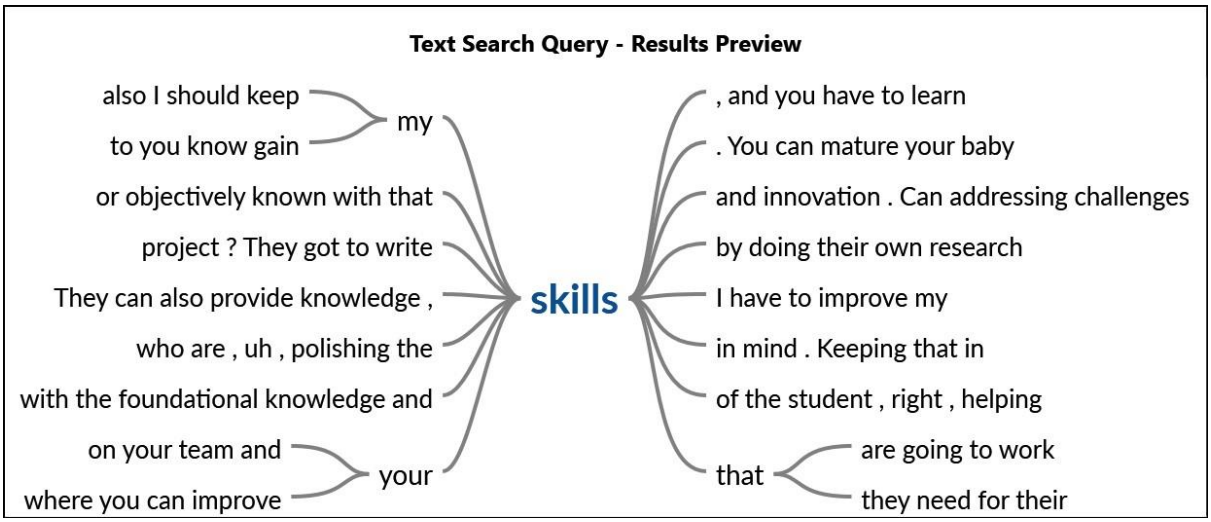


Figure 5.17: Result Review for Skills

(Source: Created by Researcher, 2023)

A distinctive and primary benefit of industry collaboration lies in the alignment of academic programs with the evolving needs of the job market. By forging partnerships with industry leaders, universities gain valuable insights into current trends, emerging technologies, and the skills required in various sectors. This collaboration ensures that academic curricula are updated regularly to reflect the dynamic nature of industries, thereby producing graduates who are not only academically proficient but also well-prepared for the challenges of the professional world. This adaptability to industry needs enhances the relevance of university education and encourages an environment where innovation and practical problem-solving are integral components of the learning experience.

5.3.4 Analysis of Theme B2

5.3.4.1 Skills Development

Skills development, as a central component of this collaboration, plays a crucial role in equipping students with the tools needed to excel in the workplace. Universities, in partnership with industries, can design specialized training programs, workshops, and internships that provide students with hands-on experience and exposure to real-world challenges. This experiential learning approach goes beyond traditional classroom education, empowering students with the practical skills and competencies demanded by employers. As universities actively engage with industries to identify and address skill gaps, they become key players in ensuring that their graduates are not only academically proficient but also possess the practical skills necessary for success in the professional arena.

Staying current with industry is vitally important for both students and lecturers; lecturers need to remain up-to-date with developments to keep their lectures pertinent. Collaboration between academics and industry is vital for economic development; however, various barriers inhibit this form of cooperation including legal issues related to intellectual property rights.

5.3.4.2 Research Opportunities

Most research-intensive universities employ a Technology Transfer Office or Technology Licensing Office that's responsible for commercialising their intellectual property to create impact and financial return for university projects, university spin-out companies or licensing technologies for specific applications. This may take the form of sponsored research projects, creating university spin-off companies or licensing technologies. Collaboration between STEM academics and industry practitioners can take many forms, from joint publications and conferences (Chryssou 2020; Figueiredo and Fernandes 2021), consulting relationships, internships, sabbaticals in industry and action research (Galan-Muros and Plewa 2016; Schartinger et al. 2002) all the way to joint publications (Chryssou, 2020 & Figueiredo and Fernandes, 2021). Collaboration between university students and industry partners can be vital in cultivating innovative research. From student interns to collaborative projects with companies, this method can facilitate knowledge transfer from universities directly into businesses quickly, allowing them to exploit research results early - an aspect which becomes especially critical when government funding for research can only stretch so far.

5.3.4.3 Networking

University students must learn to present their research to industry partners in a manner that makes the business case for. Doing this requires honing networking skills with industry leaders and developing trust relationships. University industry collaboration (UIC) is an umbrella term covering an array of activities and interactions, such as work integrated learning (WIL) such as internships, placements, and industry-related courses as well as collaborative research projects. An important motivation for creating UICs is their ability to enable companies access academic expertise at a reduced cost, while universities benefit from new funding and research capability thanks to this partnership. This model, known as Triple Helix, also allows many companies to work with universities on developing workforce skills within their core business - making UICs an essential source of innovative solutions that serve both parties involved.

5.3.4.4 Career Opportunities

Many universities already incorporate industry collaborations into their degree courses and offer internships and other work-integrated learning opportunities, but more needs to be done to bridge the skills gap between students and companies. Businesses increasingly recognize the advantages of tapping university research and students as employees, particularly when they're ready to enter the workforce. Businesses see returns on their investment through increased productivity, reduced unemployment costs and higher tax revenues due to higher wages.

Students have made it abundantly clear that career perspectives and options play a vital role in choosing their studies. Companies have an opportunity to sway this decision through providing student-facing activities such as workshops, mentoring and internships; students who experience these have expressed how these activities help build their confidence while developing valuable new skills and creating professional networks essential components in making the journey from university to career more seamless.

5.3.5 Theme B3

Regulatory and policy considerations play a pivotal role in shaping the landscape for innovation activities within universities. These considerations are essential to strike a balance between excelling innovation and ensuring ethical, legal, and societal implications are adequately addressed.

Further analysing the data, the below theme has emerged:

(Theme B3) Regulatory and Policy Considerations for Innovation Activities
• Intellectual property rights should be clarified to innovators. • Copyrights must be discussed when innovations are taking places. • Trademarks must be in alliance to regulations and policy. • Patents policy should be discussed prior to innovation start-up or product launch. • Trade Secrets policy considerations must be adhered to innovation law policies.

Table 5.8: (Theme B2) Industry Collaboration & Skills Development

(Source: Created by Researcher, 2023)

Government law on innovation activities as well as university policies on regulatory information are crucial for establishing a conducive environment for innovation. Governments craft policies that incentivise research and development, promote collaboration between the public and private sectors, and encourage the adoption of new technologies. These policies should be the part of the university programmes to stimulate innovation and economic growth. Some participants are from the same university studying the same course, but they are not aware of the laws etc, and some vaguely know about it. A stringent or outdated regulations can hinder the pace of innovation. Striking the right balance is a delicate process that requires constant adaptation to the evolving technological landscape.

Additionally, this data set explores that the ethical considerations are integral to regulatory and policy frameworks. A product development and its launch require ethical guidelines to prevent misuse and protect the rights and well-being of individuals. The regulatory and policy considerations for innovation activities require multifaceted, involving the careful calibration of rules to encourage creativity and advancement while safeguarding against potential risks. It is a delicate and requires collaboration between

policymakers, industries, and the broader society to navigate the ever-changing landscape of innovation.

The responses suggest that regulatory frameworks should be designed to provide a structured environment within which innovation could thrive. Clear guidelines and standards help mitigate risks associated with emerging technologies and novel business practices. The above Word Tree also indicates that various industries are impacted by regulations that ensure the safety, security, and privacy of individuals and Organisations involved in innovative activities.

The government plays an instrumental role in innovation through its spending, tax and legal/regulatory policies as well as through legal systems that govern innovation. Changes to these policies may alter how innovative firms act, although their impact is often indirect and hard to accurately gauge. While most discussions regarding regulation and innovation have primarily centred around negative effects, regulators have recently been exploring more systematic strategies to promote innovative activity. This requires expanding static efficiency concepts to include dynamic aspects that take temporary inefficiency into account; additionally, it recognizes that different forms of regulation have distinct impacts on innovation.

Economic and social regulations that address externalities have a strong effect on innovation activities, while institutional regulations like intellectual property rights can either have positive or negative consequences depending on their design. Unfortunately, empirical literature on the impact of different regulations is quite contradictory, ranging across sectors, companies, and time horizons. This may be partly explained by its impossibility of disentangling market innovations from their appropriability benefits in an identifiable manner. Typically, firms tend to engage in innovative activity with the expectation that there will be some market benefits because of their efforts. Therefore, barring government subsidies, social innovations cannot become real without also being market innovations.

While analysing the data, researcher performed a word search on “Innovation” and the below Word Tree is produced:

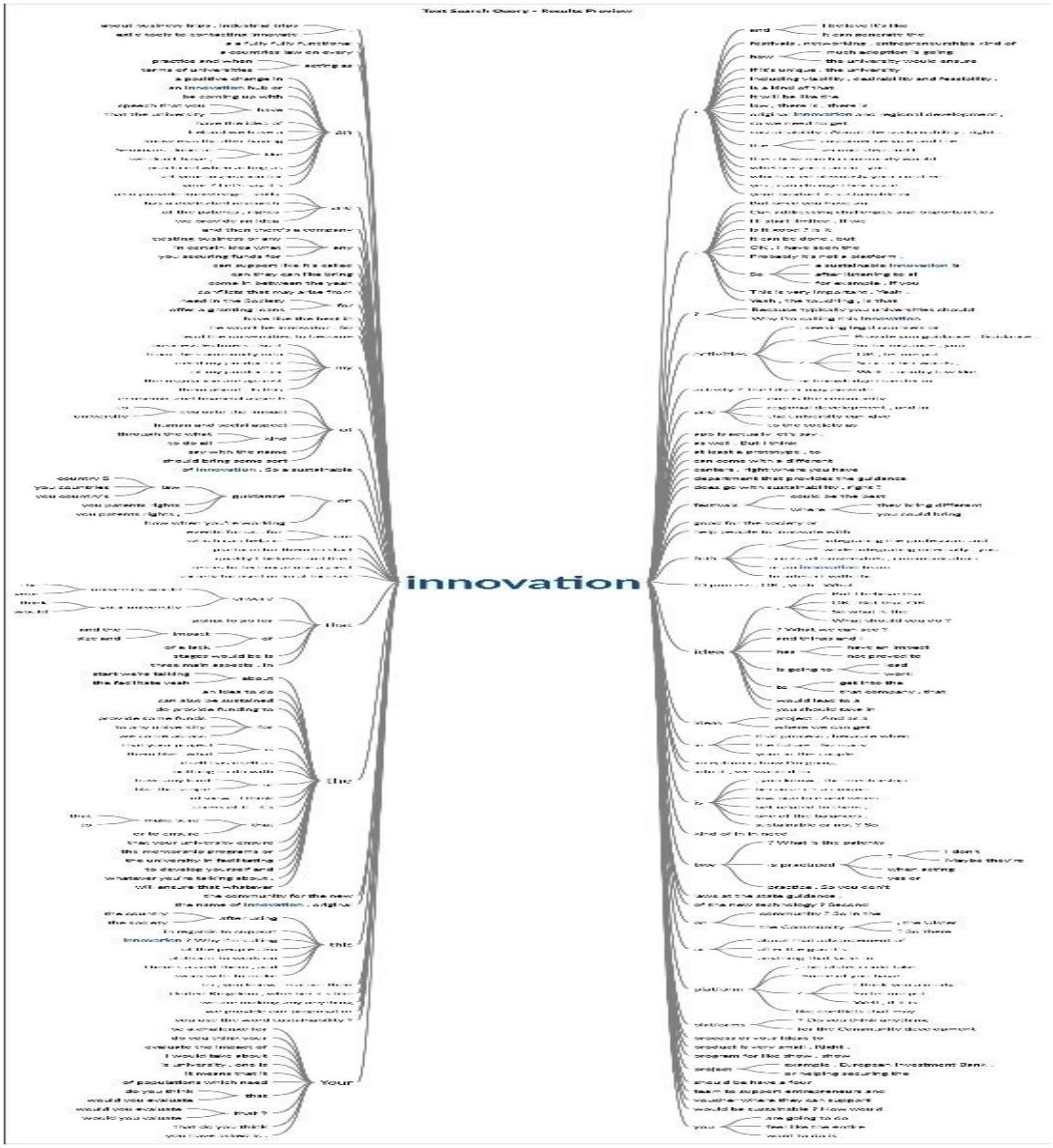


Figure 5.18: Result Review for Skills

(Source: Created by Researcher, 2023)

5.3.6 Analysis of Theme B3

Innovation is necessary to accelerate electrification and drive lower electricity costs, and to create a more resource and energy efficient economy. Institutional IP policies enable universities and research institutions to address intellectual property (IP) issues

associated with collaboration with external parties or commercialization of academic research. Such policies must comply with relevant national policies and strategies.

5.3.6.1 Intellectual Property Rights

Intellectual creativity often results in tangible outputs such as integrated circuit chips, computer software applications, biological organisms, or engineering prototypes that can be protected under patent law. Universities are required to notify government agencies who funded their research of any discoveries that may be patentable, while the Bayh-Dole Act permits universities to acquire title to these discoveries and use any licensing proceeds towards further research, education, or providing inventors with additional benefits (Audretsch, 2014). Intellectual Property developed at university may be subject to licensing processes by their creator or inventor unless it would violate conflict of interest regulations or policies (Cunningham & O'Reilly, 2018). Inventors must commit resources for development and commercialization efforts; developing medical devices, sensors, new fruit/grain varieties, and machines takes significant investment of both time and money before reaching the market.

5.3.6.2 Copyrights

Copyright protection extends to any work of authorship fixed in a tangible medium. These works include written fiction and nonfiction works, poetry, compositions (words and music), drawings, paintings, and audiovisual presentations such as movies or software code. The University encourages the individual scholarly activities of its faculty members, without making any claims to ownership for writings produced as a result of these endeavours (Creswell & Creswell, 2017). However, Institutional Works created with extensive use of university resources or financial support beyond what would typically be available to faculty are owned by the University and could claim ownership under certain conditions (Bryman, 2016). If the University does retain ownership of an innovation, its commercialization proceeds are divided among innovators via a Proceeds Distribution Agreement (PDA). To facilitate this arrangement, a copyright policy standing committee composed of faculty, academic administrators, and one student officer serves as its chairperson (Bernard, 2017).

5.3.6.3 Trademarks

Trademarks serve to differentiate one entity's goods and services from those offered by others, so the University does not permit co-branding or endorsement by external entities (with some limited exceptions for contractual relationships). Units should

carefully consider their use of university marks before distributing merchandise featuring them. Communications that suggest sponsorship or endorsement should include only factual statements that clearly explain how their contractual agreement works. The University of Texas System Office of Trademark Licensing oversees all federal registrations on behalf of UT System. For merchandise bearing University trademarks or branding elements, any indications such as TM (trademark) or (r) (federally registered) should be included on merchandise bearing them. In "trademark sense," marks should not be altered in any way (such as covering up parts of official logos, stretching or skewing them in any way, flipping colours or changing their appearance). A minimum size requirement applies for all trademarks.

5.3.6.4 Patents

Some universities have revamped their patenting, licensing, and technology-transfer functions in response to both public interest in academic inventions such as new drugs, medical devices, sensors software fruit varieties - and pressure from research sponsors. Johns Hopkins recently placed fourth on a national ranking of top universities for patenting activity. Many inventions developed at universities are patented, but around one-third never see commercialization. Perhaps a patent application or grant was submitted, but no deal ever materialised due to licensing agreements being too invasive, too costly, or too limiting on uses and benefits for their product/services.

5.3.6.5 Trade Secrets

Academic research can lead to innovations with wide commercial applications and income potential. The University has an obligation to disseminate such technologies for society's benefit and generate income that supports its research activities. The inventor must promptly notify the Committee of any invention believed to be patentable resulting from Substantial Use of University Facilities, providing a Disclosure (as defined below), along with any necessary legal documentation securing legal rights to their invention or discovery. Prior to publishing any invention or discovery made through Substantial Use of University Facilities, consultation with the Committee should occur as publication can compromise University efforts in obtaining Patent protection for it. When an inventor makes a disclosure that asserts intellectual property ownership rights, OTM will make an evaluation within a reasonable time after receipt of their submission subject to any third-party restrictions or agreements that might exist.

5.3.7 Theme B4

The researcher has explored that academia contributes research expertise, intellectual capital, and a pool of skilled individuals whether they are students or professors. Universities play a crucial role in conducting studies, analysing data, and developing innovative solutions to community issues. Industry, with its practical experience and resources, brings scalability and implementation capabilities to the table. By collaborating with academia, businesses gain access to cutting-edge research and a talent pipeline that is equipped with the latest knowledge and skills.

(Theme B4) Industry – Academia and Government Collaboration for Sustainable Community Development
• There should be collaboration between industry, academia, and government based on the Triple Helix model. • Universities should establish collaborative research projects involving industry experts, academic researchers, and government. • Universities should act as a platform for ongoing dialogue and engagement with local communities.

Table 5.9: (Theme B4) Industry – Academia and Government Collaboration for Sustainable Community Development

(Source: Created by Researcher, 2023)

The data depicts that, the government provides the regulatory framework, funding support, and a broader perspective on community needs. Collaborative efforts can focus on diverse areas. The partnerships between academic researchers, industry experts, and government agencies can lead to the development of sustainable technologies, community empowerment programs, and social initiatives that address pressing challenges. This collaborative synergy not only encourages innovation but also ensures that the benefits of development are inclusive and accessible to all. By working together, industry, academia, and government create a powerful ecosystem that encourages

sustainable community development, driving economic growth, improving quality of life, and paving the way for a more resilient and equitable future.

An ideal vision of a sustainable community involves providing decent, affordable homes; an atmosphere in which residents feel secure; economic opportunities; access to public services; high standards of living and education; as well as an appreciation of community life. Such communities recognize and appreciate the interdependencies between natural systems and humans while taking an extended view to assess how their actions may affect future generations. Community for Conservation aims to protect ecosystems while offering environmental education programs for residents. Volunteerism plays a major role in making an impactful contribution, while businesses, local government and community organisations collaborate for mutual good. Furthermore, this welcoming atmosphere accepts various perspectives while encouraging healthy debate through positive approaches that promote diversity of thought. Sustainable communities entail the skills of professionals from different professions - town planners, architects and surveyors; landscape architects, planners and sustainability specialists; housing officers and community development officers; community development officers and regeneration professionals, but according to a recent report by the Academy for Sustainable Communities (ASC), many organisations struggle to recruit enough staff with appropriate combinations of skills needed to implement their plans for sustainable communities.

A new word search (University as academia, community, industries) is performed on the data and the following word tree are produced:

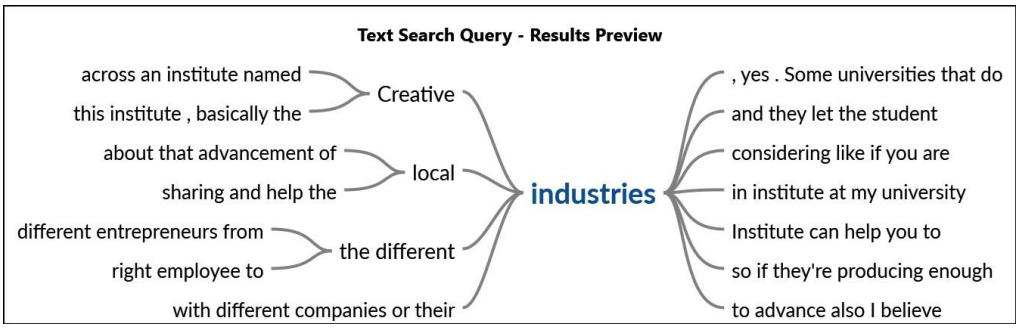


Figure 5.19: Result Review for Industries

(Source: Created by Researcher, 2023)

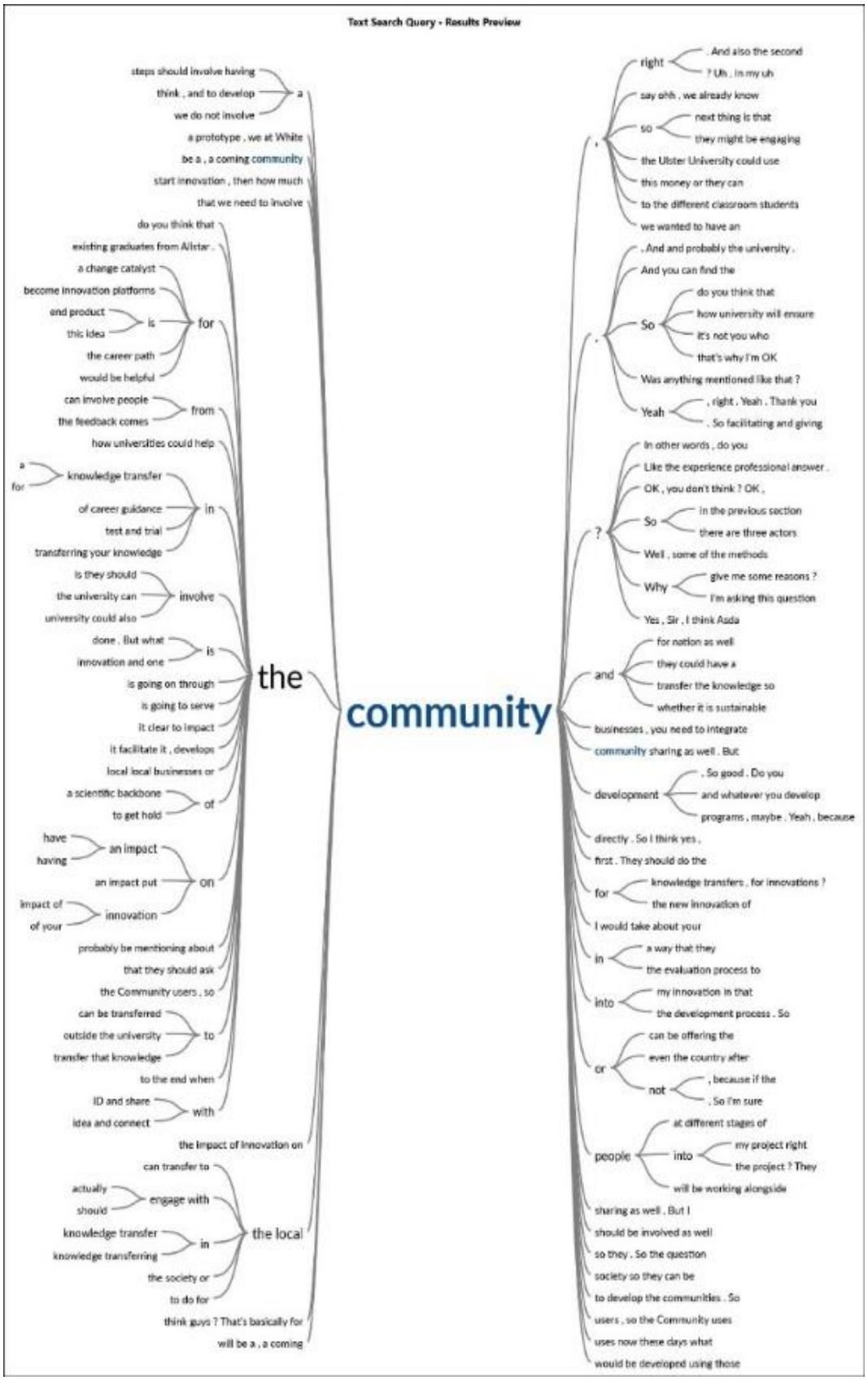


Figure 5.20: Result Review for Community

(Source: Created by Researcher, 2023)

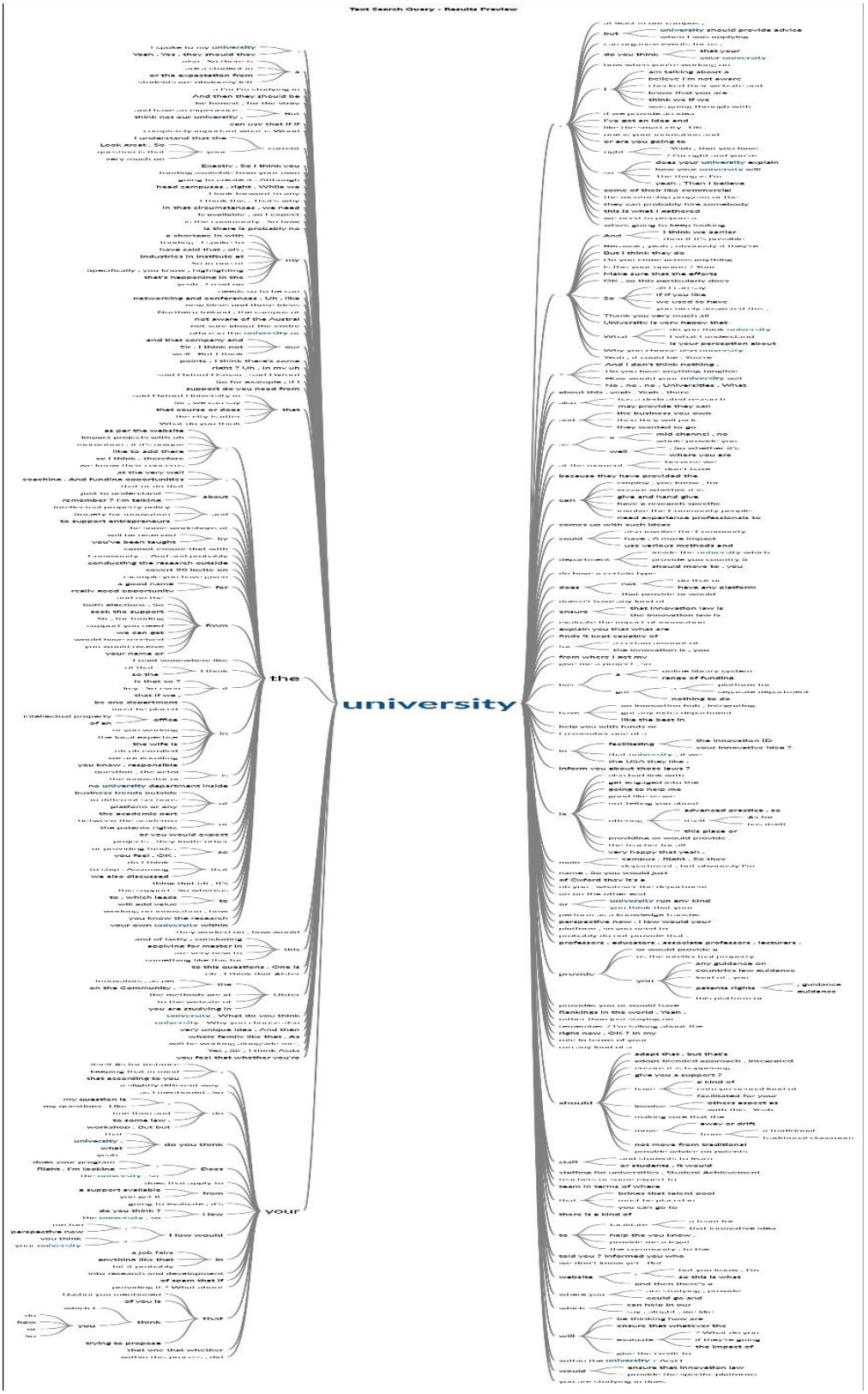


Figure 5.21: Result Review for University

(Source: Created by Researcher, 2023)

According to the data obtained from the focused groups, another theme has emerged which represents a powerful tripartite alliance that can drive sustainable community development. This collaborative approach recognizes the complementary strengths of each sector and leverages them to address complex societal challenges. The data suggests that industry-academia and government collaboration for sustainable community development is essential for several reasons, and its impact on regional development is profound. For example, this collaborative approach leverages the unique strengths of each sector, developing innovation, and creating a comprehensive framework for addressing complex regional challenges. Academia contributes cutting-edge research, developing a culture of innovation and providing the intellectual foundation for sustainable development initiatives. Industry brings practical experience, resources, and scalability, ensuring that solutions generated through research can be implemented on a larger scale. Government, with its regulatory authority and understanding of public needs, provides the necessary support and governance to drive sustainable community development.

The collaboration significantly impacts regional development by promoting economic growth and job creation. Joint initiatives between industry and academia can lead to the development of new technologies, industries, and skill sets that drive economic diversification and expansion. As industries adopt sustainable practices, they contribute to the long-term economic stability of the region, creating a positive cycle of growth and development.

5.3.8 Analysis of Theme B4

Sustainable communities are defined as those which remain healthy over the long-term, being managed through an inclusive process involving representatives of different sectors of society and seeking to encourage local economies while conserving ecosystems. Universities play an essential part in building sustainable communities. By working alongside industry and government to maximize their research, teaching, and knowledge transfer efforts for social good, universities are playing a leading role.

5.3.8.1 Industry

Universities and companies are increasingly joining forces to address real-world problems through collaborative approaches that bring universities and companies closer. This has many advantages, such as increasing productivity and improving efficiency at work; students also benefit from hands-on experience gained while learning

from experts. According to Orazbayeva et al. (2019), the collaboration between academia and industry can produce groundbreaking solutions to some of the world's most pressing problems, like climate change and cancer treatments. Projects funded by both government and corporate funds often help accelerate STEM innovation; governments also offer incentives to university-industry partnerships through programs like the National Science Foundation's Industry-University Cooperative Research Centres (Borah & Ellwood, 2022). The success of university-industry collaborations depends on various factors. Understanding the different forms of interactions that take place between academia and industry is the cornerstone of such collaborations, enabling stakeholders to select partnerships which meet their specific needs and objectives as well as implement policies which facilitate and encourage the formation of effective partnerships (Meissner et al., 2022).

5.3.8.2 Academia

Universities, as centres of innovation and social change, can contribute significantly to achieving the Sustainable Development Goals. University professors can ensure knowledge is applied appropriately while developing dialogue among stakeholders, providing advocacy, training, and quality education services (Bartoloni et al., 2021). University-led community engagement initiatives can also assist local communities in taking advantage of SDG synergies at the local level through co-creation across three settings: academic environment, community setting, and implementation site. In the first setting, students collaborate with stakeholders to draft a project proposal and develop a prototype solution, before testing it within their community environment. This helps develop students' skills while providing them with exposure to real-life issues; additionally, this provides meaningful experience and creates lasting change within communities, while faculty who participate can receive positive recognition in performance evaluations (Goddard et al., 2016).

5.3.8.3 Government

Governments play an essential role in university-industry collaboration by setting the agenda and policy surrounding research and development. Governments can support innovation by creating funding schemes or policies to support public-private partnerships; furthermore, they can also encourage closer bonds between universities and cities. However, it is essential to recognize that government involvement varies depending on the country. Some governments, like China's, prioritize spreading

knowledge via scientific research and higher education resources to achieve social change; other nations like Vietnam focus more on building their university's brand and reputation as a key factor in society through collaborations and alliances to meet Sustainable Development Goals (SDGs). No matter the approach chosen by either side, dialogue must occur between university and community - through events, projects, or any other means necessary - in order to encourage a collaborative atmosphere that facilitates SDG achievement.

5.3.8.4 Partnership

Establishing long-term and sustainable strategic partnerships among universities, governments, and communities is both a growing challenge and an invaluable opportunity for research to make an impactful difference in society. Such efforts should be guided by university missions which increasingly include social action as part of their mandate (Cai et al., 2020). Communities that have made progress toward sustainability goals have created diverse partnerships among residents and businesses, disadvantaged groups, environmentalists, local associations, and government agencies. Such places honour healthy ecosystems while efficiently using resources and encouraging a locally based economy. They exude pride of place while embodying values of ownership and engagement within their community.

5.3.9 Theme B5

Regional development and legal compliance are integral aspects of universities acting as innovation platforms. The essence of this role lies in the symbiotic relationship between universities and their surrounding regions, where academic institutions serve as catalysts for economic growth, technological advancement, and social progress. In this context, universities, as innovation platforms, play a crucial role in developing regional development through collaborative initiatives, research endeavours, and adherence to legal frameworks.

According to the data obtained from the focused groups, another theme has emerged which represents the need of legal compliance in place when innovating new products for the regional development:

(Theme B5) Regional Development & Legal Compliance
• Universities are the main roots to establish regional development & Legal Compliance when letting students do the innovations. • University's role in innovation Act should be clarified when doing start-ups. • University's role in innovation programme is to facilitate the development process cycle from the idea generation to tangible product. • University's role in innovation alliance should be made clear through workshops etc.

Table 5.10: (Theme B5) Regional Development & Legal Compliance

(Source: Created by Researcher, 2023)

The data suggests that universities are hubs of research and innovation, conducting studies that lead to breakthroughs in various fields. Through partnerships with local industries and government agencies, universities can translate their research findings into practical applications, developing innovation that directly impacts regional development. This could involve the development of new technologies, processes, or products that contribute to local economic growth.

By promoting entrepreneurship and supporting startup initiatives, universities facilitate the creation of new businesses within the region. Entrepreneurial activities, nurtured within the university ecosystem, can lead to the establishment of innovative startups that contribute to job creation and economic vitality. Incubators, accelerators, and mentorship programs offered by universities play a vital role in supporting the growth of these ventures. While universities act as innovation platforms for regional development, legal compliance ensures that these activities are conducted within the bounds of ethical and legal frameworks. Legal considerations encompass various aspects, including intellectual property rights, ethical research practices, environmental regulations, and compliance with local, state, and federal laws. Universities must navigate these legal intricacies to maintain integrity, protect stakeholders, and uphold societal expectations.

While analysing the data, research has performed a word search, and the following word tree is produced:

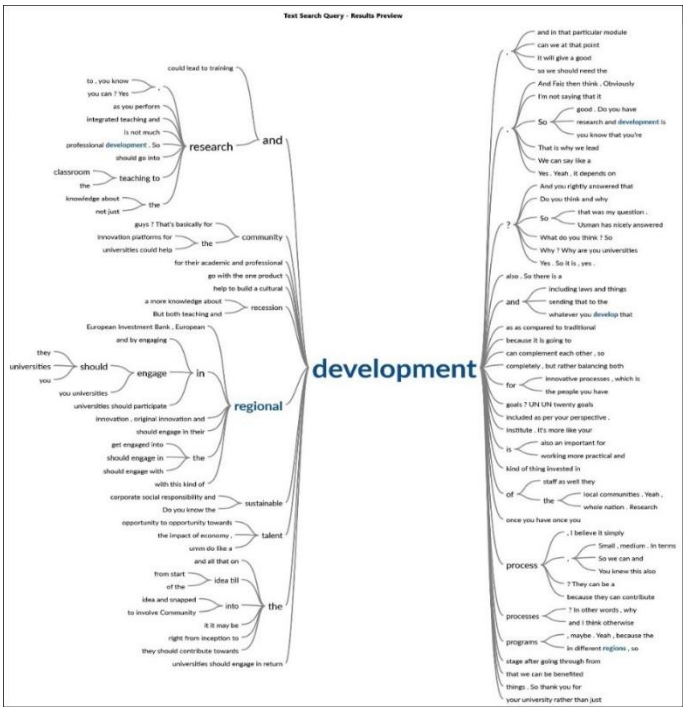


Figure 5.22: Result Review for Development

(Source: Created by Researcher, 2023)

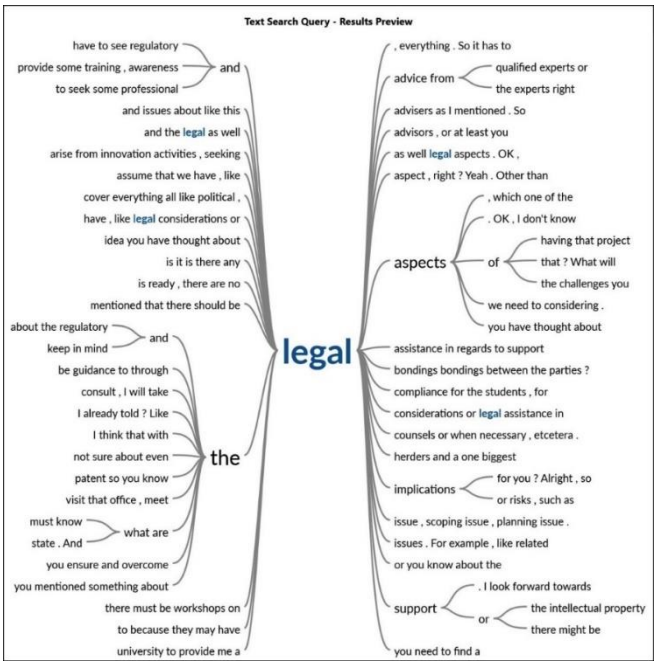


Figure 5.23: Result Review for Legal

(Source: Created by Researcher, 2023)

The word trees represent the regional development in the context of universities as innovation platforms, refers to the concerted efforts to enhance the economic, social, and cultural fabric of the local community. Universities contribute to regional development by acting as engines of innovation and knowledge creation. They serve as hubs that connect academia, industry, and government in collaborative endeavours that address regional challenges and capitalize on opportunities for growth. Through research, technology transfer, and entrepreneurship programs, universities catalyse innovation that drives economic diversification, job creation, and overall prosperity within the region.

5.3.10 Analysis of Theme B5

This research investigates how universities can leverage innovation and deliver economic prosperity, drawing from examples in the US, Bulgaria (Europe) and UK where university professional services departments lead a sustainable agenda at an institutional level. Utilising university expertise and gathering power to forge relationships with local and business partners aligned with its mission, as well as promoting innovation nationwide as part of a collective national effort is at the core of success for universities.

5.3.10.1 University's role in Regional Development & Legal Compliance

As part of innovation activities, universities must consider their role in regional development and legal compliance, including their culture and processes as well as policies and procedures. Furthermore, it must ensure their employees are aware of any relevant laws or regulations which apply to them and provide proper training or education on this matter (Arranz et al., 2020).

Universities should understand their roles in regional development and establish clear lines of responsibility between governance and operational management to avoid legal issues and violations as well as strengthen their reputations. Studies reveal the crucial roles universities play in regional development. Research indicates that universities' presence can upgrade local labour markets in peripheral regions and thus encourage new industries' emergence; however, thin graduate labour markets can hinder access to skilled labour from corporates, undermining their impact (Evers, 2019). Furthermore, staff career mobility hinders engagement with local partners as well as weaving knowledge into society - two issues often encountered when trying to sustain regional development projects.

5.3.10.2 University’s role in Innovation Act

The university plays an essential role in supporting innovation to address problems threatening human and planet health, as captured in the SDGs. To do this, it works on a strategic level by forging partnerships across campus and communities while acting as convener, connector, and adviser; additionally, it mobilizes students as key resources, using them to drive change and take leadership roles (Abbate et al., 2021). The National Innovation Council shall issue guidelines to streamline and improve the performance of key indicators that facilitate and promote innovation, including budgeting, procurement, auditing, and alliance establishment. Furthermore, it shall develop and implement an incentive framework encouraging Innovation Alliance formation. At its core, joint ventures involve partnerships between private sector companies and academic or educational institutions; these can also involve government agencies or local governments. Collaboration among all participants ensures that project objectives are achieved while results are sustained over time.

5.3.10.3 University’s role in Innovation Program

A university's ability to encourage innovation depends on its resources, abilities, and attitudes and these include tangible and intangible assets as well as experience collaborating with stakeholders within its region. Furthermore, its infrastructure (greenery, libraries), finances, and ICT resources all play a part in this regard. In the UK, many companies have built their technology ecosystems around local universities with long histories of collaboration and support from government funding agencies. This approach has allowed it to become one of the world's leading technological powers with an abundance of top-class research universities. This section explains that a socially engaged university includes voluntary acceptance of obligations that go beyond what is legally mandated, along with changes to university culture that facilitate research and education that integrate with natural environments as well as cultivate relationships with external stakeholders (Braun Střelcová et al., 2022).

5.3.10.4 University’s role in Innovation Alliances

To meet the challenges posed by this new era of innovation, universities must reconsider their roles in innovation. Instead of adhering to their traditional "second mission" of teaching and research, universities need to move beyond this with initiatives, funding opportunities, working groups that facilitate collaboration between researchers from the

industry and university members - these efforts must include working groups between researchers from both sides.

Companies participating in local innovation ecosystems can establish collaborative relationships with universities to achieve various goals, such as problem-solving; talent scouting; technology transfer; accessing students and staff at university institutions; gaining credibility with stakeholders; or supporting organisational learning and development. Not only can these partnerships offer expertise and funding from outside sources, but they also assist universities in creating research applications of their own, thus fulfilling their third mission - which in turn further their third mission. Furthermore, these relationships may help attract additional investments by capitalizing on universities' reputations as leaders in certain areas of research.

5.3.11 Theme B6

Universities, as institutions of higher learning, play an important role as change catalysts in society, developing transformative developments across various domains. This catalytic role extends beyond traditional education and encompasses areas such as innovation, socio-economic progress, and cultural evolution. Through research and academic exploration, universities contribute to the expansion of human knowledge. By developing an environment of intellectual curiosity and inquiry, universities act as incubators for new ideas, paradigms, and discoveries. This knowledge generation not only advances academic disciplines but also forms the basis for societal progress and innovation.

According to the data obtained from the focused groups, another theme has emerged which represents the role of universities as change catalyst when innovating new products for the regional development:

(Theme B6) Role of Universities as Change Catalyst
• Universities should act as change agent to academia, industry, and communities to drive technological advancements and creative solutions. • Universities should contribute significantly to research and development and should have the vision to produce cutting-edge studies.

• Purpose of innovation and the strategy to lead it should be viewed as university's goal.

Table 5.11: (Theme B6) Role of Universities as Change Catalyst

(Source: Created by Researcher, 2023)

The data suggests that Universities are instrumental in driving innovation and technological advancements. Through research and development activities, academic institutions push the boundaries of what is possible, leading to breakthroughs that have far-reaching implications. These innovations often find application in industries, contributing to economic growth and competitiveness. The collaborative efforts between universities and industry partners result in the transfer of knowledge, the creation of new technologies, and the emergence of entrepreneurial ventures. Moreover, universities serve as crucibles for social change and cultural evolution. The diverse and inclusive nature of university environments provides a platform for the exchange of ideas, perspectives, and experiences. This facilitates the cultivation of open-mindedness, tolerance, and a global outlook among students. Universities become hubs where cultural norms are questioned, and societal values are critically examined, paving the way for positive social change and progress.

While analysing the data, research has performed a word search, and the following word tree is produced:

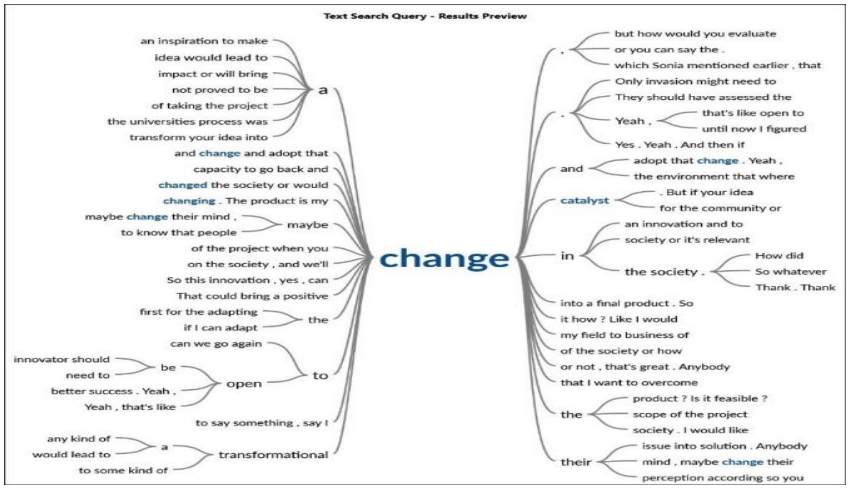


Figure 5.24: Result Review for Change

(Source: Created by Researcher, 2023)

5.3.12 Analysis of Theme B6

Universities can help address our most pressing problems by equipping future leaders, driving innovation and entrepreneurship, and cultivating the next generation. However, universities alone cannot do it. The three case studies presented here serve to demonstrate how universities can act as agents of change for society. From university-wide initiatives (BCU) to specific professional services initiatives driven by students and faculty (AUBG), each represents part of larger strategic change initiatives geared toward sustainable living.

5.3.12.1 Purpose

Universities have long been critical contributors to society through teaching and research, but universities must now go beyond these traditional duties to become active local actors if they wish to remain relevant in today's globalized environment (Audretsch, 2014). Universities can serve as agents of change, either initiating the process or speeding it along. This can happen by harnessing internal and external factors - the former may include visionary senior leadership and support from peers and faculty; while external factors may include tuition/credit funding, regulatory issues, student success networks and peer institutions influencing a larger change initiative (Abdel Latif, 2011; Clark, 1998).

Universities can serve as change agents by offering knowledge and research that contribute to local industry growth, helping firms address any sector challenges through sustainable industrial development (Brundiers & Wiek, 2011). Universities act as change agents by providing knowledge, research, and partnerships between them and their industrial partners - the latter can use this to bridge theory with practice through mutually beneficial relationships between them both (Arranz, Arroyabe & Schumann, 2020). Universities serve as hubs of innovation by offering knowledge, technology, and strategies to boost productivity and competitiveness of industry partners (Carayannis, Campbell, & Del Giudice, 2021).

5.3.12.2 Vision

Universities have historically served as powerful platforms for change. Consider feminist, civil rights, and anti-war movements as just some examples (Audretsch, 2014). Today's complex problems require multidisciplinary approaches for solving them effectively. For example, climate change requires plant and veterinary scientists to work alongside colleagues from social sciences, humanities, and law fields in collaborating

(Cai, 2022). Universities need to connect their academic departments with organizations in the community through partnerships. Leveraging data and funding resources are also vital. Central administration can support professional development to make a case for these efforts in the university and build capacity within departments, so they are sustained over time—ultimately driving its learning agenda forward (Marques et al., 2019).

5.3.12.3 Strategy

Universities play a vital role in nurturing innovation, entrepreneurship, and creativity. Furthermore, universities serve as leaders and convening mechanisms, drawing together the diverse groups, agencies, and organizations comprising a metropolitan region (Domínguez-Gómez et al., 2021). Furthermore, universities are uniquely situated to provide trusted information, clarify economic/demographic data, negotiate agreements among stakeholders of a city or region, as well as providing trusted information that facilitates negotiations among them. Strategy often emerges out of faculty efforts without formal processes; for instance, some of the great environmental programs found on university campuses today began because faculty took action without formal authorization. University leaders must recognize these initiatives and be able to recognize, support, and expand upon them instead of just nudging them along (Etzkowitz, 2003).

5.3.12.4 Action

An essential strategy is supporting social innovation (SI) in healthcare, while creating the appropriate infrastructure to allow universities to work collaboratively on innovative solutions (Audretsch, 2014). While this may present some difficulty as many universities operate like fiefdoms that don't get along well together, but that is precisely where opportunities lie. Universities have historically been powerhouses of change. Universities provide an atmosphere conducive to innovation and research while simultaneously giving their students the skills and empowerment needed to take a stand against injustices both personal and social (Cai & Ahmad, 2021).

5.3.12.5 Change Agent

Addressing food security at an international level requires collaboration among plant and veterinary scientists worldwide to increase crop yields, as well as collaboration among humanities scholars studying land ownership structures and development regulation as well as political science experts tasked with finding methods for embedding new

practices within communities and nations. Each institution has its own operating model and capacity constraints that determine which catalysts are most suitable (Findler et al., 2019). Student success networks were particularly effective with community colleges while outside consultants are widely utilized at historically Black Colleges and Universities. To successfully drive long-term reform in teaching and learning reform, the key lies in selecting an optimal combination of catalysts to use for sustained reform (Cai & Lattu, 2021).

In an era where traditional community institutions are facing criticism and changing dynamics, the University's role as change agent in community developments is essential. These partners include local government agencies, non-profit foundations, and corporations. To be a successful change agent, the University must be a good learner. Incorporating new technology into community development can help build the community's capacity for change. To be a change agent, academic institutions need to navigate multiple domains. They must develop capacity to communicate with policymakers and the public (Bryman, 2016). Moreover, involvement in institutional initiatives catalyses the change agent role in academic institutions. Involvement in the implementation of a change agent initiative catalyses the change process by including all stakeholders at the table. In fact, institutional leadership has a significant role in guiding change initiatives. Universities should incorporate Knowledge Based (KB) activities as part of an organizational long-term strategy rather than as short-term projects to facilitate successful KB interventions and encourage relationships that will facilitate their implementation (Schaffers & Turkama, 2012).

Research shows that successful companies invest in developing their employees. This includes offering training programs, encouraging collaboration among colleagues, and stimulating innovative thought (Cai, Ma, & Chen, 2020). Doing this helps reduce time spent searching for information while increasing productivity and customer service levels. To successfully implement a knowledge management strategy, it's necessary to know your customers. This may involve surveying employees to ascertain what they need to perform their jobs more efficiently or utilizing the Business Model Canvas as a means of identifying target markets. Once identified, you can then develop plans tailored specifically to their needs—such as creating a knowledge base which offers them answers when they have queries (Beiske, 2007).

5.4 Common Themes and Analysis

In this section, the researcher is exploring the findings and discuss the common themes emerged from both sets (Computing and Business) of focused groups.

5.4.1 Regional Development & Legal Compliance (Common Theme 5):

Both computing and business students recognize the importance of regional development and legal compliance. The emphasis on regional development aligns with the idea that universities play a crucial role in contributing to the economic and social development of their surrounding communities. This aligns with the concept of the "engaged university" or "local university," which emphasizes the institution's responsibility to address local challenges (Goddard, Hazelkorn, & Vallance, 2016). Legal compliance underscores the ethical and responsible conduct of research and innovation within legal and regulatory frameworks (Olsen & Shanks, 2019).

5.4.1.1 Universities Lead Innovation

Many studies examine the conditions necessary for innovation activities to flourish even in peripheral regions, despite lower accessibility or the absence of extra regional networks and contacts. A body of research explores the role of regional institutions, specifically universities, in this regard (Charles 2016). Although universities play an integral part in creating regional innovation systems, their impact depends on whether their strengths align with the requirements of regional economies. Though most studies of Regional Information Systems (RISs) centre around core regions, an increasing number of publications focus on thin RISs as well. While thin RISs are usually built accidentally (Doloreux & Dionne 2008) or deliberately (Coenen and Asheim 2012), their internal processes often depend on strategies designed to maintain contact between extra regional actors as well as local networks.

Unlike private companies, which are under the tight economic imperatives of private enterprise, government institutions do not have the same priorities, mandate, or incentives. Therefore, they are uniquely positioned to contribute to, and influence, the agendas of every sector. This is the power of universities as their unique structure, history, and epistemology. The advanced technologies that are transforming our lives are set to affect UK innovation and research sectors. Cloud technology enables AI, machine learning, image recognition, text analysis, and even the development of new vaccines. Cloud computing tools and big data are revolutionising vaccine development. Despite this, UK HE has historically under-invested in digital and technology. Campus

universities have grown by leaps and bounds over the last decade, but institutions have spent billions on building and land, yet are not investing in digital equivalents (Sachs, 2018).

5.4.1.2 Collaborations

Under federal cuts in research, health care, and workforce training investments likely to decline, local leaders must collaborate more to maintain their status as epicentres of national progress. They should collaborate in raising new revenue streams; seeking flexibility for regulatory reform; and coinvesting in shared regional priorities. Laws and regulations can play an integral role in addressing environmental and development challenges, but they cannot do it on their own. Prices, markets, and governmental fiscal and economic policies also play an integral part. As this project evolves, research and experience will shed more light on what constitutes an ideal arrangement for providing services in specific local conditions, and the costs and benefits of collaboration will become clear.

5.4.1.3 Entrepreneurship

Entrepreneurship occurs when individuals identify an opportunity or gap in the market and take steps to capitalize on it by starting their own venture. The entrepreneurial journey typically includes various steps such as selecting potential products or services, creating a business plan, seeking funding and staff, launching the company and managing its operations. An individual's perception of their ability to start and run a business is one of the primary drivers of entrepreneurialism, according to previous research. Entrepreneurial self-efficacy and perceived behavioural control are positively associated with entrepreneurial intent. This study seeks to uncover how students' ability perceptions and entrepreneurial intentions are impacted by performance expectancies of new technologies, specifically artificial intelligence (AI). It makes an invaluable theoretical contribution by uncovering an intriguing aspect of entrepreneurship development related to emerging technological factors; furthermore, it emphasizes the significance of including such new technologies into entrepreneurship education programs in Lebanon to help improve students' entrepreneurial intentions in an educational setting.

5.4.1.4 Business-Research Partnerships

There are many benefits to business-university collaborations, and the UK is no exception. In fact, 80% of companies surveyed said their interactions with UK

universities met or exceeded their expectations. Yet many companies are not tapping this resource fully. A lack of information and capacity is a primary problem, and this lack of information hampers more productive collaboration. But building business capacity to work with universities could be the answer. Below are four reasons why more businesses should collaborate with UK universities.

A business-university collaboration can be a great way to launch a new product or improve an existing one. A research partnership can also lead to the development of new revenue streams, open new markets, or instil a strong appreciation for research in the workforce. Queen Mary is one of the leading research-intensive universities in the UK and has ranked as high as fifth globally in research output in all areas except for engineering. The UK government has identified collaboration with industry as a core strategy. In fact, the Higher Education Funding Council for Wales (HEF) has identified academic-industry partnerships as four pillars of its strategy. The four pillars of successful university-business collaborations are: innovation, partnerships, research excellence, and collaboration. In addition, the government is encouraging collaboration with companies, as this is crucial to developing innovation.

5.4.2 Role of Universities as Change Catalyst (Common Theme B6 for Business and Theme C4 for Computing):

- Both computing and business students recognize the role of universities as change catalysts. This aligns with the literature on the "entrepreneurial university" (Clark, 1998), emphasizing the transformative role of universities in driving social and economic change through innovation and entrepreneurship. Universities are seen as dynamic institutions that go beyond traditional academic functions to actively engage with societal challenges.

While not explicitly common, the theme of entrepreneurship in business students (B1) and the emphasis on social projects and innovation festivals in computing students (C4) also share a connection. Literature on entrepreneurial education supports the idea that universities can encourage an entrepreneurial mindset and provide support systems for startups (Fayolle et al., 2006). Universities have always been catalysts of social transformation; feminism, civil rights and antiwar movements all began on university campuses. This report details three instrumental case studies from across three levels of analysis - pan-institutional (PU), collaborative with external partners (AUBG), and centrally led by university professional services department (HU). All strategies

employed focused on embedding sustainability at an executive-level in university missions.

5.4.2.1 Computing Students

Adopting a fresh approach to any issue requires courage, clarity, and tenacity. Successful change agents possess a vision for a brighter future and the ability to connect it to hearts and minds. Universities play an essential role in training leaders of tomorrow who must tackle our problems, so it is imperative that their students receive scholarship and research opportunities that enable them to understand these obstacles, along with innovation and entrepreneurship as potential solutions. Furthermore, universities must offer community service to catalyse action. Many university officials view their role as an extension of their mission, such as at UD where their Hub Powered by PNC serves as an outreach platform to bring its Catholic and Marianist mission of furthering the common good into local business communities and strengthen relationships between UD and its city partners. Furthermore, multidisciplinary academic programs offered through this hub equip students to be change agents themselves.

5.4.2.2 Business Students

As businesses seek to adapt traditional views of wealth creation, business schools develop individuals who possess the expertise, mindsets and experiences needed to balance profit with purpose, people, and planet. Their activities help advance socioeconomic priorities through scholarship, teaching, and outreach activities. Universities are key players in understanding trade-offs and synergies among the Sustainable Development Goals (SDGs), teaching students to collaborate with local partners in developing place-based solutions and building capacity for social innovation (SI). Furthermore, universities bring government and business together in support of local initiatives through supporting and funding local initiatives. The case study approach explores various strategies for strategizing sustainability within university settings to deliver on SDGs, with examples drawn from UK, Bulgaria (Europe) and USA cases. Each case presents its own model for driving social impact while covering key themes including:

5.4.2.3 Faculty

Universities play an essential role in equipping future generations to address global sustainability concerns, but disrupting legacy systems that rely on political support, funding and tuition fees may prove challenging. Disruption must take place carefully

since legacy systems depend on multiple layers of support from political (state support, funding) economic (tuition fees credits degrees research funding) and social (discipline-based Organisational structures and status hierarchies) factors for their existence and maintenance.

Universities must embrace timely topics like climate change and incorporate them into their curricula to help develop employability skills as well as encourage wider perspectives among their students. They should establish relationships with external companies and local partners who align with their university mission, while creating opportunities for staff and students alike to engage in sustainability projects. According to The Frontier Set report, exploiting these opportunities requires senior leadership support as well as mid-level leaders coordinating informal networks; vision of the future as well as individual willingness to assume new responsibilities.

5.4.2.4 Administration

Universities have always played an essential part in social progress through teaching and research, but now universities are also being called upon to become local actors that drive local and regional community development efforts. Institutional leaders must be willing to embrace all of the changes necessary to rewire higher education for sustainability and social impact, including setting clear goals and priorities as well as revising tenure guidelines in order to encourage faculty and staff members to embrace this challenge.

The institutions were diverse, each having different operating models and capacities that determined which catalysts they could leverage effectively for equity purposes. Common equity catalysts included visionary leadership, student success-oriented partnerships, outside consultants and advisors as well as using disaggregated data for decision making and reform analysis - essential components to improving student outcomes and equity; an opportunity for all universities to take the lead toward sustainable, equitable communities.

5.4.3 Industry Collaboration (Common Theme B2 for Business and Theme C3 for Computing)

- Both groups emphasize the importance of collaboration between academia and industry. This aligns with the literature on the "triple helix" model, which highlights the interconnected relationships between universities, industry, and government

in developing innovation and regional development (Etzkowitz & Leydesdorff, 2000). The idea is that collaboration between these sectors can lead to knowledge transfer, skill development, and the generation of innovative solutions to real-world problems.

Industry and academia each bring different strengths that can work to their mutual advantage when working together. Businesses can gain early access to research that meets market requirements while cutting R&D costs. Consumers also benefit from products developed with university involvement as they offer greater scientific credibility. Future research could explore other determinants of this positive university effect such as consumer political orientation, religiosity, or country of origin.

5.4.3.1 Research

Researching is a central tenet of university-industry collaboration. For businesses, conducting research can lead to the creation of new products, technologies and processes that increase competitive advantage and thus strengthen ties between academia and industry. Literature suggests that the success of any research project depends on numerous factors. From an industrial viewpoint, one major consideration is whether research results can be put to practical use in ways that help meet business goals. Furthermore, project management plays a crucial role in its successful completion. Academic motivations for research collaboration can also vary significantly; researchers may be drawn to industry projects by publishing their work or seeking funding from public agencies; they may also look to expand networks that may lead to future collaboration opportunities; sometimes academics even partner with companies because they offer expertise that's difficult for their own employees to acquire in-house.

5.4.3.2 Technology Transfer

At present, companies' pursuit of technological progress compels them to collaborate with universities; however, industry managers see this arrangement only as beneficial if it improves their company products or services.

Establishing university-industry interactions (UICs) takes commitment from both parties. Their success hinges on being able to encourage interaction via initiatives focused on boundary spanning and interactions that support active leaders with entrepreneurial skills - thus encouraging UICs and creating effective strategies for collaboration (Cyert & Goodman 1997). Technology transfer typically involves research and development

with industrial partners, with activities including market pull or technological spillover being two primary mechanisms by which new technologies may emerge from fields that demand them, respectively. Universities can also transfer knowledge between themselves and industry through joint publications, conferences, or seminars as well as the employment of university graduates by companies.

5.4.3.3 Commercialization

Universities can collaborate with industry to engage in various types of technology transfer activities to aid commercialization efforts. The purpose is to equip industrial partners with external knowledge that helps reduce internal R&D costs and enhance innovation performance; other activities include creating research networks to facilitate knowledge dissemination and promote an innovation culture among firms. Universities can aid industrial partners with the creation of new products and services by conducting joint research projects or offering technical support. Furthermore, universities may partner with industry to establish science parks, technology transfer offices for industrial clusters, incubators, or any other infrastructures that bridge academics and businesses. For successful university-industry collaboration, it is critical to understand the various motivations underlying university-industry interactions. These can range from problem solving and resource sharing, through information/people access. Furthermore, identifying key staff and management members that could serve as conduits will contribute significantly towards effective project management.

5.4.3.4 Innovation Management

University knowledge empowers businesses to successfully implement innovation processes and reduce internal costs, leading to the creation of new products. Furthermore, university knowledge assists these Organisations with expanding research activities and building innovation networks that not only reduce associated costs but also yield financial profits for themselves. However, prior studies focused exclusively on analysing university-company collaborations through research project outcomes, not their overall contribution to company performance. Therefore, it is crucial that Organisations realize a successful UIC requires more than simply having a scientific partnership; setting up appropriate structures can also ensure it succeeds.

Literature illustrates that, depending on how UIC is measured, results vary considerably, suggesting both open innovation and university-industry collaboration are significant

sources of firm performance enhancement; hence policies with an emphasis on these should be developed.

5.5 Uncommon Themes and Analysis: Computing Students' Uncommon Theme

5.5.1 (Theme C2) Emerging Technologies & Research Excellence

This theme focuses on the significance of emerging technologies and the pursuit of research excellence. While technology and research are integral components of innovation, business students might not have highlighted this theme explicitly, as they may have prioritized more practical and industry-oriented aspects. Computing students may inherently integrate the importance of emerging technologies and research excellence into their perspectives without explicitly stating it as a separate theme. The nature of computing fields often involves cutting-edge technologies and a strong focus on research, making it a fundamental part of their worldview. Emerging Technologies & Research Excellence may not always be seen as a unifying theme among computing and business students, which can be explained by various factors in the academic landscape. One major contributor to this apparent disconnect between computing and business programs lies in their different academic focuses; computing students tend to delve deep into technical aspects of emerging technologies such as artificial intelligence, machine learning and data science while business programs typically place greater emphasis on business aspects like accounting or finance. Computer science students tend to focus on hands-on programming, system development and the technical details of cutting-edge technologies; business students instead tend to concentrate more on management strategies, organisational aspects, and market analyses than on technical implementation of technologies. Computing and business programs differ considerably in their goals; computing programs tend to focus on equipping students with advanced technical skills while cultivating research excellence that drives technological innovation, encouraging them to explore recent advancements and contribute to solving complex technical problems as part of research communities. Conversely, business programs often emphasize strategic thinking skills, decision-making abilities, and how technology can help achieve organisational objectives instead of specific research and development processes.

5.6 Business Students' Uncommon Themes:

5.6.1 (Theme B3) Regulatory and Policy Considerations for Innovation Activities

Unlike the computing students, business students specifically emphasize the

importance of regulatory and policy considerations in the context of innovation activities. This may indicate a heightened awareness among business students about the need to navigate complex regulatory landscapes in their entrepreneurial pursuits. Establishing platforms of communication and collaboration between faculty from computing and business departments is of utmost importance. Encouraging joint initiatives, workshops, seminars that bring experts from both domains can facilitate exchange of ideas, methodologies, perspectives, and methodologies between faculty. By cultivating this culture of collaboration universities can facilitate smooth integration of emerging technologies and research excellence into both computing and business student academic experiences. Conclusion While a disconnect exists between emerging technologies and research excellence in computer and business programs, it is vital that contributors be Recognised. By doing this, more seamless educational experiences may result. By breaking down disciplinary silos, encouraging collaboration, and revalorizing curriculum structures, universities can create an ideal learning environment where computing and business students can discover the interconnections between emerging technologies and research excellence. Not only will this approach benefit the students directly; it will also lead to professionals who can effectively navigate the intersection between technology and business in our rapidly evolving world.

5.6.2 (Theme B4) Industry – Academia and Government Collaboration for Sustainable Community Development

The emphasis on collaboration between industry, academia, and government for sustainable community development is not explicitly reflected in the computing students' themes. Business students may place a stronger emphasis on multi-stakeholder collaborations, recognizing the diverse roles these entities play in developing sustainable community development (Abbate et al., 2021). Academic institutions also play a part in contributing to this perceived lack of commonality. Computing and business departments tend to operate separately with limited integration between their academic themes (Orazbayeva et al., 2019). These disciplinary silos often create separate priorities and prevent cross-department collaboration, hampering joint initiatives which combine emerging technologies with business acumen seamlessly (Cai et al., 2019). Another factor influencing this distinction lies in the different priorities and interests of computing and business students. Computing students tend to have a keen fascination for emerging technologies and the technical challenges involved with their development;

they're drawn by coding, algorithm development, and system optimization challenges. By contrast, business students may prefer understanding how technology can enhance business operations, increase market competitiveness, or encourage innovation from an organizational standpoint (Aloulou, 2019). Curriculum structures also contribute to this lack of commonality. Computing and business programs may be designed to meet accreditation criteria or fulfill traditional expectations within their disciplines, leading to rigid program structures that limit flexibility when it comes to incorporating interdisciplinarity (Pan & Guo, 2021). Students may not be encouraged to explore emerging technologies that converge across both fields. Though these challenges present significant difficulties for computing and business students alike, there remains the potential for unifying their educational experiences by engaging in interdepartmental courses, collaborative projects, or joint research efforts that break down disciplinary boundaries (Domínguez-Gómez et al., 2021). Such initiatives offer students exposure to both technical depth and strategic applications of emerging technologies that offer them a holistic understanding of their place within a business context (Pique et al., 2018).

5.6.3 (Theme B1) Entrepreneurial Education & Support System for Startups

While entrepreneurship is implicitly present in computing students' themes through "Social Projects Through Innovation Festivals & Overcoming Challenges" (C4), business students specifically highlight the need for an "Entrepreneurial Education & Support System for Startups" (B1). This suggests a greater emphasis among business students on formalized education and support structures for entrepreneurial ventures. Business students may place a higher emphasis on the regulatory and policy environment, industry-academia-government collaborations, and formalized support for startups due to the practical and regulatory challenges inherent in entrepreneurial ventures. These aspects align with the complex and multifaceted nature of business and entrepreneurship, where regulatory compliance and collaborative efforts are critical for success.

5.6.3.1 Implications

The differences in themes highlight the diverse perspectives and priorities among computing and business students. While both groups recognize the importance of regional development, legal compliance, and the role of universities, their unique emphases shed light on the specific considerations and challenges within their

respective disciplines. In developing interdisciplinary collaboration, it becomes crucial to acknowledge and bridge these differences. Recognising the value of technology, research excellence, regulatory awareness, and multi-stakeholder collaborations can lead to holistic approaches that leverage the strengths of both computing and business perspectives in driving innovation and societal impact.

5.7 Advancing the Triple Helix Model (Quintuple Helix Model)

The findings from the exploration of common and uncommon themes among computing and business students provide significant insights instigate the advances the Triple Helix Model to Quintuple Helix Model as represented below:

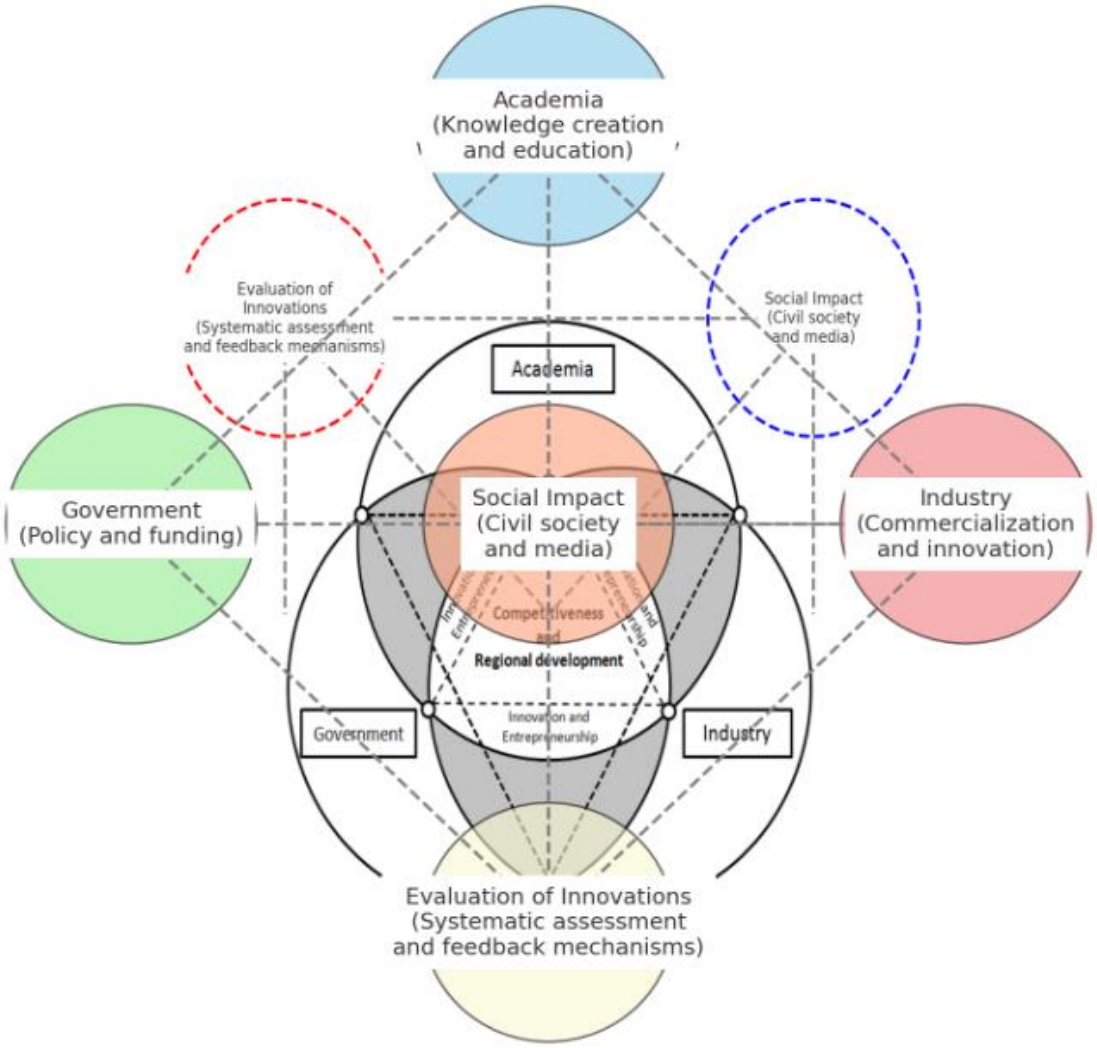


Figure 5.25: Quintuple Helix Model

(Source: Created by Author, 2024)”

The proposed Quintuple Helix Model conceptualizes the social impact of innovations with intertwined relationships between academia (universities), industry, and government as drivers of innovation and regional development. This proposed model integrates five key elements to develop competitiveness and regional development through innovation. The central circle represents "Social Impact," highlighting the role of civil society and media in influencing and shaping innovation. Surrounding this core are four circles representing "Academia" (focused on knowledge creation and education), "Government" (providing policy and funding), "Industry" (driving commercialization and innovation), and "Evaluation of Innovations" (ensuring systematic assessment and feedback mechanisms). These elements are interconnected, illustrating their dynamic interactions and mutual influences. Each circle connects to the others through dashed lines, symbolizing the collaborative and interdependent nature of these sectors in promoting sustainable and impactful innovations. This model emphasizes the importance of a holistic approach, where social considerations and continuous evaluation play crucial roles alongside traditional academic, industrial, and governmental functions in driving regional growth and development.

Here's how the findings of this research contribute to this new proposed Quintuple model:

5.7.1 Enhanced Role of Universities in Regional Development and Legal Compliance

Both computing and business students underscore the importance of regional development and legal compliance, highlighting universities' pivotal role in contributing to the economic and social advancement of their surrounding communities. Universities are seen as critical players in creating regional innovation systems, particularly in peripheral regions where innovation can thrive despite lower accessibility. This aligns with the Triple Helix Model's premise that universities are not just knowledge creators but active participants in regional economic development. It emphasizes the need for universities to align their strengths with regional economic needs, thereby enhancing their role as crucial nodes in facilitating regional development and innovation.

5.7.2 Universities Leading Innovation through Advanced Technologies

The findings reveal the transformative impact of advanced technologies, such as AI and cloud computing, which are revolutionizing sectors like vaccine development. Despite historical underinvestment, universities have significant potential to lead innovation

through these technologies. This perspective advances the Triple Helix Model by highlighting the strategic role of universities in leveraging advanced technologies to drive innovation. It calls for a shift in investment priorities towards digital and technological infrastructure within universities, developing more effective collaboration with industry and government sectors.

5.7.3 Collaboration and Entrepreneurship

Emphasis on collaborations among local leaders, raising new revenue streams, seeking regulatory reform, and co-investing in regional priorities underscores the importance of joint efforts. Entrepreneurship is identified as a crucial component, with universities playing a role in developing an entrepreneurial mindset and providing support systems for startups. These findings reinforce the Triple Helix Model's emphasis on the synergistic relationships between academia, industry, and government. By nurturing entrepreneurial activities and developing collaboration, universities can drive economic growth and innovation, making them central players in the Triple Helix framework.

5.7.4 Business-Research Partnerships

The benefits of business-university collaborations are well-documented, with high levels of satisfaction among companies engaging with universities. However, a lack of information and capacity hampers more productive collaborations, suggesting a need for building business capacity to work with universities. For the Triple Helix Model to be more effective, it is crucial to enhance the capacity of businesses to collaborate with academic institutions. The government plays a pivotal role in facilitating these collaborations by providing necessary information and support infrastructure.

5.7.5 Role of Universities as Change Catalysts

Universities are recognized as change catalysts, driving social and economic change through innovation and entrepreneurship. This aspect advances the Triple Helix Model by reinforcing the university's role beyond traditional academic functions to actively engage in societal transformation. It aligns with the idea that universities should be active agents of change, working closely with industry and government to address global challenges.

5.7.6 Emerging Technologies and Research Excellence

Computing students focus on emerging technologies and research excellence, integral to innovation, while business students emphasize regulatory and policy considerations

and industry-academia-government collaborations for sustainable community development. These themes highlight the need for interdisciplinary collaboration, essential for the Triple Helix Model to function effectively. Bridging the gap between computing and business perspectives can lead to more holistic approaches to innovation, integrating technical advancements with strategic regulatory and policy frameworks.

5.8 Data Collection Instruments: Linking Findings with Literature

The primary data collection instrument used in this study was focus group discussions, strategically applied across various student cohorts at Birmingham City University, QA Higher Education, and Ulster University. The use of focus groups aligns well with the research objective of exploring how universities act as catalysts for innovation and regional development.

Focus groups provided a rich qualitative insight into participants' lived experiences, perspectives on knowledge transfer, innovation, and sustainability. According to Creswell (2014) and Bryman & Bell (2015), focus groups are particularly effective in generating deep discussions and uncovering shared themes and divergent opinions, which was evident in the emergence of themes such as Community Development through Knowledge Transfers and Industry-Relevant Curriculum for Sustainable Product Developments.

Moreover, Creswell & Poth (2018) highlight that focus groups foster an environment conducive to idea sharing, which supports the collaborative and participatory ethos of innovation festivals studied here. This resonates with findings where students described team-based learning, community engagement, and institutional support as key enablers of their projects.

The deployment of NVIVO's Word Cloud and Word Tree functions helped streamline thematic coding and identify high-frequency concepts such as "innovation," "community," and "technology." As Palys & Atchison (2018) argue, such visual data exploration enhances researcher reflexivity and helps detect latent patterns in the data. The combination of visual tools and thematic analysis echoes Patton's (2015) suggestion that qualitative research should be iterative, data-driven, and contextually grounded.

The study ensured methodological rigor through careful transcription, coding, and cross-validation of data – a practice recommended by Guest, MacQueen, & Namey (2012) and Marshall & Rossman (2014) to increase trustworthiness. Additionally, ground rules for discussions (e.g., promoting equal participation and respecting opinions) helped mitigate biases such as the halo effect or groupthink, aligning with Denzin & Lincoln's (2018) guidance for facilitating inclusive and balanced discussions.

One of the known challenges of focus groups is their limited utility in discussing sensitive or individualised topics. However, the use of online formats, as noted in the study and supported by Bryman & Burgess (2019), likely helped overcome these limitations by providing more anonymity and convenience.

Another potential limitation lies in the interpretation of visual data analytics. While word trees and clouds are effective at spotting trends, their reliance on frequency can obscure nuance. The researcher addressed this by anchoring thematic interpretations in verbatim quotes and linking them to broader conceptual frameworks (e.g., knowledge brokering, sustainable development, and entrepreneurial ecosystems), thereby reinforcing validity and interpretive depth.

The findings from the use of focus groups support Etzkowitz & Leydesdorff's (2000) Triple Helix model, highlighting how universities can mediate between industry and government to foster innovation. Moreover, the themes of social innovation, community engagement, and curricular relevance are well-aligned with Lozano et al. (2017) and Gallardo-Vázquez et al. (2021), who advocate for curriculum integration of sustainability and entrepreneurship.

Finally, the study's use of thematic analysis guided by participant discourse reflects Braun & Clarke's (2006) model, emphasizing inductive theme generation from qualitative data.

Summary

The findings from the study of computing and business students advances the Triple Helix Model by providing evidence of the dynamic role's universities play in regional development, innovation, and societal transformation. They underscore the importance of interdisciplinary collaboration, the strategic use of advanced technologies, and the necessity for universities to engage actively with industry and government. This enriched

understanding of the Triple Helix Model highlights the evolving nature of these relationships and the critical role of universities in developing sustainable and inclusive innovation ecosystems. All these findings advance the Triple Helix Model to Quintuple Helix Model by illustrating the dynamic roles universities play in regional development, innovation, and societal transformation. They emphasize the importance of interdisciplinary collaboration, advanced technologies, and the strategic engagement of universities with industry and government to drive sustainable and inclusive innovation ecosystems.

Chapter 6: Conclusion

6.1 Conclusion

The analysis expresses on why universities should be involved in innovation activities. To achieve their mission, they need to embrace societal impact as their top priority, engage with a broad ecosystem of research, and create open, transparent reward systems for their researchers. They must also promote societal impact as a dynamic process, developing cooperation between all four helices of the innovation ecosystem. In this chapter, research is concluding the whole research followed by recommendations.

6.1.1 Developing a Culture of Entrepreneurship

To cultivate entrepreneurial behaviours, institutions must encourage an entrepreneurial culture. It should be characterized by risk-taking, attention to detail, result orientation, team orientation, aggressiveness, and stability. To create a strong entrepreneurial culture, the following elements should be present: human talent, external environment, and resource provision opportunities. It must develop a vision and mission statement along with a strategic entrepreneurial plan and engage faculty, students, and staff in the process. The next step is to hire staff as strategic entrepreneurial team members. These staff members must have a high level of leadership skills and be willing to take risks. Good entrepreneurial culture helps students build entrepreneurial attitudes, which are critical to achieving business success (Carayannis, Del Giudice, Tarba, & Soto-Acosta, 2021; Bertello, Battisti, De Bernardi, & Bresciani, 2022). Creating an entrepreneurial university can promote academic success through entrepreneurship, while also generating a robust entrepreneurial ecosystem. While these two components are not mutually exclusive, they are complementary. The entrepreneurial university acts as a multiplier for the entrepreneurial ecosystem (Cai, Ahmad, 2021). The university's mission and context are also important. To build a vibrant entrepreneurial ecosystem, it needs to encourage university-industry collaboration. This will encourage an entrepreneurial mindset and encourage students to take risks (Costa, Neves, & Reis, 2021).

6.1.2 Developing New Partnerships with Leading Companies

The innovation ecosystem in Silicon Valley is increasingly dominated by collaborations between universities and leading companies. Universities are critical participants in this

ecosystem because they serve as an extended workbench and source of talent. As more corporations focus on open innovation, universities are increasingly important partners and anchors for a broader range of innovation activities and engagement with regional innovation ecosystems. While there are many benefits of university-industry partnerships, many companies find the process difficult, even though key financial and human resources are available. This challenge is magnified in ecosystems where there are several stakeholders with varying ambitions. Developing new partnerships with leading companies, such as PSAV, can provide a valuable resource for both parties. This way, universities can increase their capacity to recruit new students and can help companies build a pipeline of future job-ready candidates for their companies.

6.1.3 Developing a Social Innovation Aimed at University Staff

A strategic orientation to social innovation in universities remains a challenge. In addition to the conflicting expectations of stakeholders, a university must balance its autonomy and scientific excellence. The following discussion will provide an overview of the key aspects of an effective strategy. It also outlines how universities can make their social innovation efforts more effective and sustainable. We will discuss the role of social innovation in universities and how it can benefit students, staff, and communities. An effective framework for social innovation includes establishing a cross-sectoral network, which brings together different actors. This helps create a collaborative environment that encourages intrapreneurship. In addition, a social innovation lab should embed social innovations in the context of a local or regional Organisation. This makes it easier for university staff to participate and make their ideas a reality. While social innovation labs are not the solution for every social problem, they have proven to be highly effective. Vin addition to providing resources and expertise, universities can play a significant role in social innovation. According to Sauter, (2021) universities can play a role in collaborating with social innovators by offering advice and involvement. Universities can provide support to social innovators at various stages of the process. In addition, universities may also provide training to university staff. In addition, universities may have social innovation programs that are part of the university's curriculum.

6.1.4 Re-Thinking Existing Working Methods and Approaches Toward Innovation

The new research on social innovation in higher education offers important lessons for policymakers seeking to improve the quality and affordability of higher education. Initiatives encourage innovation in higher education. These efforts will be more

successful if they acknowledge the differences between disruptive innovation and sustaining innovation and the roles of value networks and new business models. These two concepts are crucial in defining the nature of disruptive innovation (Carayannis, Del Giudice, Tarba, & Soto-Acosta, 2021). The student demographics have been changing for some time. More mature students are combining work and study, while others seek flexible learning options. While school leavers remain an important group of students, they no longer represent the dominant segment in determining an institution's strategy. Today, institutions are more likely to pursue international markets and expand their scope to meet the needs of a larger student body (Bertello, Battisti, De Bernardi, & Bresciani, 2022).

Tradition casts a long shadow over higher education. It has allowed many universities and colleges to achieve their goals by replicating the same structures of power and authority. Many of these models are no longer relevant and may discourage innovation and innovative approaches. The traditional design logic of higher education is still rooted in the 11th century when an expert passed knowledge to his or her apprentice. This design logic is also what determines the number of books in a library, how many hours of seated lectures are required, and what constitutes a degree (Costa, Neves, & Reis, 2021).

6.1.5 Entrepreneurial University Mindset

The entrepreneurial university mindset has special relevance for the knowledge society and can be considered a theoretical framework to introduce the concept of entrepreneurial universities, which focuses on the role of universities in the environment and the interactions that support progress and development. The role of universities in the knowledge society is both critical and challenging. To address these challenges, universities need to adopt a mindset that promotes entrepreneurship. Moreover, this mindset can be a strategic tool in the knowledge spillover process, which results in competitive advantages and the transfer of individual knowledge to collective knowledge. Entrepreneurial universities play a critical role in regional development, notably in the context of entrepreneurship networks. The regional innovation system, or RP3, is a strategic framework for establishing regional development goals. Entrepreneurial universities also have formal factors related to knowledge capitalization, independence from other institutions, and renovation. Unlike traditional universities, entrepreneurial universities usually have a diversified funding base, high research

intensity, and global scope of academic activities. These attributes are associated with massive government funding and extensive networking activities. Most related studies also highlight the regionalized nature of HEIs' socioeconomic impact. Entrepreneurial universities, therefore, have a disproportionately greater impact on regional development than their non-entrepreneurial counterparts.

6.1.6 Collaboration Projects

The role of universities in regional development is not always clear. For instance, some universities have established satellite institutes to reach out to local industries and support technology transfer. Other universities have cultivated entrepreneurial ecosystems that leverage the complementary knowledge resources of universities and local SMEs. In this way, the impact of universities on regional development may be greater than originally thought. Here are a few of the key challenges associated with the role of universities in regional development.

The challenges of aligning the goals of higher education with regional initiatives are significant. In many cases, a good policy will recognize the diversity of regional development and cut the imbalance between regional institutions and universities as primary actors. In the case of universities, a good regional engagement policy will address these challenges, as well as recognize the importance of local and regional diversity. Overall, this will result in a more positive impact on regional development.

6.2 Recommendations

Why should universities participate in innovation activities? To help entrepreneurs leverage university assets, universities should focus on cultivating talent pipelines, developing innovation environments, and developing organisational culture. In short, they should build meaningful relationships with businesses. And as a bonus, they can drive the local innovation ecosystem. This article explores some of these key elements. It will be interesting to see how each university approaches these challenges.

6.2.1 Developing Collaboration with Business

Companies often realize the value of external R&D and recognize the value of working with universities to tap into diverse pools of talent. University collaborations also save companies money in the form of reduced R&D costs and access to an international talent pool. However, most company-university collaborations are piecemeal, driven by individual initiatives and not by corporate strategy. This leads to duplication of effort,

missed opportunities, and disputes over intellectual property. One crucial factor in successful industry-university collaboration is the level of trust between the two Organisations. A lack of trust can inhibit the flow of information and divert focus from the original goal. To improve collaboration, both institutions should spend time developing mutual trust. Some ways to build trust include sharing previous experiences and histories of working together, taking on smaller projects, and establishing similar operating styles. In addition, companies and universities should engage in innovation activities that involve the entire company and the university.

Another factor that influences collaborations is the environment. This is the governmental support and network, as well as the market environment. Public funding, tax incentives, and regional support structures can enhance or detract from collaborations. Similarly, universities benefit from additional funding, access to industry equipment, and licensing income. The bottom line is that companies and universities benefit from each other's research. In short, collaboration between universities and businesses will create more jobs and higher value for society. The differences between the two Organisations' backgrounds are the primary obstacles to collaboration. University bureaucracy and structure are not compatible with the flat hierarchy of company management. The lack of administrative support, the difference in decision-making, and the cultural differences between the two Organisations can hinder successful collaborations. In some cases, the collaborations may not be as successful as expected.

6.2.2 Co-Creation with Stakeholders and Communities for Sustainability

University lecturers and students should be engaged in collaboration with external stakeholders to address the pressing problems of our time. The transition from a developed to a sustainable society will largely be a process of decentralisation. Individual communities and regions will be able to contribute to the transition to a sustainable society, through technological innovations and entrepreneurialism. But these efforts must be coupled with meaningful collaboration with external actors, in order to make them successful. Sustainable human development has long been an issue for scholars. It has become an open problem for the world, as increasing inequality and lack of sustainability impede progress. Social innovation is essential to finding solutions to these problems and is one way to do this. For this reason, the Sustainable Development Goals (SDGs) were developed to address the challenges of sustainability and inequality.

The first "deep transition" ushered in a science-based and industrialized society, but we must make a similar transformation now to overcome the challenges of sustainability and inequality.

In addition to participating in such innovation activities, universities should consider developing socially committed innovations. This practice can help the region overcome collective challenges, legitimize research, and show that innovation is endogenous. The social commitment to innovation processes also helps in defeating voluntary underdevelopment. Lastly, this type of innovation creates new possibilities for inclusion and sustainability. There are numerous examples of inclusive innovation that are based on social commitment and a partnership between academia and local actors.

6.2.3 Impact Indicators Should Be Verified in a Several-Year Perspective

When participating in innovation activities, impact indicators should be verified in several-year time frames. They should be based on the ultimate outcomes and not just the short-term outputs of the activities. The timescale for evaluating impact depends on the objectives and the scope of the activities. Short-term goals can be measured in months while long-term goals may take years. The impact indicators should be verified on a consistent time scale with flexibility for some outcomes.

The production of impact indicators is a crucial step in innovation and should be checked in a multiple-year time frame. Indicators are based on expert judgement. While some indicators are analytically proximate, it is important to check their several-year perspective. The most accurate indicators are those that indicate a change after a given period. In addition, disruptive innovation can take a long time to implement.

The panel has identified eight issues to monitor for the impact of STI on the economy. These include issues relating to the development of human capital, institutions and networks, regulation, subnational STI activities, and the future of STI. The authors also recommend monitoring and benchmarking of STI indicators in several-year time frames. The results of STI indicators are useful for policy makers and those interested in developing innovation.

6.2.4 Strategic Orientation Towards Social Innovation Within Universities

The strategic orientation towards social innovation within universities requires the implementation of innovative methods and practices. Universities should focus on their staff members, who may benefit from a programme that integrates social innovation with

the current work culture. These programmes could include the development of on-site nurseries or task-based work systems, and financial incentives for researchers, such as preferential loans, scholarships, subsistence allowances, and other benefits. The growing need for a flexible work-life balance is particularly important in the face of an aging population with increasing demands for childcare and caregiving. The strategic orientation towards social innovation within universities is becoming more important than ever, as the academic environment is increasingly complex and global. Rapid technological progress and global challenges have raised expectations for universities, which have increased their role in society. Global challenges require trans-disciplinary approaches and a high degree of engagement of social capital. Strategic orientation towards social innovation within universities requires a balance between local contexts and global issues. Universities have a key role to play in shaping economic and social development, but the specific role they play depends on their size.

However, the strategic orientation towards social innovation within universities still faces challenges. Universities must balance conflicting expectations of different stakeholders and develop a framework for action that addresses these conflicts while protecting autonomy and scientific excellence. The authors highlight several examples of successful social innovation projects and argue that the university structure is a significant barrier to developing innovation.

6.2.5 Innovation-Driven Regional Growth

The entrepreneurial university performs an essential role in facilitating the advancement of innovation-led regional growth within a given region. These universities cultivate an environment suitable to entrepreneurship, offer advice and services that are in line with the requirements of the business sector, and establish regional networks to promote innovation. Moreover, these initiatives boost the advancement of knowledge-based societies and contribute to the development of provinces. However, these advantages are not necessarily accompanied by a higher cost but also imperative for these institutions to effectively manage and harmonize the diverse interests of students, staff, and the community's economy. The regional growth resulting from the university model, which is driven by innovation, has distinct characteristics compared to conventional techniques. The initial stage involves the identification of the significant difficulties faced by the region.

Several factors can influence the contribution of a university to regional innovation networks. Firstly, academics from a world-class university may contribute to these networks if they are in the right region. This is dependent on the geography of the R&D in partner industries and the motivation of individual academics. Additionally, universities should be located near the regional innovation network, where they can support entrepreneurship. The University of Lincoln, for example, has moved from a knowledge-sharing approach to a more entrepreneurial model in its engagement with its partner industries.

Entrepreneurial universities have also been shown to enhance innovation-driven regional growth. Entrepreneurial universities can develop smart specialization strategies and deliver innovative ideas and models from their prototype regions. As a result, universities can facilitate regional innovation systems and encourage a high-performance entrepreneurial environment. Therefore, innovation-driven regional growth from universities is an important part of economic development. There are many benefits to using the entrepreneurial mindset of universities.

6.2.6 Students' Need to be Creative Thinkers

Creativity is essential to innovation, and universities play a vital role in encouraging creative thinking among their students. Developing creative thinking among students can lead to meaningful innovations with significant societal benefits that address complex challenges through novel solutions and perspectives. Creative thinking thrives best in environments which develop curiosity; universities should offer their students space to question, explore and seek unconventional answers without feeling restricted in doing so - encouraging curiosity helps spark the imagination, which lays a solid foundation for innovative thought processes. Creative thinking involves breaking out of traditional confines and exploring uncharted territories. Universities should create spaces that encourage their students to challenge existing norms, question assumptions and think beyond traditional disciplines. Interdisciplinary programs and collaborative initiatives can play a crucial role in helping develop this kind of innovative mindset.

Universities play a pivotal role in cultivating creative thinking by emphasizing that intelligence and creativity can be developed with effort and persistence. When students believe their abilities can expand with dedication and hard work, they're more likely to embrace challenges creatively to overcome them. Creative thinking thrives when exposed to diverse learning experiences such as various teaching methods, interactive

projects, real world applications and culture immersion; diversity enhances perspectives while stimulating innovation. Creative thinking involves taking risks, which invariably involve failure. Universities should develop an environment in which failure is seen as an invaluable learning opportunity rather than as a setback; encouraging students to view it this way builds resilience and promotes experimentation, key ingredients of creative thinking. Finally, creativity thrives best through teamwork, interdisciplinary collaboration, and communication skills training; when diverse backgrounds meet one another to share unique perspectives that fuel creativity leading to innovative solutions.

Summary

The chapter discusses why universities should be involved in innovation activities and provides recommendations to achieve this goal. Universities must prioritize societal impact, engage in a broad ecosystem of research, and create transparent reward systems for researchers. Developing a culture of entrepreneurship is essential, involving risk-taking, result orientation, and team collaboration. Universities should also develop partnerships with leading companies, developing open innovation, and enhancing regional innovation ecosystems. Social innovation aimed at university staff can create a collaborative environment, encouraging intrapreneurship and community involvement. The chapter suggests rethinking traditional methods and adopting disruptive innovation to improve higher education. The entrepreneurial university mindset is crucial for regional development, leveraging knowledge spillover and establishing regional networks. Collaboration projects and co-creation with stakeholders for sustainability are emphasized. The chapter concludes with recommendations for verifying impact indicators over several years and developing creative thinking among students to drive meaningful innovations. Overall, the findings highlight the dynamic role of universities in regional development, innovation, and societal transformation, advancing the Triple Helix Model by integrating technical advancements with strategic regulatory and policy frameworks.

Study Limitations

This study has some limitations that need to be acknowledged such as:

- The study's focus on specific case studies, such as the University of Applied Sciences Utrecht and Birmingham City University, may limit the generalizability

of the findings to other contexts or institutions with different socio-economic and cultural settings (Etzkowitz & Leydesdorff, 2000; Cai, Ma, & Chen, 2020).

- The study's cross-sectional nature restricts the ability to observe long-term impacts and trends in innovation and collaboration activities. Longitudinal studies could provide a more comprehensive understanding of how these activities evolve over time (O'Kane et al., 2020).
- The research primarily considers the perspectives of academic staff and students, potentially overlooking the viewpoints of industry partners and policymakers, which are crucial for a holistic understanding of the innovation ecosystem (Etzkowitz & Leydesdorff, 2000; Cai, Ma, & Chen, 2020).
- The rapidly changing landscape of technology and innovation means that some findings may become outdated quickly, requiring ongoing research to keep pace with new developments and emerging trends (Bernard, 2017; Saunders, Lewis, & Thornhill, 2019).

These limitations suggest areas for future research to build upon and address the gaps identified in this study.

Future Research

In future research in the field of university-industry-government collaboration, several significant gaps identified in the literature should be addressed. For example, one prominent area requiring further exploration is the development of a unified theoretical framework and clear definitions for the term "entrepreneurial university." Current studies use this term variably, leading to inconsistencies in understanding its implications. So that we can grasp their roles and impacts more clearly, what is sorely needed is a comprehensive framework that integrates the various perspectives on entrepreneurial universities cultivating entrepreneurial minds and endeavours, with emphasis on technology transfer and commercialization.

To further elaborate is the fact that there is a great need for quantitative analysis in this field. Although qualitative case studies abound widely, robust measuring tools and methodologies to evaluate systematically the contributions of universities towards regional economic growth, social inclusion, and environmental sustainability remain a gap in research. Setting up a system for such an assessment is essential for all levels of government to implement policies for universities and research workers to follow suit.

Another emerging area for future research is sustainable innovation in the context of entrepreneurial universities. Existing studies often ignore the environmental and social dimensions of innovation, instead concentrating heavily on traditional scores such as the number of patents or spin-offs. It is necessary to align research with the larger goal of sustainable development Through longitudinal research that follows the development of entrepreneurial universities and their regional impact over a period, we will be able to understand more comprehensively what is happening now. Most current research only provides a snapshot, and longitudinal studies could reveal insights into the long-term effects and even sustainability of these institutions' enterprise activities as well as the regular give-and-take between universities and their regional economic environments.

Finally, more extensive research is required into the role of policy and institutional support in nurturing entrepreneurial universities. What specific policies, funding mechanisms, regulatory environments, and university governance structures help bring about sustainable innovation? How effective are they? What is their efficacy?

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Publications Related to This Research

Winner of the ICEIRD 2017 Best Paper Award

Living Labs (LILA): A Community Driven Approach to Technology Transfer and Internationalising Entrepreneurship.

Asim Majeed, Rehan Bhana, Hanifa Shah, Anwar Ul Haq, Rebecca Goode, Steve Adigbo

Abstract

The collaboration between cross-border networks for technology diffusion has embraced innovation, which includes systematic, dynamic and strategic processes of the product development. Although a similar concept was embraced by various private and public organisations (e.g. google glasses) to produce real value and sustainable products from their investments; they have struggled to do that. A response to this is the concept of Living Labs (LILA) as an open real staged environment for experiments and developing innovative products in collaboration with community users. The participation of university campuses as living labs in these projects gives high importance in relation to innovation capabilities and long-term investment plans. This research explores an understanding of living labs as an arena for innovation based on collaborative networks and user-centric project development methods. Project initiations in open based environments, supporting cross-border collaborations, accelerates the acceptance and development of innovations internationally since it has the potential to meeting the needs of users from diverse cultural backgrounds. Researchers of BlindX Ltd. at Birmingham City University (BCU) generated an idea of designing and building a cane with facial recognition, GPS navigation and obstacle detecting sensors up to 10 metres distance in the environment. This cane would help blind and visually impaired people in their day-to-day life. This innovative project which will be used as a case-study to review and evaluate our approach. It was accomplished at the BCU campus through the use of a living lab where students, computer scientists, researchers, local community representatives and electronics engineers collaboratively participated. During the compilation phase of this project, we learned that there is a need for thorough understanding of actors, each stakeholder's objectives, opens and collaborative culture establishment, operational processes of technology transfer when adapting the living labs development approach for internationalisation the entrepreneurship.

Keywords: Community, Technology Transfer, Internationalising, Entrepreneurship.

Introduction

The concept of cross-border technology transfer is embryonic and entails a variety of views (Smith et al., 2015). The study carried out by Dechezleprêtre et al., (2008) classified the innovation process as being of three type: bottom-up innovation, user-led innovation and living labs. The industry has put considerable effort into reducing the gap

of technology transfer and refining the services and products by taking account of user's perspective. The central theme of various research forums is focused on integrating the real needs of a community with the research and development which would help directly with solving the issues and social demands through real world experiments (Jerzmanowski, 2008). The modernisation of product systems, enhancements to public services, urban renewables and healthcare transformations are amongst current societal challenges. Technological innovations adoption can address these challenges through open and systematic innovation in a broader context (Bruton, 2008; Draca, 2013; Stua, 2013). Systematic innovation ranges from, interrelated technologies, through organisational adoptions of legal and financial aspects to community involvement from human practices and behaviours. It is often very difficult to accomplish innovation and change in complex systems due to competing interests and priorities of the actors involved. The identification of interventions, causes, dependencies and interactions are quite difficult to discover in hyper-complex innovative systems (Wielemaker & Gedajlovic, 2011). Therefore, understanding and addressing the requirements of community users, systematic nature of cross-border interventions in complex systems development leading to change and innovation is particularly important.

Systematic innovation through cross-border collaborative innovative networks is being developed to deliver the "XploR" smart cane project. Different roles and responsibilities were assigned to all living labs participating in this project because a phased approach is required to develop such networks addressing both operational and strategic issues are shared and resolved with a common vision. The smart cane is designed for the blind and visually impaired, so when developing the cross-border collaborative platform to develop this project, the ecosystem was built with great care and to ensure none of the requirements or details are missing. The collaborative agreement was defined among three living labs which include contractual agreements, business proposition, intellectual property rights and business model. As this project was funded by Interreg IVB North West Europe (NWE), the initial phase of technology transfer was piloted amongst partner located in England, France and Luxemburg, so there were no restrictions if any partner living labs chose to drop-out at any stage of the co-innovation. In general, it is always better to take precautionary measures to avoid participants exiting from any phase of the project.

To avoid any delays in the project completion, all roles and responsibilities were allocated to all participant living labs. It was also discussed and encouraged to one contact point for each living lab, to reduce the existence of conflicts at a later stage. Each living lab is held responsible for possessing required skills, competencies and expertise to develop this project. Before this networked project was initiated, all stakeholders supported the business case to avoid potential difficulties in the future. The goal, objective, outcome and time frame were discussed and expectations were clearly defined. In the case of the development life cycle of "XploR" project, opportunities were disseminated to all stakeholders to support advance the product and target clear business opportunities after the project ends. Adequate project management and planning was ensured through a cross-border collaborative online platform as complex infrastructure. The communication tools and collaborative workspaces were intended to facilitate the commitment, interaction and intra-communication. Through the

development of the “XploR” project it was established that the same technology could not be diffused to France and Luxemburg, requiring different options for them; additionally, legal, cultural, social, and organizational issues may hinder the adoption of a technology solution in a different context than originally envisaged.

Systemic Innovation for Internationalising Entrepreneurship

The spectrum of innovation activities is consistently growing; motivating the innovative cycles for reshaping products and services, leading management through internationalising entrepreneurship (Webster, 2004). The ongoing competition and globalisation forces have backed a systematic approach to innovations, connecting trends of global markets and networked-based philosophy for economic and societal developments (Moon, 2008). These developments and networks lead to innovative ecosystems with a range of collaborations, exchange of ideas, skills and interactions. Actors sharing their competencies, resources and facilities practice innovation and further their presence in the ecosystem (Finley, 2007). Innovative ecosystems are governed by open business models, which amplify the complex nature of technology transfer and internationalisation process. There is a need for catalysers of systematic change to show off the systematic nature of innovations reflected through the instruments of smart innovations (Foray, 2009). Within this context, the concept of living labs offers user-centric, open and real environments to accomplish the innovation. Collaborative innovation is offered in living labs for experimentations, research, development and product innovations using specific tools (modelling) and methodologies (SDLC and Prototyping) through collaborative platforms (Dechezleprêtre et al., 2008). These projects based in real life user-centric environments help community building through innovative ideas and product developments and their disseminations (Abdel, 2011).

The prime focus of living labs is to operate within the market, maturing developed services and technologies for the betterment of the community; consequently raising the acceptance of integration of community-driven development approaches (Abdel, 2011). Various initiatives have been taken through the concept of living labs during the last half decade and the real life methodologies are demonstrated, experimented and developed in a series of European Commission Framework Programmes. The European Network of Living Labs (ENoLL) has further institutionalised the concept and by 2015 noted 388 labs operating in the whole world for community development projects (Wendin et al., 2015). Although the concept of living labs has gradually been maturing and has generated valuable products through conceptual and methodical streams of ideas; it still requires more empirical tests on its effectiveness, impact and methodologies to understand the cross-border requirements (Van et al., 2007). The role of innovation network catalyser is required to be fulfilled by the methods, practices and processes by demonstrating a specialised and professional outlook. The articulation of proposed product valuation requires strong integration with the innovation ecosystems in living labs (Buckley & Casson, 2009; Tawney et al., 2013). The living lab project “XploR” demonstrates the requirement of strong collaboration of innovation networks through systematic innovation paradigm. The development of project “XploR” has also shed light on how systematic innovation could effectively accelerate the internationalising of entrepreneurship.

Cross-disciplinary systematic innovations cannot be produced by autonomous activities of a single organisation due to the various demands of users' needs and its use in diverse cultures (Arora, 2002). The collaborative platform for cross-culture product development requires a systematic overview of users' needs, demands, experimentation with their help and keeping them involved in the development life cycle (Cockurn, 2007; Ståhlbröst et al., 2015). The open collaboration networks are driven by the innovation processes enabling stakeholders to share risks, resources by strategic pooling and leveraging the competitive positions of the product in the market. Industry partners contribute to the process of internationalising entrepreneurship through the involvement of enterprises and entrepreneurs (Foray, 2009). Previously project development through living labs has tended to neglect to manage, designing and steering processes for cross-culture needs and shown less focus on understanding cross-cultural project needs of internationalising entrepreneurship (Haites et al., 2006). Modern living labs have defined detailed processes for collaborating in the networks for co-innovation in the form of intellectual property management, agreement definition, negotiation on product features and partner selection (Xie and Zhang, 2015). There is growing evidence of a need for a framework for living labs to identify the tools, methods and processes when orchestrating the role of living labs in cross-culture product developments.

Innovation Networks and Systemic Change

Project initiation and catalysing change should be considered as a backbone when systematic innovation is considered within open innovation networks. Living lab methodologies are supported by transition management, which helps resolve complex issues through catalysing change and focusing on sustainable solutions for societal problems (Comin, 2008; Xie and Zhang, 2015). The concept of transition management is based on the pillars of transition arena, regime and niche notions. The idea of "niche" is very similar to the concept of disruptive innovation where new innovations incubate and learning takes place (Manuelli & Ananth, 2003). The emergence of dominant policies, rules and business structures through the continuous growth "of niche" could be classified as a regime. The third factor of transition management is the "transition arena" which constitutes the identification of large-scale system change strategies and conditions. As a comparative analysis of living labs and transition management, the methodologies and processes involved in living labs are more user-centric with settings of the most open-innovative mode of play (Athreye & Cantwell, 2007). Consequently, a valuable framework is provided that is suitable for action research paradigms through living labs.

Transition management helps create a dialogue between end-users, developers and stakeholders to shape the practical implementation of the project (Correa, 2007). Within this context, partnerships and innovation communities are created in the living labs development life cycle enabling practice and strategic dialogues between the involved stakeholders which are called "transition arenas" (Wielemaker & Gedajlovic, 2011; Lewis, 2013; Ståhlbröst et al., 2015). The dialogues effectively catalyse the systematic innovation and form the basis of institutional change. Different conceptual frameworks and numerous theoretical approaches regarding service innovation have been studied and not only been failed to adapt the product change adequately in the ecosystem but also in recognising the importance of existing organisational environments (Yiu, 2007).

The neutrality and impartialness of the existing living lab environment are focused on this research along with the change and dynamism of the demands and needs of cross-cultural users. There should be appropriate adjustments in arrangements of processes, user-centric product logics, values within the regimes of socio-technical systematic innovations (Watts & Peter, 2007). The interdependencies and characteristics of ecosystems are considered through a living lab approach along with resolving the technology adoption sources of resistance and potential barriers.

Birmingham City University (BCU) Campus: Living Lab as Innovation Catalyst

The formation of living labs as an innovation catalyst is important requiring an understanding and recognition of the systematic character of innovation, which involves stages of adapting the collaborative network, tools, methods and processes for the product development (Correa, 2007; Lewis, 2013). The organisational inertia is overcome by community building-based transition arenas reflecting living labs acting as open-innovation cycle. The stakeholders have access to user-driven innovations, product trials and competencies through the comprehensive platforms of living labs. The focus of living labs is quite dynamic entailing, user-acceptance, integrating to prevailing systems, investing in services and infrastructure to producing mature technologies; but pilot outcomes are intangible and less predictable.

University campuses are the best way of forming the open real living labs for innovating new technologies. For this purpose, various students, researchers, engineers and lecturers brought an idea to design and prototype a cane “XploR” for the blind and visually impaired. The idea had many potential features (e.g.; facial recognition, GPS navigation and obstacle detection from the 10-meter distance, and 5 different pulses of haptic touch) to be integrated within one cane. Birmingham City University (BCU) used its living lab, where end-users, researchers, developers and lecturers all collaborate to evaluate and progress the development of the project. As part of the Interreg NWE Living Lab Application (LILA) project, the team had various discussions and trials with a diverse range of users and conflicting demands on internationalisation of entrepreneurship when discussed with France and Luxemburg. Birmingham City University living lab partners in Luxembourg mentioned that their users did not find the facial recognition feature particularly useful for them but they emphasised the importance of scanning the obstacle from 10 metres. Whereas when working alongside the France living lab, they emphasised facial recognition features more rather than the Global Positioning Support (GPS) navigation that was the preferred function emphasised by England users. During the life cycle of this project, it was realised that there should have been a discussion on this project with all the partners, stakeholders and end user’s experience, in order to form the basis of internationalising the entrepreneurship. The development of “the project through the living labs supports business model innovation, user-behaviour transformation and crowdsourcing. The simulating business models are created through living labs environments penetrating in real-life and low-risk markets. The “XploR” cane project also identified the need for defining the roles and relationships between all the stakeholders yielding a more competence development eliminating the cultural barriers as well smoothing the internationalisation of entrepreneurship process. The development of XploR in the BCU campus (Living Lab) is amplified as catalyst and has broadened industrial and societal transformations.

Technology Transfer through Networks of Living Labs (BCU, France and Luxemburg)

Technology transfer has been the integral challenge of the "XploR" project where different users from different domains have diverse demands; consequently, wide range of issues emerges when internationalising entrepreneurship through market creation. LILA enables and establishes living labs in cross-border collaboration this is very important when the product development is themed for various parts of the world, so to be aware of the options to be made available in the product when launching. The diffusion of new technology within the same country is different than developing a product which satisfies the cross-border user's requirements. The aspects are not limited to regulatory settings but also entail cultural, contextual factors including service and product innovation. During the phase of cross-border collaboration for "XploR", we decided to define the storylines so to identify the collaboration needs, planning, setting up and maturing needs of the users.

The network development process of living labs starts with the emergence of the international opportunities for an entrepreneur, business and organisations to contact living labs. The living lab establishes the collaborative relationship with cross-border living labs and foreign partners. The next step is the setup of collaboration agreements which are the arrangements for defining the market development and product innovation. The implementation and management of collaborative networking project take place before the final phase of conclusion. In regards to technology transfer and co-innovation development, the following phases are identified as the core for collaboration e.g.; analysing, connecting, planning, support and testing. Table 1 represents the five dimensions of a framework model for cross-border collaboration issues.

Table 1: Framework of Cross-Border Collaboration Issues

Analysing	• **Finding the gap in the market.** • **How it would help the users?** • **What barriers are there?**
Planning	Finalizing the contracts and agreements, planning and building a network and defining responsibilities and roles. • Business model design • Organisation of cross border living lab planning and development process • Contracting frameworks and partnership structuring • Elaboration of the common plan • Defining roles and responsibilities • Details of processes, procedures and planning • Methods or tools used for collaborating (e.g.; shared workspace, etc.)
Connecting	Identifying collaborative innovation opportunities, market development and potential market and partners selection.

	• Potential partners finding and their requirements • Agreement on approaches and common goals • Principles of intellectual-property • Negotiation support and dialogue building • Collaboration procedures • Tools for communication among cross-networks
Support	Conducting collaborative testing, innovation, and market-development activities. • Structuring living labs operations • Governance models • Support for collaboration in the network • Defining the project management and co-ordination tools • Co-ordination among cross-border living labs during support phase (e.g.; web conferencing etc.)
Testing	The product should be tested through pilot testing to ensure it has transferred the technology through internationalizing the entrepreneurship. • Facial recognition is required in France product model. • 5-zones obstacle detection is required in Luxemburg product model.

Adapted from: Schaffers and Turkama, (2012)

The framework presented by Schaffers and Turkama, (2012) depicted three dimensions of the project internationalising phase such as; connecting, planning and support. This model does lack an analysis phase in which it is required to understand the existing market requirements, look through the demand curve, as well as the viability of the product. Their model also lacked a testing phase, where it could confirm that the designed and built product has matured the users' needs failing which it needs to come back for re-development (Ståhlbröst, 2015). Similarly, the "XploR" project requires the understanding of the needs of the collaboration of various stakeholders involved and then developing a process to design, build, develop, evaluate and adopt the technology as per the users requirements. The focus of the "XploR" project is to experiment with the new innovative product and diffuse the technology in real life. Since the smart cane idea was generated by Birmingham City University students and this project was initiated, there was a need for close interaction with the real-life users so to validate the technology transfer and rules presented in Table1 were backed to form the co-innovation. The collaboration for market creation and technology transfer has witnessed wide range of issues form and execute the innovative projects.

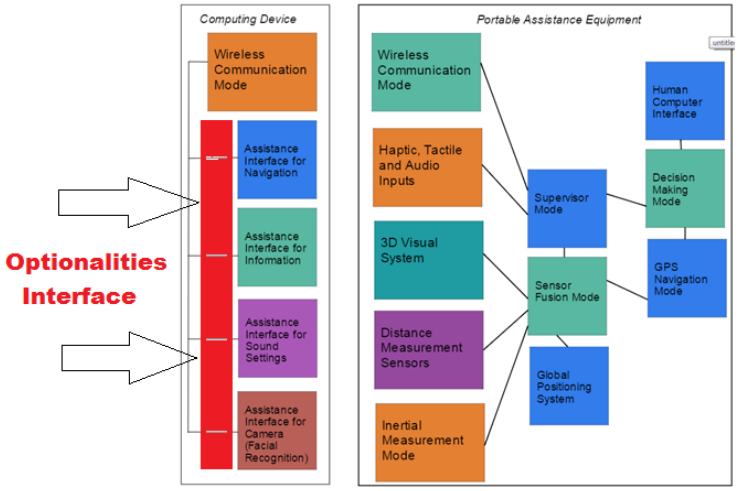
"XploR" Project: A Proposed Systematic Innovation Framework

While the "XploR" smart cane has embedded features of GPS navigation system in it for aiding the user's mobility, it this has raised many questions from a user's perspectives. The questions range from the adoption of this technology to appropriate route selection, obstacle detection and avoidance of objects. The adoption of this technology raised

questions when it was introduced in France and Luxemburg to see the potential of internationalising the product. During the internationalising phase of “XploR” in France, the users were more interested in the facial recognition system but less interested in 10-meter distance recognition with the haptic touch. Whereas in Luxemburg, users were less interested in facial recognition and seem more interested in 10-meter obstacle detection and the haptic touch. The designed technology requires more advancement and has to stay in the development phase since all stakeholders could see the full potential of this product as per their needs and requirements. Although the “XploR” cane assists users in navigating through a GPS navigation system and facial recognition through assistive technology in normal as well as unusual situations, the users involved in the internationalising entrepreneurship evaluation have their particular needs to be met. The traditional tools used for navigation in the past have been enhanced with the embedding of ultrasonic sensors and signal processing capabilities. The proposed framework depicts the sense of any emergency and uncertain situation to the user as appropriate. The integrated monitoring system within the cane ensures that the user would reach their destination with the re-routing capabilities of module path. The human-computer interface attached to this cane helps blind and visually impaired people in their everyday lives.

A model is presented in Figure 1, used to base the “XploR” project.

Figure 1: The Proposed System Block Diagram.



Adapted From: Assistive Technologies for Visually Impaired People (Liu et al., 2011)

The proposed model in Figure1 elaborates the combined working of various modes together through the communication mode. This device has embedded different modes such as Assistive Interface for Navigation, Assistance Interface for Information, Assistance Interface for Sound Settings and Interface for Facial Recognition. All these modes are specialised in their respective controls and assistances for the users. The interface for facial recognition would recognise the family and friends faces and check those pictures through the stored database in the smart cane. As soon as it matches any records, the assistance interface for sounds would be activated and those details would be informed to the user through the Bluetooth earpieces. The navigation interface

would help the user in navigating their journey's along with the re-routing capabilities if the cane detects any obstacle on its way.

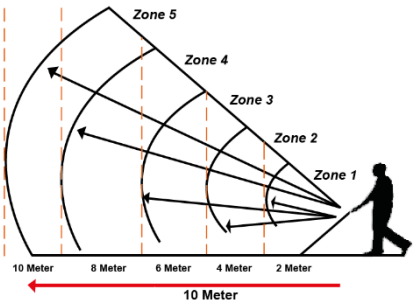
An extra layer of "Optionalities Interface" has been proposed in this model to meet the demands of internationalising entrepreneurship. The demand outcome from France was highly in the favour of using facial recognition in contrast to Luxemburg users. The embedded interface would have the options to facilitate the user to use or nor use the camera. Similarly, if the users in Luxemburg, have demanded 4-meter obstacle detection instead of 10-meter, it could be changed from the interface. This interface of technology is designed with a view to internationalise this product throughout the world eliminating the technology adoption barriers. Along with this new interface layer, the movement sensors are used within the GPS navigation system which helps to locate and tracking the trajectory of the user. The smart cane would help in locating the actual position of the user but there may be a little error in the distance measurement due to the low frame rate sampling of the sensors. To produce the better results, the magnetic compasses are used within accelerometers and gyroscopes. This integration would also help to reduce the errors in locating the user's exact place. The smart cane would not only be beneficial for the outdoor journeys but also be useful for the indoor movements. The complex computational processes are required since this cane is made up of various types of sensors. The sensor fusion module is responsible for the cross collaboration and communication among other sensors and interfaces of the cane. The Kalman Filer has been embedded in the smart cane to resolve noise, distance measurements and assistive technology issues in "XploR".

Proposed System Design

The current research aims to design and build a new smart cane with the features of facial recognition, obstacle detection from 10-meter, haptic touch and GPS navigation. Although there have been many canes available in the world but none of them has the above-mentioned features in them. The sensing capability of the cane of up to 10-meter was divided into 5 zones leveraging different pulses. Each zone would facilitate the obstacle detection through the Mowat sensor motor and Nottingham Obstacle Detector (NOD) to sense the objects and alert the user. The "XploR" smart cane is one of its own kind and a new innovation for the visually impaired and blind people in navigating their day to day lives.

The proposed structure is presented through Figure. 3.

Figure 2: Detection Zone and Angular Coverage



Adapted From: "Xplor" Cane Assisted Mobility for the Visually Impaired (Sakhardande et al., 2012)

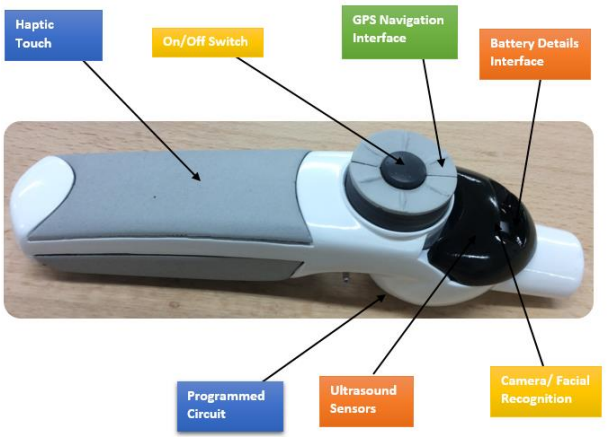
This initiative included participation by students, lecturers, electronics engineers and community users at Birmingham City University Campus (BCU). During the discussions held with partners (France, Luxemburg) to internationalise entrepreneurship this co-innovative product, different requirements from them came on the scene. The partners in France mentioned that the survey was conducted in regards to this new technology adoption, it came to attention that facial recognition feature is highly liked by the blind and visually impaired people living there, but they did not like the 5-zone sensing capabilities. And when Luxemburg partners communicated the same pilot test with their users, the outcome suggested the use of facial recognition was highly liked, whereas 5-zones obstacle detection was not highly liked by their users. Since the project is in the experimentation phase of technology transfer, so there has to be the embedding of features, which are important to internationalizing the concept.

Sustainable Product: "XploR" Smart Cane

The designing and development of new technologies does not solely reflect sustainable innovation but considers minimising the negative impacts on the economy, social and environment collectively. The economic growth necessitates product innovation as an integral part of the sustainable product. Competitive advantage is achieved through sustainability and successful innovation that has informed the methodology of the "XploR" project. The different levels of innovations are engaged in developing as well as developed countries to enhance strategic growth, so "XploR" has been designed with a wide range of functionalities those could be applied and tailored to improve the system, services, efficiency and social qualities of products. The "XploR" project has encompassed the approaches of radical and incremental innovation targeting development of new a product enhancing the existing canes patterns and features. A complete re-thinking approach has been applied for "XploR" development keeping in view the user's needs. The "XploR" cane is designed to create a successful solution not only for the developed countries but also for the developing countries with the help of local communities.

The working and features of "XploR" is elaborated through various parts of this paper. This sustainable product is designed having multiple features of facial recognition, haptic touch, sensing capabilities and GPS navigations. A usability interface "Options Interface" has been added to the design to ensure meeting the requirements of international market demands regardless of the facts, they want to use some features or not. The users would have the options to choose from. A detachable handle is used to make the cane length adjustable. This device runs on rechargeable batteries eliminating the inconvenience caused for visually impaired and blind people to open battery pack and change them.

Figure 3: “XploR” Cane (Real Design)



Source: Living Labs (LILA) & BCU Project (2015)

The cane developed in the “XploR” project is designed and developed with a pair of receivers for both the ears. The Ultrasonic sensor will sense the environment, the camera will take the pictures of people within the 10-meters radius and scan through the database for recognition purposes, haptic touch would alter the user through the various set of vibrations and embedded GPS would navigate the users within that environment to determine the obstacles and their ways. The crux of the whole concept to design “XploR” was to help blind in their day-to-day mobility using navigation through instructions using pathfinder system. The cane determines the presence of the object through Nottingham Obstacle Detector (NOD), measuring the distance and inform the user through Bluetooth and haptic touch.

Assistive technologies are developed in various countries but still remain unreachable by the blind and visually impaired due to the cost of high-tech, the lacking of digital navigation support and detection features and the fundamental essence of the physical cane being the fall-back mechanism for the user. The navigation support and facial recognition have always been a challenging problem for blind people along with finding the precise location of the obstacle. The already developed assistive technologies (e.g.; EyeCane, White-Cane...etc) did not have facial recognition features as well as no ability to sense the external environment through the auditory stimuli.

Conclusion

In a real world, the development of new products is always a challenge due to bringing new and useful products in the market. Development of new products is classed as the transformation of a market opportunity keeping in view the needs of customers. It is also important to know the competitive environment success factors of newly developed products. Quality, time, cost and usability are the main variables that drive the needs of the market and ultimately customers. Aimed at these three variables, companies develop continuous practices and strategies to better satisfy the customer requirements and increase their market share by a regular development of new products. Modern organisations achieve this through collaboration. Similarly, the concept of living labs is comprised of collaborative innovative networks to accelerate systematic innovation. In “XploR”, the living labs have acted as catalysers and initiators of systematic innovation

due to the diversified nature of user's requirements. The concept of this innovation was thoroughly analysed, discussed, planned and implemented with the co-operation of living labs in France and Luxemburg. The technology was devised with facial recognition, GPS navigation and 5-zone obstacle detection features. Due to the requirements of users in France, they wanted to have the facial recognition system and on the other side, they disliked the idea of 5-zones obstacle detection. The "XploR" is designed and developed through a systematic innovation embedding a new layer of "Optionalities Interface". It would lead to satisfying the cross-cultural and cross-border conflicts on using this product. The systematic innovation of "XploR" while assigning the responsibilities to various labs has shown the integration of regional innovation ecosystems.

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Living Labs (LILA): An Innovative Paradigm for Community Development: Project of "XploR" Cane for the Blind.

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Mike-Lloyd Williams[5], Andy Till[6]

ABSTRACT

The community development in different domains (business, education, welfare etc.) has been the prime focus over the last decade due to the evolution of digital technologies and the shift in working patterns. However, many public and private investments have failed to produce sustaining and real value from them. The observed deficiencies which are causing the failure of community development projects ranged from initiation within the artificial and closed laboratory to open learning environments. The community development is entailed without understanding the real community needs, community's value chain and potential problems with limited interactions. These shortcomings have resulted in failure to develop effective, prosperous and world class communities leveraging the new innovative and powerful approaches. An approach to developing collaborative systems, called Living Lab (LILA) is discussed in this paper and this approach has empowered and engaged the communities (students, lecturers, computer scientists, electronics engineers, visually impaired and blind people) to experiment and learn the innovative solutions of their real-world problems. The theme of this innovation led approach is to embed community driven solution within the communities.

This paper presents the actual framework for the establishment of a Living Lab using specific case study at Birmingham City University (BCU) along with its impact on community development. This research determines the key features that the visually impaired would find useful in a mobility cane called "XploR". The smart cane incorporates facial recognition technology to alert the user when they are approaching a relative or friend from up to 10 metres away. This is a revolutionary 'smart' cane enabling blind people to instantly identify friends and family. The cane also features GPS functionality to aid navigation. This project is part of LILA, a European initiative encouraging entrepreneurship and fostering internationalisation.

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Keywords: Innovation; Living Labs; Visually Impaired; Facial Recognition; Assistive Technology.

1. INTRODUCTION

The open real environments staged for experimenting, collaborating and knowledge sharing is called Living Labs. The future directions of product developments are revealed through user experiences in Living Labs. The open-innovation model is drawn in many aspects and it gathers the interests of various action based research active industries (Allee, 2008). The original concept of Living Lab became apparent when real-world projects were undertaken by the university students and the intention was to resolve those as part of their studies. The real purpose of concept LILA is to bring up the technological issues at home to the real-life context with the intention of prototyping, refining and validating their solutions (Jackson, 2008). The international interests rose about integrating LILA approach within the community since 2006 when European Commission promoted a project of European innovative system requiring coordination and advancement. The users from the community would be involved by LILA in the process of co-creation of applications, services and developments of new products (Kokkinakos, 2012). The LILA approach believes that furnishing a service or designing a product; the average user from the community is equipped well to do that. Therefore, LILA supports innovations creation and their validations within the real world of collaborative environments through Research and Development methodology.

The themed structure of LILA is to support innovations in all phases of the lifecycle and is based on diverse resources, actors, and activities. According to Welfens et al., (2010) LILA is a virtual reality or physical region partnerships of public-private-people; which are formed by the stakeholders, universities, agencies, firms and agencies collaborating with each other throughout the development lifecycle. The development lifecycle by LILA encompasses creation, prototyping, formation, validation of new products, services and technologies within the context of real life environments, which helps in upscaling and commercialising the innovations rapidly within the global market (Schaffers et al., 2010). This development approach also determines LILA as an open-innovation network offering an innovative platform and research think-tank for various establishments associating the user-driven practices of innovations.

The user-led innovations are highly accredited by the organisations due to having a high commercial value minimising the risks involved when launching a service, technology or a new product (Yu, 2015). LILA's role as a platform for collaborative development brings all stakeholders: end-users of new technologies, developers, public sector agencies and exploiters of services or products. The fundamental theme of open-innovation is based on the self-organising model because all stakeholders work on voluntary collaboration and each player is assigned a specific task in the network (Bowyer et al., 2006). According to Johnsen et al, (2006), the co-creation and innovation in provider-customer relationships could be customer-driven, producer-driven, or in equilibrium due to any actor being more dominant and active in completing the work as compared to another one. This depicts that LILA is an open-innovation network encompassing various actors under one platform working towards the same operation in various capacities.

2. CO-INNOVATION AT BIRMINGHAM CITY UNIVERSITY (BCU)

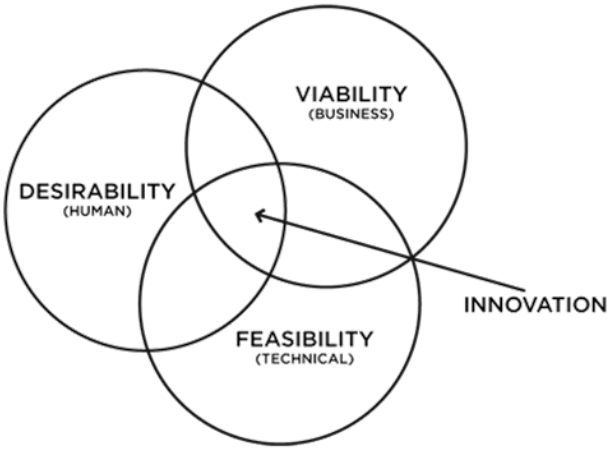
Living Labs is a new way of benefiting from technologies. Modern businesses are using living Labs to take benefits from open innovations of operating business to business or from business to consumers (Lee, 2012). This approach not only shares ideas between the companies but also saves time and cost. Living Labs as an open innovation business model enhances the profit for the company and in the modern era most organisations want to achieve such goals and are battling in this complicated environment to improve business credentials (Jayal et al., 2010). The business models of value co-creation and sustaining multidisciplinary collaboration forms new organisational parody which dresses the need of service driven market and collaborative networked development approach (WHO, 2016). The self-organising, co-creation and innovation model improves the collaboration of various stakeholders and relationships to build better learning orientation. The research conducted by Haraszy et al, (2011) it is strongly suggested that collaboration between computer scientists, clinical experts domain users are required in making the handheld devices using audio sensory channels of haptic and user-friendly nature. The purpose of developing such technology is to show the potential benefits for the visually impaired people.

By involving a targeted group of users in living labs in the early stages of product and service development, the start-up is provided with a reliable overview of a targeted regional market and the local needs associated with it that lead to the validation and adoption of the product or service following user insights and recommendations (Chen & Liu, 2014). This ensures that when a product or service reaches the market that there is a reduced risk of failure both with the acceptance and understanding of the technology and other risks associated with the enterprise (Helal et al., 2001). Start-ups will have gaps in their knowledge and may be lacking in resources to understand what is expected by the target users as well as statistics related to their specific innovation (Calamela et al., 2012). The involvement of both a higher education institution and business innovation centres will enable an entrepreneur to strengthen their innovation capacity within their organisation due to their diverse range of knowledge and networks (Calamela et al., 2012). It is also due to “cross-fertilization and collaboration between different actors” (Calamela et al., 2012).

The Living Labs offers a research platform for experimenting and innovations from industry and market point of view eliminating the borders of cultural systems and different social norms. This approach is considered a good basis for rapid mass customization even with global reach" (Patel & Vij, 2010) and by innovating alongside regional partners and targeted users, risks and rewards are shared (Tiponut et al., 2011).

The model presented by Thøgersen, (2007) depicts three elements of desirability, feasibility and viability behind the startup process of innovation through living labs.

Fig 1: Living Labs (LILA) and Innovation



Source: Thøgersen, (2007)

The difference between co-development and co-innovation topology is clarified by Thøgersen, (2007) pointing the fact that the relationship between customer and supplier is a key. The new methods of innovation by the service delivery procedure have been coined by the participation of the end users. The contributions by end-users are not expected as audiences but as creators, collaborators and dynamic contributors Chen & Liu (2014). Therefore, the suggested that the collaboration of research organisations, users, suppliers have a great impact on the novella tea of innovation and on the other side collaboration with competitors could have an adverse impact on the business. The dynamic interplay centred through the fundamental knowledge between competition and collaboration is considered a highly distinctive tactic, which gathers organisations on the co-innovation approach (Kramp et al., 2010). The clusters of innovations for project-based organisations form collaborative research with other organisations for a common goal (Smit et al., 2011).

Birmingham City University in partnership with Birmingham City Council has been part of European Network of Living Labs (ENoLL). The project was co-innovated at the universities laboratories in collaboration for the sole purpose to design and develop a smart cane for the blind. This concept of helping both the blind and visually impaired was established with funding support from Living Labs Application (LILA) an Interreg NWE project and the lifecycle development of this cane was executed within a living lab at Birmingham City University where various students, researchers, electronics engineer and computer scientists were involved in developing this co-innovation. The development of the cane was initiated and led by user groups feedback consisting stakeholders and individuals with varying level of sight loss to none who were already were introduced the white cane in three regions of North West Europe (NWE).

3. “XploR” PROJECT

Birmingham City University (BCU) in collaboration with LILA has developed “XploR” smart cane based on Assistive Technology focusing on safety, improved quality of life and independence of visually impaired and blind people. The “XploR” cane is embedded with a panic button, GPS navigation system, object avoidance sonar sensor, facial recognition software and a built-in HD camera. The “XploR” cane will carry a

database of names and pictures of friends and family members and as soon as pictures are taken, it will be scanned through the stored database and inform the details to the blind person through a haptic touch as well as audio sensory Bluetooth ear piece. The "XploR" cane will detect the family and friends up to 10 meters away aiming to empower the inclusive and improve the independence of visually impaired and blind people.

According to the statistics published by RNIB, (2015) almost 360,000 people are registered as blind and two million with sight loss. It is also forecasted that this figure would increase to 2,250,000 by 2020 and to four million by 2050.

Table 1: No. of People Registered as Visually Impaired and Blind in UK

	Number Registered	Number Living with sight loss	% By 2020 living with sight loss	Cost of Sight to NHS
England	143,385	1,564,340	3.36%	£2,216,149,038
Wales	7972	98,650	3.75%	£122,643,000
Scotland	18942	156,230	3.43%	£233,526,091
Northern Ireland		46,680	3.05%	

Source: RNIB, (2015)

4. PROPOSED FRAMEWORK FOR "XploR" CANE

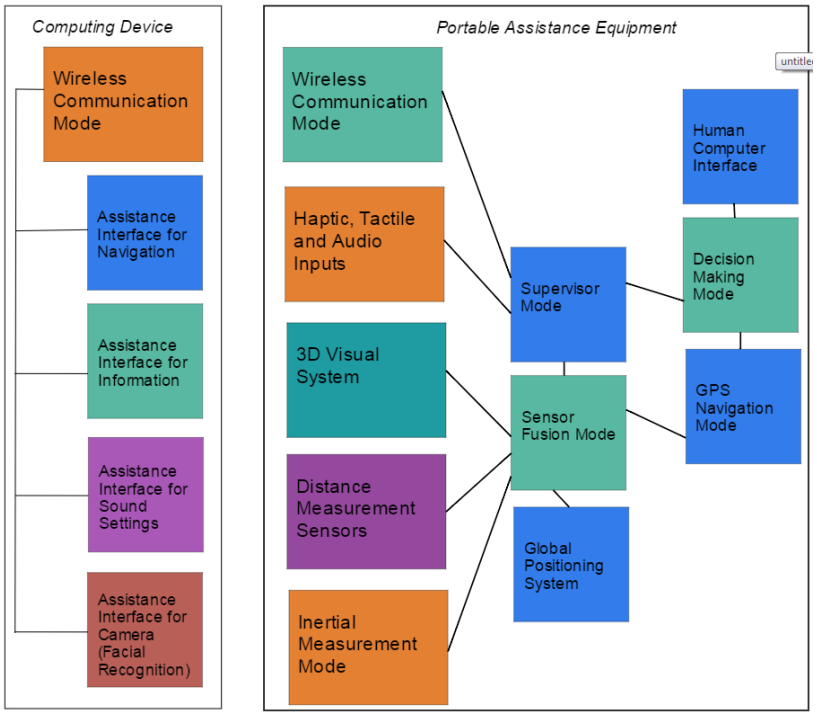
There have been various researches conducted on helping visually impaired and blind people in getting commands to avoid obstacles on their journeys. Various past innovations have segregated various distance lengths to sense obstacles and the highest measured was up to 4-meters. "XploR" cane is designed as a new innovation which does not only sense the obstacles up to 10-meterss and alarm the user but also embedded with the GPS navigation facility. This innovation of integrating GPS navigation has raised questions of detecting obstacles, object avoidance and appropriate route selection by the visually impaired and blind people. The technology is continuously in the advancement phase and many new sensors based on ultrasound rays have been developed which provides better support than guide dogs. Those who are visually impaired may not realise the full potential of these technologies and still use guide dogs for route guidance but are helpful in taking decisions in navigating/orientation in unusual situations.

The electronic navigation aid systems have replaced the traditional tools used for navigation by visually impaired people during the last half decade. The newly developed systems are based on various types of sensors and have the signal processing capabilities which helps the visually impaired person to improve mobility within the continuity-changing environment or unfamiliar situations (Tiponut, 2011). The embedded monitoring systems are integrated to ensure that the person using this is moving and will reach to his target (Zarandi et al., 2011). The proposed framework and develop system will be integrated with the facility to sense the changing environment or emergency situations about the current position of the visually impaired and blind person.

A module for path planning is integrated into this device and it would be responsible for generating and recalculating the route if it finds any obstacles on the

way. The visually impaired person using "XploR" cane find obstacles on the way the sensors will detect the object in a 3D format and this must meet requirements for trajectory planning. The man-computer interface provides information extracted from the environment in a friendly manner and assists visually impaired people by navigating "hands-free" in their work environment and everyday life (Wong & Cohen, 2012). The “XploR” cane is designed on the following proposed model:

Fig. 2: Block Diagram of the Proposed System.



Adapted From: Assistive Technologies for Visually Impaired People (Liu et al., 2011)

The Assistance Interface for Navigation would store the current position of the person and the details of the environment in its database through the Information Assistance Interface. Several functions are embedded within this portable device and it involves processing capabilities and control of embedded systems (Følstad, 2008). The Communication module embeds other modules such as Assistance Interface for Navigation and Assistance Interface and this would serve as a Human Computer Interaction interface. This interface is used to input various commands to operate “XploR”. The detection of obstacles and objects is very important for visually impaired people when moving around as well as obtaining location data. The current location of the visually impaired person is very important because this information must be stored and correlated to the database of the environment. The obstacles can be detected by using Ultrasonic systems for measuring the distance. The GPS tracking uses movement sensors to locate the orientation of the person and trajectory tracking (Haraszy, 2011).

The absolute position of the visually impaired person can be obtained through a GPS system but with errors of few meters due to slow sampling rate (Kramp et al., 2010).

The GPS navigation embedded within “XploR” can be useful for outdoor journeys. The integration of quantization noise and measurement helps to identify the location error to the inertial positioning system which is encompassed by gyroscopes and accelerometers. To obtain superior results, magnetic compasses are used along with gyroscopes and accelerometers (Allee, 2008). The detection of obstacles and locations of people can be obtained through mobile robots integrated within the navigation. In the proposed model various types of sensors are used to measure the location and consequently it requires complex computation processes (Lee et al., 2012). The sensor fusion module is responsible for communicating with the various types of sensors. In “XploR”, the resolution of these problems is looked at carefully while embedding a Kalman Filter within the device.

5. PROPOSED SYSTEM DESIGN

The theme of this research work is to design and build a device which uses ultrasonic sensors to sense the surrounding environment and incorporating a GPS navigation as well as a built-in camera to take pictures and scan them for the details of family and friends from information stored in the database. As soon as it finds obstacles, it sends feedback to the blind person wearing this device. The “XploR” cane has more features than the existing model of cane available for the blind and visually impaired people. The design of XploR differentiates itself from the traditional s which scans the obstacle from 10-meters distance and alerts the user with four different types of vibrations. The design of previous devices scans the objects from an only four-meter distance and there is no camera embedded in it. The “XploR” cane is embedding a camera, vibration motor, sensors to scan the obstacle, 10-meters distance and four different types of vibrations.

6. FACIAL RECOGNITION (FR) AND ASSISTIVE TECHNOLOGY (AT)

The Living Labs for this project have experimented with four different versions of facial recognition software called OpenCV and these are presented in the workshops. All previous versions have been classed and prototype version 4B includes features such as built-in camera, facial recognition, GPS navigation and Haptic touch. “XploR” cane has been designed in incubation hubs where students, computer scientists, entrepreneurs, and researchers met and discussed the project idea collaboratively. Birmingham City University and living lab collectively helped to exhibit version 4B are the European BIC network.

A survey conducted by Liu et al., (2007) investigated the problems blind and visually impaired people faced when using the internet and identified four main problems to consider. Accessibility, the usability of assistive technology, content overview, and structure overview were identified as the main problems. This also leads to believe that there is a high percentage of unemployment among blind and visually impaired people due to the fact of being excessively demanding or extremely challenging for using office equipment. There are adverse opinions stated by employers about employing visually impaired people and rehabilitation counsellors have presented their views; that lead them to focus on consumer abilities and then the employer needs (Patel & Vij, 2010).

Academic results of visually impaired and blind students varied considerably and depended on the assistive technology learning aid used. This disability restricts the blind people's learning and studying chances as compared to other normal students. Research conducted by Liu et al., (2007) finds that evidence from teachers of visually impaired students that there is a positive relationship between results and the use of assistive technology, and this has enriched the quality of students’ life and worked as a driving force to access academic information. However, there was a lack of knowledge

amongst the teachers about the range of assistive technology available. Most of the teachers portrayed themselves as “IT Illiterate” assuming that Information communication technology (ICT) and assistive technology (AT) are related to each other. To avoid the confusion it is shown by Tiponut, (2011) ICT is used to represent individuality, fitting and capability whereas assistive technology is used to represent reliance variance and constraints. Hence, ICT and ICT assistive technologies have inherently inconsistent sets of associations (Wong & Cohen, 2012).

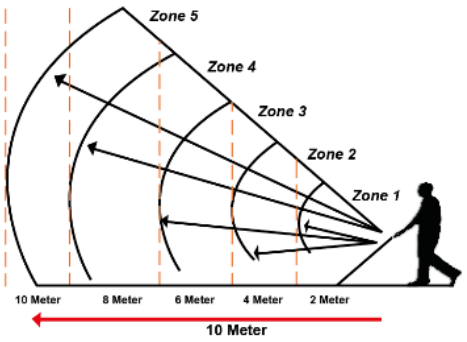
The research conducted by various scientific scholars has also discussed that blind and visually impaired students find various academic subjects more complex than the others. They use a special kind of web browser called AsteriX-BVI to perform chemical and mathematical calculations, which in turn generates haptic-enhanced presentations (Patel & Vij, (2010). According to Liu et al., (2007) the technologies produced (virtual-EyeCane, White-Cane) for BVI people lacks the ability to simulate the user to the relevant locations and destinations.

The results gathered from earlier developed devices for BVI people, suggest that there is still more room for assistive technology development which could not only navigate the user but also measures the distance of the obstacle on the way. A lot of research and development has been done on assistive technologies which include alerting the user about the obstacle from the 4-meter distance. Chen & Liu, (2014) researched areas of assistive technology (AT) devices that are most appreciated by AT users. AT results are needed for the reported data regarding the impact of AT on participation, costs of AT provision and key elements in the AT service delivery process. The “XploR” would not only help blind people from one particular sector of the community but it would help almost all the sectors where blind people are linked to.

The students and lecturers at Birmingham City University have taken the initiative to overcome these issues faced by BVI people. For this purpose, BCU campus was used as a Living Lab where project “XploR” was serviced. The idea was to embed the sensors those could sense the obstacle from 10-meters range and for this purpose, Nottingham Obstacle Detector (NOD) sensor was used. The NOD sensor was set to sense the objects on the basis of five zones. Each zone range was set for 2-meters and as soon as “XploR” would sense the obstacle, the cane will inform the user through haptic touch. Mowat motor is used for the haptic touch as it has the stimuli of various types of vibrations.

The proposed structure is presented through Figure. 3.

Fig. 3: Angular Coverage of the Detection Zone

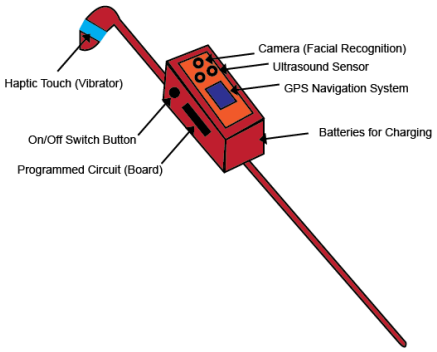


Adapted From: “Xplor” Cane Assisted Mobility for the Visually Impaired (Sakhardande et al., 2012)

The purpose of embedding an ultrasound sensor is to provide obstacle detection along with GPS for navigation purposes. The “XploR” cane is embedded with Mowat sensor which has five different analogue vibratory haptic pulses. The classification of these haptic vibrations is based on every two-meter distance. The vibration frequency is inversely set of the distance between the sensor and the obstacle. There are other sensors available for detecting the objects and obstacles, but “XploR” has used Ultrasonic sensor due to being less affected by the color and materials of obstacles. It also has the capability of detecting the objects up to 10-meters range. The ultrasonic sensor is designed with a function of resisting the external disturbances, noise, and radiations. This sensor continuously emits the sound rays and as soon as these hit any object, they are reflected back to the source with the location and distance of the obstacle. The functionality of “XploR” cane is based on Bluetooth Antenna, Bluetooth headset, HD Camera, Power Supply (via Rechargeable Battery), ON/OFF Button, Mowat Sensor (Vibrating Motor), Hardware Rest Button, Micro SD Slot (SD/MMC), HDMI Port, 4GB DDR3 SDRAM, EEPROM, Nottingham Obstacle Detector (NOD), GPIO Extension (1, 2, 3 and 4), Recovery Button, Hardware Rest Button and 32GB NAND Flash. While developing the “XploR” cane prototyping framework, the researchers in BCU had the assumptions of designing the cane length as per users choice, to be made of lightweight but strong material, proposed weight would be light, would have horizontal and vertical full spectrum IR camera and 270 degrees viewing angle, smartphone interface mount within the handle, 24h battery life, vibrating device in handle to detect force feedback from camera detection, handle could be detached from bottom part of cane, panic button for assistance and voice assistance/ recognition.

The proposed model of “XploR” is designed and presented in Figure 4.

Fig. 4: Proposed Model



Adopted From: “XploR” Cane Assisted Mobility for the Visually Impaired (Sakhardande et al., 2012)

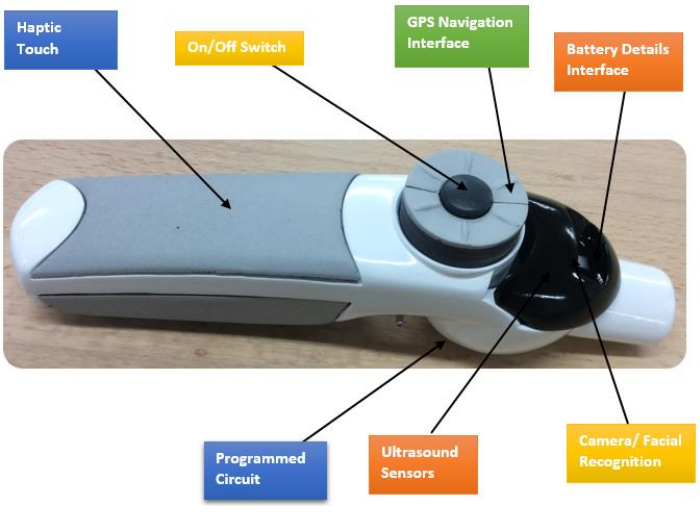
The “XploR” cane includes hearing aid and the prototyping phase required to ensure what technology would be used for the hearing purpose which would enhance user’s experience. The process of listening involves both ears working together combining the inputs and exchanging the information. To make it possible for “XploR” cane, the binaural coordination sonic device is used. Sonic products use binaural coordination to exchange the information between the right and left devices. If it is not embedded in the framework, the user would have to adjust the hearing device manually. The hearing experience of the user is so natural that they would never recognize that

they would have worn the device when listening to the instructions. The “XploR” cane would come with two different types of material choices, from which the individual can make a choice from. This is giving the individual choice to make instead of imposing our choice. (Aluminum and Graphite). There would be a choice for folding or telescopic. The embedded camera for facial recognition would have the capability of 1000fps for good quality pictures and be adjustable to viewing angle. The panic button will be linked to a call center where help can be dispatched with the aid of the GPS incorporated in the cane.

7. SUSTAINABLE PRODUCT DESIGN

The features and working of “XploR” are explained in various sections of this paper. The Ultrasound rays detector is embedded in the device to detect the obstacles from a 10-meter distance and this information is transferred to the user through Bluetooth. The device sensory detector detects the object and the stimuli of vibrations are changed according to the distance of obstacle. The distance of 10-meters is divided into 5 zones. The “XploR” cane is a new innovation on the basis of previous models as none of the past inventions had the integration of facial recognition and GPS navigation facilities embedded within it. The mechanism of device attachment with the cane does not require sighted assistance and could easily be attached or detached by the visually impaired or blind person. This device can also be used for general purpose distance measurement and GPS navigation. This device runs on rechargeable batteries and can be charged using a simple charger like those used for mobile phones. This eliminates the inconvenience of opening the battery pack to replace batteries.

Fig. 5: “XploR” Cane (Design)



Source: Living Labs (LILA) & BCU Project (2015)

The “XploR” is designed with a pair of receivers for both the ears. The Ultrasonic sensor will sense the environment, the camera will take pictures of people within the 10-meters radius and scan through the database for recognition purposes, haptic touch would alter the user through the various set of vibrations and embedded GPS would navigate the users within that environment to determine the obstacles and their ways. The crux of the whole concept to design “XploR” was to help blind in their day-to-day

mobility using navigation through instructions using pathfinder system. The “XploR” determines the presence of the object through Nottingham Obstacle Detector (NOD), measuring the distance and inform the user through Bluetooth and haptic touch. The technical specifications of the “XploR” cane is laid out in table 3.

The insights of “XploR” functionality are laid out in Table 2.

Table 2: Insights of “XploR” Functionality

Technical Specifications	**The “XploR” cane incorporates the following on its own board.** • **Bluetooth Antenna** • **Bluetooth headset, Jabra** • **HD Camera (Facial Recognition)** • **Power Supply (via Rechargeable Battery)** • **ON/OFF Button** • **Mowat Sensor (Vibrating Motor)** • **Hardware Rest Button** • **Micro SD Slot (SD/MMC)** • **USB_OTG** • **USB_HOST1** • **HDMI Port** • **4GB DDR3 SDRAM** • **EEPROM** • **Nottingham Obstacle Detector (NOD)** • **GPIO Extension (1, 2, 3 and 4)** • **Recovery Button** • **Hardware Rest Button** • **32GB NAND Flash** • **CHG_LED** • **PWR_LED**
Ultrasound Sensor Module	There are other sensors available for detecting the objects and obstacles, but “XploR” has used Ultrasonic sensor due to being less affected by the colour and materials of obstacles. It also has the capability of detecting the objects up to 10-meters range. This ultrasonic sensor is designed with a function of resisting the external disturbances, noise and radiations. This sensor emits the sound rays every time and as soon as these hit any object, they are reflected back to the

	source with the location and distance of the obstacle.
Haptic Touch (Vibrators)	Mowat sensor is used in “XploR” which has five different analogue vibratory haptic pulses, and these ranges could be set based on the distance. In “XploR” cane case, the scanning area is up to 10-meters and that is classified into 5 zones. The haptic touch would execute on the basis of where the object is located. All five zones have different level of haptic touches.
Standard Functionalities	The device “XploR” has following standard functions to help blind and visually impaired people for their mobility. • Cane length could be increased or decreased by the user • Cane would come in two different, materials (Graphite & Aluminium) • Its weight would be light and easy to carry • Horizontal and Vertical full spectrum IR camera and 270 degrees viewing angle • Smartphone interface mount within the handle for navigation purposes • 24h battery life • Vibrating device in handle to detect force feedback from camera detection • Handle can be detached from bottom part of cane • Panic Button for assistance • Voice Assistance/ Recognition
Constraints	While developing “XploR” cane following constraints were raised: • Aluminium may not be durable enough and cane could be easily be broken • Weight of “XploR” cane would vary due to the specifications • Battery life issues

	• Camera would require to be adjusted by the user for viewing angle • Facial recognition depends on user's height • In "XploR" cane, we could not use Android OS due to the technical incompatibility issues of supporting camera, Mowat motor and ultrasonic sensors.

The details mentioned in Table 2, depict the technical working and details of instruments within the XploR cane. This project was initiated collaboratively by LILA and Birmingham City University. The development of "XploR" presents Living labs perspective in-depth comprehension of the operations and interrelations of various components in the environment they function, for its user groups. This idea is gaining popularity for entrepreneurs to deliver innovative solutions for the communities and provide deeper awareness of the contemporary procedures by sharing best practices among network of other connected living labs.

8. CONCLUSION

There is an enormous number of assistive technologies available globally for the blind and visually impaired people but their use is quite complex for them. Some of the assistive technologies are developed in various countries but still unreachable by the blind and visually impaired people due to being expensive and lacking navigation features. The navigation support and facial recognition have always been a challenging problem for blind people along with finding the precise location of the obstacle. The already developed assistive technologies (e.g., Eye Cane, White-Cane) did not have facial recognition features as well as no ability to sense the external environment through the auditory stimuli.

This paper presents "XploR" cane, a new innovation for blind people which is designed and developed at Birmingham City University (BCU) in co-operation with Living Labs (LILA). Although the integration of various assisted technologies within XploR was a great challenge and while developing it, it was ensured that all necessary aspects and features such as; obstacle avoidance, facial recognition, route planning, GPS navigation, Bluetooth, haptic touch and path sounder were embedded in it. This product concept was innovated with about 100 users across three NEW regions as part of LILA and following the feedback from users and stakeholder, improvements were made in it, resulting in functionality of the "XploR" include face recognition and the ability to detect obstacles of up to 10-meters radius.

9. FUTURE WORK

Although this device is developed keeping in view the various requirements of BVI people it still requires future researchers to look into it through the following perspectives:

1. “XploR” can contain Braille keyboard, voice input unit, etc. Through this interface different commands can be addressed to the computer.

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