FROM UNIVERSITY TO MARKET: A CASE STUDY ON THE COMMERCIALIZATION OF A NOVEL ELECTRIC MOTOR TECHNOLOGY

Crafting a Strategic Roadmap for Bridging Innovation and Market Adoption.

Lappeenranta–Lahti University of Technology LUT

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Ali Rezaei

Examiner(s): Adjunct Professor, D.S. (Tech.) Nina Tura

Antti Kojola, M.Sc. (Tech.)

ABSTRACT

Lappeenranta–Lahti University of Technology LUT

LUT School of Engineering Science

Industrial Engineering and Management

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Ali Rezaei

From university to market: a case study on the commercialization of a novel electric motor technology

Crafting a strategic roadmap for bridging innovation and market adoption**.**

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Bringing innovation to market has long been a challenge—and an opportunity—at the intersection of academia and industry. While groundbreaking inventions often remain confined to research labs, their true value is only realized when they reach real-world applications. This thesis develops a structured roadmap for transitioning innovations from the earliest stages of research to market readiness and scale. Grounded in established commercialization theories and enriched by insights from industry experts, the study focuses on the Bridgeless Rotor Synchronous Reluctance Machine (BLRSynRM), a novel electric motor technology. The proposed roadmap offers a practical, theory-driven approach to overcoming the challenges of commercialization, bridging the gap between invention and industry adoption.

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ABBREVIATIONS

ACT	Absorptive Capacity Theory
BLDC	Brushless DC
BLRSynRM	Bridgeless Rotor Synchronous Reluctance Machine
DCT	Dynamic Capabilities Theory
IP	Intellectual Property
OEM	Original Equipment Manufacturer
PMSM	Permanent Magnet Synchronous Motor
R&D	Research and Development
RBV	Resource-Based View
SME	Small- and Medium-sized Enterprise
SynRM	Synchronous Reluctance Motor
TAMA	Technology Advanced Metropolitan Area
TPB	Theory of Planned Behavior
TTO	Technology Transfer Office

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1 Introduction

It starts with a question: What if the key to a more sustainable future lies hidden in a university laboratory, waiting to be unlocked? Deep within the research facilities of LUT University, engineers and scientists have reimagined what an electric motor can be. Their creation, the Bridgeless Rotor Synchronous Reluctance Machine (BLRSynRM), is not just another motor—it's a concept that challenges the very foundation of modern electrification. At a time when the world is heavily reliant on rare-earth materials to power electric vehicles and renewable energy systems, this motor offers an ingenious solution to one of the most pressing, yet often overlooked, issues of the industry: the environmental and geopolitical vulnerabilities tied to rare-earth dependency. The BLRSynRM disrupts this dynamic by demonstrating that high efficiency and sustainability are possible without these critical materials, opening a pathway to a more resilient and equitable technological future.

But innovation alone is not enough. Groundbreaking ideas often remain confined to research papers and prototypes, unable to realize their full potential due to the complexities of commercialization. This thesis is about bridging that gap—transforming the BLRSynRM from a concept into a market-ready product capable of reshaping industries. In a time when global attention is fixed on electrification as a cornerstone of climate solutions, the successful adoption of technologies like the BLRSynRM is critical not only for environmental sustainability but also for the resilience of global supply chains and economies.

Yet, this work is about more than motors and roadmaps. It speaks to the broader potential of academic research to drive changes. The BLRSynRM is a microcosm of a much larger question: How can we unlock the transformative power of innovation to solve the world's most complex challenges? By addressing the technical, strategic, and systemic barriers to commercialization, this study contributes to a narrative of collaboration—one that connects academia, industry, and policy to chart a sustainable path forward. Through the lens of the BLRSynRM, this thesis envisions a practical method where disruptive ideas not only thrive but also redefine the boundaries of possibility for a more sustainable and equitable world.

1.1 Background and Problem Statement

The electric motor industry has witnessed significant advancements in technology, leading to the development of various types of motors, each with distinct benefits and drawbacks. Among the most prominent technologies are Permanent Magnet Synchronous Motors (PMSM), Synchronous Reluctance Motors (SynRM), and Induction Motors.

PMSMs are widely recognized for their high efficiency, compact size, and excellent torque characteristics, making them particularly suitable for applications in electric vehicles (EVs) and industrial automation (Mohammad and Jaber, 2022; Silva and Eriksson, 2022). They utilize permanent magnets, often made from rare-earth materials, which provide high magnetic flux density and enable superior performance (Silva and Eriksson, 2022). However, the reliance on rare-earth magnets poses a significant challenge due to supply chain vulnerabilities and fluctuating prices, raising concerns about sustainability and long-term availability (Artetxe et al., 2021; Nam et al., 2024).

In contrast, SynRMs offer a viable alternative as they do not require permanent magnets, thus alleviating the dependency on rare-earth materials. These motors operate based on the principle of reluctance, which allows them to achieve competitive efficiencies without the associated costs and supply risks of PMSMs (Artetxe et al., 2021). However, SynRMs typically exhibit lower torque density and may require more complex control strategies to optimize performance (Abimbola Oluwatoyin Adegbite et al., 2023; Tabora et al., 2021).

Induction motors, on the other hand, are known for their robustness, reliability, and relatively low manufacturing costs. They have been extensively used in various industrial applications due to their mature technology and ease of maintenance (Mohammad and Jaber, 2022; Tabora et al., 2021). However, induction motors generally have lower efficiency compared to PMSMs and SynRMs, particularly at partial loads, which can lead to higher operational costs in energy-intensive applications (Tabora et al., 2021, 2020).

Additionally, other technologies such as Brushless DC (BLDC) motors are also gaining traction, particularly in applications where precise control and high efficiency are paramount. BLDC motors share some similarities with PMSMs but typically offer simpler control mechanisms and are often used in consumer electronics and small appliances (Azizah et al., 2023; Sayed et al., 2023).

Despite the advantages of PMSMs, the critical issue of rare-earth magnet supply necessitates a shift towards alternative technologies. The ongoing research into non-rare-earth permanent magnets and the development of advanced motor designs, such as ferrite permanent magnet-assisted SynRMs, highlights the industry's response to these challenges (Artetxe et al., 2021; Nam et al., 2024). By exploring these alternatives, the electric motor industry can enhance sustainability while maintaining performance standards essential for future applications.

As introduced by Allahyari et al. (2024) the BLRSynRM, invented by LUT University, represents a groundbreaking advancement in the electric motor sector, particularly in addressing the limitations associated with traditional Synchronous Reluctance Motors (SynRMs). Their innovative design eliminates the need for radial and tangential bridges commonly found in conventional SynRM rotors, which often hinder performance by introducing unwanted flux paths and increasing core losses. By utilizing non-magnetic backplates to support rotor flux guides, the BLRSynRM achieves enhanced electromagnetic performance, including increased torque and power factor, making it a highly efficient alternative for high-speed and high-power applications (Allahyari et al., 2024). The significance of the BLRSynRM lies not only in its potential to improve the operational efficiency of electric traction motors but also in its contribution to sustainability by reducing reliance on rare-earth materials, thus addressing critical supply chain vulnerabilities faced by the electric vehicle industry. As the demand for efficient and environmentally friendly solutions in transportation grows, the BLRSynRM stands out as a viable option, offering a path towards more sustainable and economically feasible electric motor technologies.

The electric vehicle (EV) industry has predominantly relied on Permanent Magnet Synchronous Motors (PMSMs) due to their superior efficiency and performance characteristics, which have made them the preferred choice for various applications, including electric traction systems (Loganayaki and Kumar, 2019; Zhou et al., 2021). However, as the global demand for electrification intensifies, driven by the need for sustainable technologies to meet future energy requirements, the limitations of PMSMs become increasingly apparent. Zhou et al. (2022) claim a critical concern is the supply chain vulnerabilities associated with rare-earth magnets, which are essential for PMSM operation. These vulnerabilities not only pose risks to production stability but also raise questions about the environmental sustainability of relying on materials that are often sourced from geopolitically sensitive regions (Zhou et al., 2022).

In this context, the BLRSynRM emerges as a promising alternative, offering the potential to enhance operational efficiency while mitigating the reliance on rare-earth materials (Allahyari et al., 2024). Currently, the BLRSynRM technology is still in the research phase at LUT University, which underscores the urgency of developing a robust commercialization strategy for this new innovation. The significance of transitioning this innovative technology into the commercial sector cannot be overstated, as it aligns with market dynamics that increasingly favor sustainable and economically viable solutions. Therefore, there is a pressing need to formulate a comprehensive commercialization strategy that addresses the unique challenges of bringing the BLRSynRM to market, ensuring that it meets the evolving demands of the electric vehicle industry while contributing to a more sustainable future.

1.2 Research Objectives

To design the research objectives, it is first necessary to take a closer look at the current progression of the BLRSynRM project. The project has demonstrated significant advancements across both technical and intellectual property (IP) domains, underscoring a well-structured approach toward transitioning from academic research to a market-ready innovation.

On the technical front, the development of the BLRSynRM has yielded promising results. Simulation outcomes and laboratory tests indicate that the technology consistently performs in alignment with its design specifications. The project has now reached a critical juncture, as the prototype nears its final stages of assembly. This milestone marks the beginning of the proof-of-concept phase, which is essential for validating the technology's functionality in controlled environments and establishing a foundation for its eventual deployment in real-world applications.

In parallel, considerable progress has been made in securing intellectual property rights for the technology. A patent has been granted for the core innovations underlying the BLRSynRM, providing a robust legal framework to protect its novel aspects. However, the documentation of key technical know-how remains an area requiring further attention. Comprehensive IP documentation will strengthen the overall IP portfolio, thereby enhancing the project's position in licensing negotiations and partnership discussions.

Despite these advancements, the project faces challenges in securing the funding required for further progression. Currently, the development is supported by a Research-to-Business (R2B) grant, which is sufficient to bring the technology to the proof-of-concept stage. However, additional financial resources will be necessary to bridge the gap between academic research and market entry. Addressing this funding gap is critical for ensuring the project's transition from research to commercialization.

To navigate these challenges and establish a pathway to commercialization, the development of a comprehensive commercialization roadmap is imperative. This roadmap will provide a structured plan for addressing the project's technical, financial, and strategic needs, guiding its progression toward market readiness. The goal of this research is to bridge the gap between academic innovation and market application by designing a roadmap that integrates theoretical frameworks with actionable strategies specific to the BLRSynRM project.

To enhance the practicality of the roadmap, the study incorporates insights from industry experts obtained through interviews. These perspectives are instrumental in aligning the BLRSynRM's capabilities with real-world market demands. By integrating theoretical models with industry expertise, this research not only contributes to the academic understanding of technology commercialization but also provides actionable strategies for universities and innovators aiming to bring research-driven innovations to market.

This research seeks to address the overarching question:

- RQ1: How can the BLRSynRM technology be effectively commercialized to meet the demands of the industry?

To explore this major question, the following sub-questions will be investigated:

- RQ2: What commercialization theories and technology transfer models are applicable to the BLRSynRM?
- RQ3: What specific steps and strategies should be taken to develop a comprehensive commercialization plan for the BLRSynRM?

1.3 Structure of the Thesis

As shown in Figure 1, this thesis is structured to guide the reader through the key stages of research, analysis, and discussion related to the commercialization of university-based technologies, with a focus on the BLRSynRM. The introduction establishes the study's background, significance, and objectives, providing a foundation for the subsequent chapters. The literature review explores theoretical frameworks and critically examining their relevance to academic commercialization.

The methodology chapter details the research design, including the case study approach and data collection methods, ensuring alignment with the study's objectives. Practical insights derived from the findings follow, addressing key factors in commercialization, such as market validation and stakeholder engagement, while bridging theory with actionable strategies. The discussion chapter synthesizes these findings into a strategic roadmap for the BLRSynRM, highlighting contributions, limitations, and future research directions. Finally, the concluding chapter provides a critical analysis of the work conducted, evaluating its effectiveness in addressing the research questions. It also offers recommendations for future research directions to build upon the findings of this study. This structure ensures a logical flow, integrating theory, methodology, and practice to address the commercialization challenge effectively.

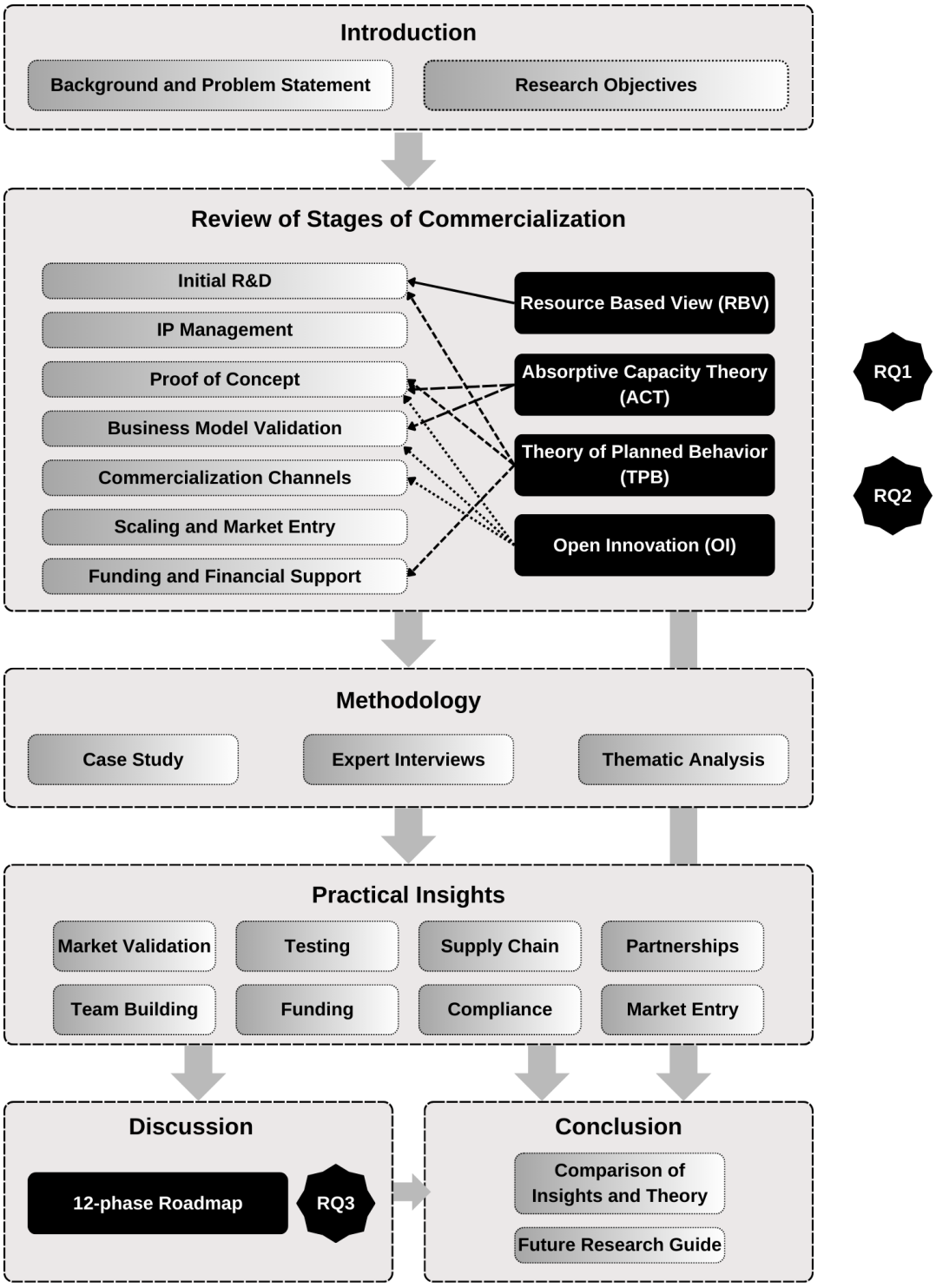

Figure 1 Structure of the Thesis

2 Literature Review

The literature review serves as a pivotal foundation for this study, offering the theoretical underpinnings necessary to design a comprehensive commercialization roadmap for the BLRSynRM technology. As a novel innovation emerging from academic research, the BLRSynRM exemplifies the challenges and opportunities inherent in the transition from university laboratories to market applications. For the specific purpose of this research, the literature review is structured around distinct stages, each highlighting a critical aspect of the commercialization process along the journey to market. Theories, frameworks, and key studies are examined within these stages, providing targeted insights that align with the progression of the commercialization roadmap.

The review was conducted in two distinct phases to ensure comprehensiveness and focus. During the preliminary phase, broad searches were carried out using a Boolean strategy, proposed by Gudivada et al. (2018), across multiple academic databases, including Google Scholar, Emerald Insight, ScienceDirect, Scopus, JSTOR, and ProQuest (Gudivada et al., 2018). These searches employed terms such as "commercialization OR technology transfer AND university OR academia OR academic AND technology OR innovation OR invention OR IP OR intellectual property" to gather a wide range of theories and frameworks. Key models and frameworks emerged as central themes, reflecting foundational principles of commercialization processes.

In the subsequent main research phase, the review shifted to a targeted exploration of each identified framework. By combining specific theory names with the original query, the search refined the scope to include practical and theoretical dimensions of each framework, ensuring relevance to the BLRSynRM's commercialization objectives. Articles were critically evaluated based on their academic impact, citation metrics, and practical applicability, prioritizing peer-reviewed publications while also considering less-cited works when relevant.

Through this in-depth and iterative review process, the study synthesizes theoretical and empirical insights to develop an actionable roadmap. This literature-informed approach ensures that the roadmap is grounded in rigorous academic foundations while remaining adaptable to the dynamic demands of market realities.

Stages of Commercialization

The stages of commercialization, as shown in Figure 2, represent the sequential and iterative processes involved in transitioning an innovation from research to market. This section outlines the critical phases, including research and development, intellectual property management, proof of concept, market validation, and scaling. These stages provide a structured framework to navigate the complexities of bringing university-invented technologies to successful market adoption. Throughout the review of these stages, the relevant theories and frameworks potentially contributing to the context will be discussed.

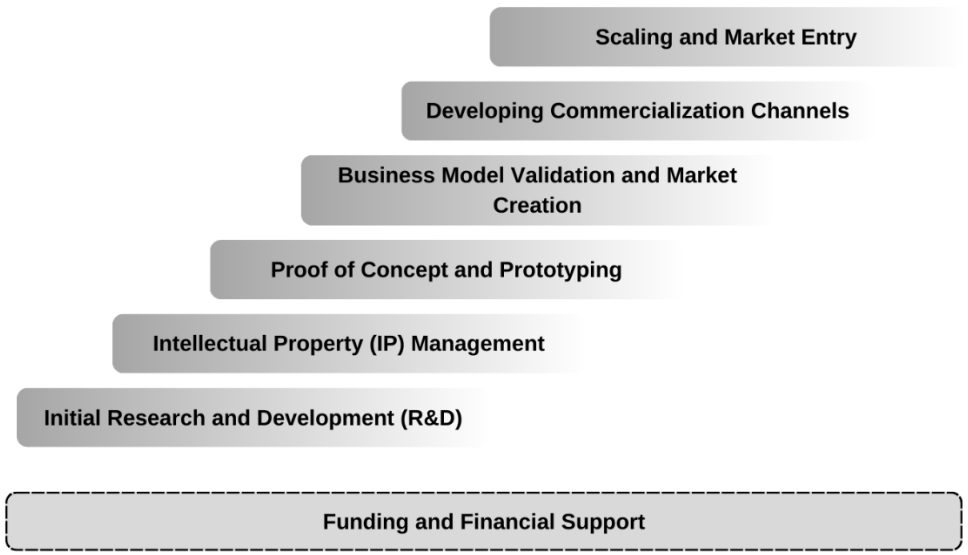

Figure 2 Stages of Commercialization Followed in The Literature Review

2.1 Initial Research and Development (R&D)

This stage typically begins with fundamental scientific discoveries made within academic settings, aiming to explore these discoveries for potential commercial applications. Effective R&D in this context involves both generating new scientific knowledge and actively assessing its commercial relevance—a dual objective that ensures scientific findings can transition from laboratory innovations to marketable solutions (Bazan, 2019; Olawore and Wong, 2022).

R&D in universities serves as the bedrock for technology commercialization by producing new knowledge and fostering innovation (Bazan, 2019). University research, particularly in research-intensive institutions, is often structured to bridge the gap between theoretical science and practical applications, as highlighted by Olawore and Wong (2022). Translational R&D frameworks, described by Bazan (2019), facilitate a seamless flow from lab-based discoveries to product-oriented development phases. These frameworks, which encompass steps from applied research to new product development and commercialization, encourage researchers to consider market needs alongside scientific exploration from the early stages, thus aligning academic output more closely with potential industry applications (Olawore and Wong, 2022). Resource management plays a vital role in ensuring that innovations emerging from universities are effectively positioned for commercial success (Vasudevan, 2021). One contributing resource management theory here is the Resource Based View (RBV), the core principles of the RBV highlight that organizations can achieve competitive advantage by effectively managing and utilizing their unique resources (Lee and Yun, 2020). Valuable resources enable firms to exploit opportunities or neutralize threats in their environment. For instance, universities that possess strong patent portfolios or highly regarded faculty can create unique offerings that are difficult for competitors to imitate, thus enhancing their market position (Lee and Yun, 2020).

The RBV has been instrumental in understanding how universities can achieve competitive advantage through innovation. By focusing on the management of their resources, universities can enhance their technology commercialization efforts (Lee and Yun, 2020). Studies indicate that universities with robust resource orchestration capabilities—such as effective technology transfer offices and strong industry partnerships—are more successful in translating research into marketable products (Dzakiy et al., 2023). This aligns with the findings of O'Shannassy, who emphasizes that sustainable competitive advantage arises from the effective utilization of unique resources (O'Shannassy, 2008). According to Wright et al. (2001), universities can leverage their skilled workforce, comprising both faculty and researchers, to create unique capabilities that drive innovation. These human resources embody specialized knowledge and skills that are difficult for competitors to replicate, thus reinforcing a university's competitive position (Wright et al., 2001). These studies collectively highlight the importance of resource management in enhancing innovation outcomes and achieving competitive advantage. Furthermore, the RBV has been utilized to assess the impact of intangible resources, such as academic reputation and institutional

culture, on innovation processes. Research indicates that universities with strong reputational capital can attract better partnerships and funding opportunities, thereby enhancing their innovation capabilities (Lee and Yun, 2020; Vasudevan, 2021).

The R&D phase also emphasizes the importance of interdisciplinary collaboration. For example, university R&D efforts may bring together experts in science, product design, and business development to collaboratively refine innovations with real-world applications in mind. This collaboration, referred to as the science team, facilitates a multi-dimensional approach to problem-solving, enhancing the innovation's robustness and market adaptability (Bazan, 2019; Kirchberger and Pohl, 2016). The formation of a science team is therefore essential, comprising individuals with the internal motivation to passionately drive development forward and support the project through to the commercialization stage. The study by Shane (2004) showed that the university's culture around entrepreneurship, coupled with supportive policies, can empower researchers to navigate the commercialization journey effectively (Shane, 2004). In addition, incentive structures, such as royalty sharing, equity options, or career advancement based on commercialization achievements, encourage researchers to actively participate in technology transfer (Bercovitz and Feldman, 2008). Furthermore, researchers who are trained in entrepreneurship or who have prior commercialization experience are often more successful in bringing inventions to market (Franklin et al., 2001).

An additional theoretical framework relevant to this stage of commercialization is the Theory of Planned Behavior (TPB), introduced by Ajzen in 1991. The TPB is a psychological framework that an individual's intention to perform a specific behavior is determined by three key factors: attitudes toward the behavior—their evaluation of the behavior's desirability, subjective norms—the social pressures they perceive to conform, and perceived behavioral control—their belief in their ability to successfully execute the behavior (Ajzen, 1991). Faculty members' intentions to disclose inventions or engage in entrepreneurial ventures are often shaped by positive attitudes towards commercialization and by perceived behavioral control. Wang and Cai (2023) highlight that a department’s scientific reputation and role models further influence these intentions (Wang et al., 2023). Importantly, institutions that integrate entrepreneurial education and support mechanisms within their programs may significantly enhance faculty members' attitudes and self-efficacy toward commercialization (Aloulou, 2016; Andrade and Carvalho, 2023). Studies examining

the influence of departmental context emphasize that factors such as reputation and the presence of role models directly impact subjective norms and attitudes toward commercialization among academic scientists. Wang et al. (2023) note that, even in departments lacking robust entrepreneurial support, motivational factors like commercialization attitudes and perceived control can positively shape faculty intentions, underscoring the importance of a supportive academic environment (Wang et al., 2023).

Moreover, cross-regional studies underscore the flexibility and adaptability of TPB in diverse cultural contexts. For instance, research by Wach et al. (2023) comparing Namibian and German students reveals that TPB's predictive power varies by region due to differing cultural and economic conditions. Namibian students, for example, exhibit strong entrepreneurial attitudes, while perceived control appears more influential among German students, reflecting the context-specific nature of entrepreneurial intentions (Wach et al., 2023). Therefore, understanding and accounting for the contextual environment is essential to effectively leveraging the benefits of TPB.

2.2 Intellectual Property (IP) Management

Universities manage IP primarily through Technology Transfer Offices (TTOs), which act as intermediaries to secure IP rights for the institution while facilitating partnerships and agreements with external entities. By establishing patents, licensing arrangements, and other IP protections, TTOs enable universities to both safeguard their inventions and make them commercially attractive to potential industry collaborators (Maresova et al., 2019; Tweheyo et al., 2022). One study by Debackere and Veugelers clearly showed that a well-organized and competent TTO can significantly enhance commercialization outcomes by ensuring that researchers understand market needs and by fostering relationships with industry (Debackere and Veugelers, 2005). Studies indicate that the efficiency and expertise of TTO staff in technology evaluation, patent management, and networking are strong determinants of success in technology transfer (Markman et al., 2005).

Researchers must often adapt their inventions to fit market demand, which requires an understanding of industry needs and potential applications (Siegel et al., 2007). Therefore, the role of TTOs extends beyond mere IP registration. These offices strategically evaluate the potential commercial value of an invention before committing to a patenting process.

This assessment often involves gauging the invention's market potential, technological feasibility, and alignment with industry needs (Maresova et al., 2019). Once deemed viable, the TTO navigates the patenting process, which serves as a legal mechanism to prevent unauthorized use while preserving the inventors' rights to further development and commercialization (Maresova et al., 2019).

A critical function of IP management is to create a conducive environment for academic entrepreneurship. By facilitating licensing and providing support for spin-off companies, TTOs encourage inventors to bring their innovations to market independently or in partnership with established firms. Tweheyo et al. (2022) suggest that this approach aligns with broader commercialization objectives, allowing universities to retain a stake in the IP while granting inventors entrepreneurial freedom. Additionally, licensing agreements and partnerships provide revenue streams for universities, which can be reinvested into further research and innovation (Tweheyo et al., 2022). However, the patenting process can be costly and time-consuming, and patents must be managed strategically to attract industry partners and investors (Jensen and Thursby, 2001). A university's IP policies, including licensing arrangements and royalty distribution, also influence the incentive structure for faculty and researchers, which in turn impacts the motivation to commercialize inventions (Mowery et al., 2001).

2.3 Proof of Concept and Prototyping

At this stage, the primary goal is to validate the feasibility of the technology through early testing and to develop prototypes that demonstrate its functionality and potential utility (Bazan, 2019). This validation helps to reduce technical risks and clarify the technology's unique value proposition, a process that is essential for attracting interest from industry partners and potential investors (Nieto Cubero et al., 2021).

Universities often engage in translational research frameworks to manage this phase effectively. These frameworks, originally applied in fields like biomedical research, now guide a structured approach that includes iterative testing, prototype development, and refinement (Bazan, 2019). Translational research aims to expedite the transition from laboratory findings to practical applications by incorporating feedback from early testing and aligning the technology with market demands (Bazan, 2019). In doing so, universities

adopt best practices from project management and product development, emphasizing interdisciplinary collaboration to optimize the prototype's functionality and relevance to real-world applications (Pujotomo et al., 2023).

In addition, Many studies have shown the importance of demonstration projects with industry partners in driving successful commercialization of university-developed technologies. These projects provide access to essential resources, technical expertise, and advanced facilities, enabling universities to refine prototypes and validate the feasibility of their innovations. These studies highlights that By leveraging industry knowledge, demonstration projects align technologies with market needs and commercial standards, build credibility with stakeholders, and facilitate early market entry, ultimately enhancing the likelihood of success (Chen et al., 2019; Daniel and Alves, 2020; Wirsich et al., 2016). Moreover, industry involvement helps in identifying potential applications early on, as industry partners can offer insights into specific market needs, regulatory considerations, and customer expectations (Pujotomo et al., 2023). Demonstration projects showcase the relative advantage and compatibility of new technologies, addressing two primary factors influencing the rate of innovation diffusion as proposed by Rogers (2003). By providing real-world examples, demonstration projects lower perceived complexity, making the innovation more accessible and increasing potential adopters' confidence in its viability. Litan, Mitchell, and Reedy (2007) emphasized that such projects can act as proof-of-concept initiatives, enabling potential industry adopters to observe an innovation's practical applications and benefits directly. This can be especially effective for innovations that may otherwise be perceived as complex or abstract, as it allows stakeholders to interact with the technology under realistic conditions, fostering a better understanding and accelerating adoption (Litan et al., 2007). Furthermore, demonstration projects help universities and industries navigate compatibility challenges. According to Wonglimpiyarat and Yuberk (2005), in a study on R&D projects in Thailand, demonstration projects helped potential adopters visualize how new technologies could be integrated with existing processes, thus easing compatibility concerns and encouraging commitment from early adopters. These projects help stakeholders understand not only the functional benefits of innovations but also the practical adjustments needed to incorporate them within existing frameworks, which is crucial for adoption beyond initial phases (Wonglimpiyarat and Yuberk, 2005).

As universities and industry partners collaborate at this stage, the role of absorptive capacity becomes critical. Absorptive Capacity Theory (ACT) plays a crucial role in the proof-of-concept stage, enabling industry partners to acquire and internalize complex academic knowledge. First introduced by Cohen and Levinthal (1990), ACT emphasizes an organization's ability to recognize the value of external knowledge, assimilate it, and apply it to commercial ends. Firms with higher absorptive capacity—bolstered by prior R&D investments and strong internal knowledge networks—are better equipped to engage in collaborative prototyping efforts and integrate academic innovations into early-stage development (Cohen and Levinthal, 1990; Winkelbach and Walter, 2015). Wang and Tsai (2007) extend this understanding by highlighting the importance of the "fit" between absorptive capacity and the specific technological needs of the organization. Their study of high-tech firms demonstrates that cultural and operational alignment between transferring organizations and recipient firms enhances the effectiveness of absorptive capacity. Frequent communication and shared objectives enable smoother integration of new technologies, underscoring the relational dimensions of absorptive capacity alongside its technical competencies (Wang and Tsai, 2007). This alignment not only facilitates knowledge transfer but also ensures the practical application of innovations in a manner that maximizes value creation for both academic and industry partners.

The "Valley of Death" a gap between prototype development and commercialization, is a well-documented challenge at this stage (Munari et al., 2017). Study by Nieto Cubero et al. (2021) shows this gap often stems from the high financial and technical risks associated with moving a prototype toward a market-ready product. Successful navigation of this phase requires not only technical validation but also strategic planning to secure funding and support, often from both public sources and private industry, to sustain development efforts and overcome barriers to market entry (Nieto Cubero et al., 2021). This stage presents a prime opportunity for the application of Open Innovation theory. First conceptualized by Chesbrough (2003), open innovation challenges the traditional "closed innovation" model by advocating that firms and institutions should not rely solely on internal research and resources. Instead, they should open their innovation processes to external inputs and partnerships, fostering a more dynamic and collaborative approach to development (Chesbrough, 2003). Open innovation framework play a vital role in the proof-of-concept stage by enabling universities to access external resources, technical expertise, and funding to develop and validate early prototypes (Gulbranson and Audretsch, 2008). Technology

Transfer Offices (TTOs) and proof-of-concept centres leverage these networks to bridge the funding gap and connect academic research with industry stakeholders, accelerating the transition from laboratory concepts to functional prototypes (Gulbranson and Audretsch, 2008). While Open Innovation is instrumental in early-stage development, its significance extends beyond technical validation, shaping strategies for market creation and alignment as technologies progress that discussed in further details in the next section.

Furthermore, Theory of Planned Behaviour (TPB), introduced in previous section, provides insight into industry partners' readiness to adopt university-based technologies. Studies suggest that perceived control—specifically, confidence in resource availability and project feasibility—is a major determinant in industry adoption decisions (Ma et al., 2022). Moreover, subjective norms, including competitive and industry standards, play an influential role, as companies often prioritize partnerships that align with these norms (Ma et al., 2022). Successful partnerships often involve formalized agreements, such as sponsored research or licensing contracts, that align the goals of both parties (Santoro and Gopalakrishnan, 2001). The presence of established networks and collaborations can increase commercialization success, as they provide a platform for mutual trust and knowledge sharing (Bruneel et al., 2010).

2.4 Business Model Validation and Market Creation

At this point, validating a viable business model is essential for demonstrating the commercial potential of a new technology. This stage involves refining the invention's value proposition, assessing market needs, and configuring the innovation to meet market demand (Maresova et al., 2019). The iterative process of aligning the business model with market dynamics enhances the technology's relevance and appeal, ultimately reducing commercialization risk (Nieto Cubero et al., 2021).

As introduced in the previous section, the use of Open Innovation framework can be extended to this stage. By fostering collaborations between universities and industry, Open Innovation helps align academic innovations with real-world market demands. Technology Transfer Offices (TTOs) that adopt Open Innovation strategies, such as engaging industry partners in licensing negotiations or fostering spin-offs, play a pivotal role in facilitating smoother transitions from academic research to market-ready products (Markman et al.,

2005). These networks also enhance trust and strategic alignment, ensuring that commercialization efforts are not only technically feasible but also resonate with market needs (Abdul Razak et al., 2014). For instance, partnerships facilitated by open innovation networks can provide valuable insights into customer preferences, pricing strategies, and adoption barriers, enabling universities to refine their business models effectively (Abdul Razak et al., 2014).

As discussed in a study by Maresova et al. (2019), key activities in this phase include engaging with potential users to gather feedback, evaluating competitive positioning, and iterating on product-market fit. The study shows user involvement in this phase is particularly vital, as it provides insights into customer preferences, adoption barriers, and pricing sensitivity, thereby refining the business model to meet real-world demands effectively. Additionally, this stage may involve identifying early adopters, who play a pivotal role in demonstrating the value of the innovation to a broader audience and can help in tailoring the business model for broader scalability (Maresova et al., 2019). Relational capabilities emphasized in Absorptive Capacity Theory (ACT), discussed earlier, are particularly relevant here. Wang and Tsai (2007) demonstrate that frequent communication and shared objectives between universities and industry partners enhance the effective exploitation of academic knowledge. This alignment helps validate business models by ensuring that innovations not only meet technical requirements but also address operational and cultural needs of target markets (Wang and Tsai, 2007).

Market creation is also integral to this stage. Beyond merely validating the business model, market creation entails defining and shaping the market for the technology, often by identifying novel applications or untapped user segments. Nieto Cubero et al. (2021) state that for disruptive or radical innovations, universities and their spin-offs frequently leverage ecosystem-building strategies to foster acceptance. These strategies can include forming strategic partnerships, securing endorsements from key stakeholders, and establishing adoption networks that facilitate diffusion and credibility of the new technology (Nieto Cubero et al., 2021). Open innovation strategies also contribute here by building trust and fostering networks that support the diffusion of disruptive innovations. Such networks help to expand adoption and accelerate market acceptance (Abdul Razak et al., 2014).

Furthermore, the relational dimensions of absorptive capacity, including trust, communication, and alignment, enhance the university’s ability to identify and engage with

early adopters and stakeholders who are critical for market creation. These capabilities help reduce the risks associated with entering untested markets while fostering a supportive environment for innovation diffusion (Wang and Tsai, 2007).

2.5 Developing Commercialization Channels

In the commercialization of university-developed technologies, various channels offer distinct pathways to bring innovations to the market. Each channel has unique characteristics, catering to different strategic goals, risk tolerances, and financial capacities of the involved parties (Olawore and Wong, 2022). The primary commercialization channels include licensing, spin-offs, direct market entry by startups, and partnerships with established firms (Kirchberger and Pohl, 2016).

Licensing, as stated by Sharma (2020), is one of the most prevalent commercialization channels used by universities and research institutions. This approach involves transferring intellectual property (IP) rights to an external entity, typically in exchange for royalties or other forms of revenue sharing. According to Sharma (2020), licensing is particularly suitable for universities seeking to capitalize on their IP without assuming the financial risks associated with product development. This channel allows universities to partner with established firms that possess the market presence and infrastructure necessary to bring the technology to consumers effectively. Moreover, licensing can be adapted for both exclusive and non-exclusive agreements, allowing flexibility based on the technology's maturity and market potential (Sharma, 2020).

Spin-offs, as described by Olawore and Wong (2022), represent another significant commercialization channel, where a new company is created specifically to bring a university invention to market. This approach often leverages the entrepreneurial drive of researchers or academic staff, who, according to Olawore and Wong (2022), may have both the technical expertise and motivation to further develop and market the technology. Spin-offs are common for high-tech innovations where sustained development and close management are essential (Olawore and Wong, 2022). Universities often support spin-offs through incubators, offering resources, mentorship, and networking opportunities to enhance the likelihood of market success. However, as noted by Olawore and Wong (2022), spin-

offs require substantial initial capital and pose higher financial risks, which are often mitigated through venture capital or public funding.

As noted by Sharma (2020), collaborative partnerships with established firms provide another valuable commercialization pathway. In such arrangements, universities or startups may enter into joint ventures or research partnerships with corporations that can scale production and manage complex market entry processes. These partnerships not only facilitate knowledge exchange and resource pooling but also allow universities to access broader market channels (Sharma, 2020). This model is often beneficial for high-risk or highly specialized technologies, as established firms can bring in expertise in regulatory compliance, large-scale manufacturing, and distribution (Kirchberger and Pohl, 2016).

Finally, direct market entry by technology startups is a less common but increasingly viable channel. This model involves universities or affiliated researchers directly entering the market with a newly developed product. Though high-risk, this channel allows for full control over the technology's commercialization process, from development through to sales. Startups following this approach must invest heavily in market research, product development, and scaling strategies. This channel is particularly suited for technologies with clear, immediate market applications and significant competitive advantages (Sharma, 2020).

The choice of commercialization channel depends on several factors, including the nature of the technology, market conditions, and the strategic objectives of the institution. For instance, technologies at an early stage of development or those with high market potential may be better suited for spin-offs, while mature, market-ready innovations are often licensed or sold directly (Pries and Guild, 2005). Market dynamics, including competitive pressures and demand for the technology, also influence the decision-making process (Daniel and Alves, 2020). Furthermore, Kenney and Patton (2009) emphasize that institutional goals, such as revenue generation, societal impact, or academic reputation, play a pivotal role in determining the appropriate pathway. Universities aiming to maximize societal impact may prioritize open innovation and collaborative models, while those focused on financial returns may emphasize licensing and equity in start-ups (Kenney and Patton, 2009).

Each commercialization channel offers distinct advantages and trade-offs. Whether through licensing, spin-offs, partnerships, or direct market entry, universities have multiple pathways

to bring their innovations to market. Selecting the most appropriate channel, guided by the nature of the technology, market demands, and resource availability, is critical to maximizing the likelihood of successful commercialization.

2.6 Scaling and Market Entry

Scaling and market entry represent critical phases in the commercialization process, marking the transition of a technology or innovation from limited deployment to broader market adoption. These stages require strategic planning and resource alignment to overcome barriers, establish a competitive position, and ensure sustained success. Scaling focuses on expanding the reach, impact, and production capacity of an innovation, while market entry entails navigating barriers, building a market presence, and securing a foothold in competitive environments. Together, these phases determine the ultimate success and longevity of an innovation in the marketplace.

The scaling process is often conceptualized as a progression through distinct phases: exploratory development, incremental growth, aggressive expansion, and standardization. Each phase demands strategies tailored to specific technical and market challenges. For instance, Foster and Heeks (2013) show that the scaling of ICT systems, such as Kenya's M-Pesa platform, demonstrates the importance of adaptive innovations and learning at different stages to address contextual complexities. These adaptations often emerge from a diverse range of actors and highlight the socio-technical nature of scaling (Foster and Heeks, 2013). Likewise, scaling technologies developed in academic settings requires building reliable supply chains and scaling production capabilities, which are typically limited in initial stages (Nieto Cubero et al., 2021; Olawore and Wong, 2022).

Market entry strategies during this phase must be customized to the attributes of the innovation and the industry it targets. Disruptive technologies, for example, often require phased introductions that focus on early adopters or niche markets. This approach allows for iterative feedback and adjustments to align the product with market requirements and user expectations, which can significantly reduce the uncertainties associated with market entry. Collaboration with industry partners at this stage provides additional resources, such as access to established distribution networks, brand credibility, and regulatory expertise, further facilitating market penetration (Nieto Cubero et al., 2021; Olawore and Wong, 2022).

Effective scaling and market entry are inextricably linked to the preparatory work conducted in earlier commercialization stages. Foundational activities, including securing intellectual property rights, validating product-market fit, and developing a robust financial model, mitigate risks and establish a strong platform for growth (Nieto Cubero et al., 2021). Innovation and technological readiness are particularly crucial, as they enable firms to remain competitive in dynamic environments. For small and medium enterprises (SMEs), partnerships within industry networks and shared production ecosystems are instrumental in overcoming resource limitations and accelerating market entry (Osano, 2023). Additionally, attention to supply chain robustness and scalability is essential to meet market demand during this (Olawore and Wong, 2022).

User involvement and adoption networks are equally critical to the success of scaling and market entry. Engaging early users as beta testers or pilot customers allows firms to refine their technology, optimize user experience, and build credibility. Strategic alliances with adoption networks help integrate innovations into existing market ecosystems, mitigating compatibility challenges and enhancing user acceptance (Nieto Cubero et al., 2021). Partnerships with complementary companies, for instance, can align new technologies with established solutions, increasing the likelihood of market entry success (González et al., 2018).

As emphasized by Cavallo et al. (2024), during the scaling phase, aligning technological advancements with market demands is paramount. Both incremental and radical innovations, play a central role in enhancing product offerings and maintaining competitiveness in dynamic markets (Cavallo et al., 2024). According to Cavallo et al. (2024), high-tech businesses, in particular, rely on the integration of new and existing technologies to adapt to evolving customer needs. Strategic marketing efforts, including branding and positioning, further amplify scaling by building consumer trust and expanding market share. In technology-intensive sectors, growth hacking and business model innovation have emerged as critical tools for efficient scaling (Cavallo et al., 2024).

Market entry strategies hinge on timing and scale. Study by Rodríguez-Pinto et al. (2011) state early entrants, or pioneers, often gain advantages such as brand recognition and customer loyalty but must contend with substantial risks and resource demands. The study suggests fast followers, on the other hand, can strategically position themselves by leveraging lessons from early adopters, refining their strategies to efficiently capture market

share. The success of these approaches depends on a firm's ability to adapt to market dynamics, regulatory frameworks, and consumer behaviors (Rodríguez-Pinto et al., 2011).

Ultimately, scaling and market entry rely on both internal and external factors. Internally, organizational readiness—financial stability, operational capacity, and leadership capabilities—plays a pivotal role in ensuring smooth transitions (Foster and Heeks, 2013). Externally, understanding the intricacies of the target market, including consumer preferences, competition, and regulatory environments, is critical (Foster and Heeks, 2013). Adaptive innovations, strategic partnerships, and user engagement frequently serve as catalysts, enabling firms to navigate complexities and sustain growth (Nieto Cubero et al., 2021).

2.7 Funding and Financial Support

Funding and financial support are fundamental to the commercialization of university-invented technologies, serving as the backbone for transforming innovative research into market-ready products. The availability of funding at various stages of the commercialization process is crucial, as financial support must be strategically integrated across all phases rather than following a strictly sequential order. Early-stage university inventions often face significant challenges in advancing beyond the concept phase; this is primarily due to high perceived risks and uncertain financial returns. Venture capital, government grants, and university support through technology transfer offices (TTOs) play critical roles in bridging the "valley of death," the gap between prototype development and market application (Siegel et al., 2003). One research by Wright et al. (2008) has shown that universities with robust financial support mechanisms and access to venture capital have consistently demonstrated higher commercialization rates, underscoring the importance of targeted financial interventions during early and intermediate stages of innovation (Wright et al., 2008).

Public funding, often provided through government grants or research-focused initiatives, supports foundational research and early-stage technology development. However, these funds are frequently insufficient to sustain projects through later stages of commercialization. In this context, alternative funding mechanisms, including private sector investments and industry partnerships, have emerged as essential supplements to public

funding (Harman, 2010). Private industry funding has been shown to accelerate commercialization by aligning research with market demands, fostering industry collaboration, and facilitating the transfer of intellectual property through licensing and spin-offs. However, industry funding can sometimes shift the focus of academic research toward applied goals, potentially at the expense of long-term exploratory studies (Babina et al., 2020).

The Theory of Planned Behavior (TPB) provides a useful framework for understanding investor decision-making in the context of commercialization. According to East (1993), investors are significantly influenced by their perceived control over resources and project feasibility. Perceptions of resource availability and financial stability play a crucial role in determining investor confidence, enhancing the likelihood of engagement with university-based projects (East, 1993). These insights align with TPB's emphasis on resource control as a key determinant of behavior. Subjective norms, as emphasized by Raut (2020), further influence investor decisions, as social pressures and peer opinions encourage alignment with prevailing market standards and practices. Investors are motivated not only by profitability but also by adherence to broader social and industry trends, reinforcing the importance of societal expectations in shaping funding behaviors (Raut, 2020).

In contrast to private funding, seed funds and proof-of-concept grants provided by universities or through TTOs help bridge the funding gap for early-stage technologies that are not yet viable for private investment. These instruments play a crucial role in de-risking projects and attracting follow-on investments from venture capitalists and other private stakeholders (Munari et al., 2018). Spin-offs, a prominent pathway for commercialization, face unique funding challenges as they require substantial financial resources to scale. Studies indicate that the uncertainty inherent in spin-off ventures often deters investors, necessitating the development of innovative financing strategies such as government-backed venture funds or hybrid funding models combining public and private capital (Sørheim et al., 2011).

The strategic alignment of funding sources with commercialization goals is critical. Public funds remain indispensable for sustaining basic research and infrastructure, while private investments enhance market orientation and scalability. Policy frameworks that encourage interdisciplinary collaboration, reduce bureaucratic hurdles, and foster a culture of innovation within universities are vital for maximizing the impact of financial support

(Owen et al., 2024). By addressing these dimensions, universities can effectively mobilize funding sources to transition research from the laboratory to the market.

3 Methodology

This study employs a qualitative case study methodology to develop a comprehensive commercialization roadmap for the BLRSynRM technology. As the Commercialization Officer responsible for the project, my professional role has directly influenced the approach, merging theoretical exploration with practical insights. This methodology is designed to address the challenges of transitioning BLRSynRM, a pioneering innovation developed at LUT University, from research to market deployment. By integrating theoretical frameworks on technology commercialization with empirical data from industry professionals, the study aims to bridge the gap between academic knowledge and real-world application.

The case study approach, as defined by Yin (2018), enables an in-depth investigation of complex phenomena within their real-life contexts. This makes it particularly suitable for exploring the commercialization process of BLRSynRM, which involves intricate interactions between academic research, market dynamics, and stakeholder requirements (Yin, 2018). By employing this methodology, the study captures the challenges, opportunities, and critical success factors specific to BLRSynRM. Furthermore, it synthesizes theoretical insights with practical feedback to ensure that the resulting commercialization roadmap is both academically rigorous and directly applicable.

3.1 Case Selection, Description, and Context

The BLRSynRM, developed at LUT University, represents a groundbreaking advancement in electric motor design by offering a sustainable alternative to traditional motors that heavily rely on rare-earth elements. Utilizing its unique design, BLRSynRM eliminates the conventional "bridge" structures found in typical rotor designs, instead incorporating flux guides and non-magnetic backplates to enhance magnetic flux efficiency. This innovative

approach not only improves the motor's power factor and torque but also reduces environmental and economic costs by entirely removing the need for rare-earth magnets (Allahyari et al., 2024).

The development of BLRSynRM addresses critical challenges in the electric motor industry, particularly in the context of the electric vehicle (EV) market. As global demand for electric motors continues to rise, the reliance on permanent magnet motors has highlighted significant vulnerabilities, including supply chain constraints and price volatility tied to rare-earth materials, which are predominantly sourced from a limited number of global suppliers. These challenges have motivated both academic institutions, such as LUT University, and major industry players, including Tesla, to pursue magnet-free solutions. BLRSynRM's design meets this demand, offering a high-performance, magnet-free alternative with up to 25% greater efficiency and 26% more torque than traditional synchronous reluctance motors, while remaining scalable for mass production (Allahyari et al., 2024).

The context for this innovation is framed by the rapid growth of the electric motor market, which was valued at approximately USD 128.35 billion in 2023 and is projected to reach USD 246.59 billion by 2032, with a Compound Annual Growth Rate (CAGR) of 7.61% (Fortune Business Insights, 2024). Within this expanding market, there is a strong emphasis on sustainability, energy conservation, and reducing dependency on rare-earth materials due to the ecological and **geopolitical challenges** associated with their extraction (Mouterde, 2024; Scoltock, 2023). BLRSynRM aligns seamlessly with these industry trends, offering a rare-earth-free solution that mitigates supply chain risks and environmental impact.

Despite its promise, transitioning BLRSynRM from research to commercialization poses significant challenges, often referred to as the "valley of death." This phase requires overcoming technical obstacles, such as optimizing design, achieving cost-effective manufacturing, and developing reliable supply chains, to ensure adoption across industries. Establishing initial market entry niches and securing early-stage funding are pivotal steps in gaining traction and scaling production. Addressing these hurdles is crucial for creating a sustainable and reliable commercialization roadmap that supports BLRSynRM's market transition.

The selection of BLRSynRM as the case for this study is driven by its innovative design and the substantial impact it could have on the electric motor industry. As a rare-earth-free motor

solution, BLRSynRM meets performance demands while aligning with global sustainability objectives, filling a critical market gap. The technology's development comes at a crucial time, as industries increasingly seek alternatives to permanent magnet motors to enhance supply chain resilience and reduce environmental impacts. By advancing the commercialization of BLRSynRM, this project contributes to broader environmental goals while addressing industry challenges related to cost-effectiveness and material availability.

3.2 Data Collection Method – Expert Interviews

The expert interviews conducted in this study were strategically designed to gather empirical insights that complement the theoretical foundations derived from the literature review. Given the unique and multifaceted challenges associated with commercializing the BLRSynRM technology, an unstructured, open-ended interview design was chosen to facilitate a broad exploration of the complex factors impacting the commercialization of the technology. To ensure a comprehensive understanding of the commercialization landscape, the interviews were designed around several critical themes, each targeting a specific aspect of the BLRSynRM commercialization process, such as; market identification and segmentation, product development, validation, and adoption, strategic partnerships and collaboration potentials, regulatory and certification preparation, go-to-market strategy, scaling and long-term production planning.

The unstructured nature of these interviews was particularly suited to the exploratory aims of this study. Given the early-stage status of BLRSynRM and the variability in market readiness across industries, an open-ended interview design was essential for capturing a wide range of expert opinions and identifying trends not readily apparent through structured questioning. This design also allowed each interview to be adaptive to the specific expertise of the participant, ensuring that topics could be expanded upon based on the interviewee's insights and real-world experiences. Through this flexible approach, the interviews yielded a rich and diverse dataset that is integral to developing a commercialization roadmap that is both theoretically sound and practically viable.

The sampling strategy for the expert interviews aimed to capture insights from high-level industry professionals directly involved in sectors relevant to the commercialization of BLRSynRM. To ensure a comprehensive perspective on market needs and adoption trends,

participants were carefully selected from a range of industry segments, including the electric bus sector (with an emphasis on companies already engaged in the E-bus market), the electric vehicle manufacturing industry, the marine sector, retrofitting companies, special-duty machinery producers, and leading electric motor suppliers. As shown in Table 1, the geographic scope included diverse regions across Europe—such as Finland, the Netherlands, Croatia, France, and Slovenia—as well as markets outside Europe, including Kenya and other African markets. In each case, only senior-level managers, such as Product Managers or Chief Technology Officers (CTOs), were invited to participate to ensure that the data reflected not only current market conditions but also forward-looking insights into market trends and challenges. A total of 14 interviews were conducted, with participant identities anonymized to maintain confidentiality.

Company	Interviewee	Company type	Position	Location
Company 1	Interviewee 1	Automotive (EV)	Product Manager	Croatia
Company 2	Interviewee 2	Automotive (EV)	Engineering Lead	Finland
Company 3	Interviewee 3	E-bus	Product Manager	Kenya
Company 4	Interviewee 4	Bus and E-bus	Test Engineer Lead	Netherlands
Company 5	Interviewee 5	Bus and E-bus	CEO	Finland
Company 6	Interviewee 6	Retrofitting	Product Manager	France
Company 7	Interviewee 7	Special-Duty Machineries	Technical Product Manager	Finland
Company 8	Interviewee 8	Special-Duty Machineries	CTO	Finland
Company 9	Interviewee 9	Special-Duty Machineries	CTO	Netherlands
Company 10	Interviewee 10	Powertrain supplier	Product Manager	Finland
Company 11	Interviewee 11	Bus and E-bus	Development Manager	Finland
Company 12	Interviewee 12	Bus and E-bus	Technical Director	Finland
Company 13	Interviewee 13	Transportation (Bus)	CEO	Finland
Company 14	Interviewee 14 & 15	E-Marine	CEO & CTO	Finland

Table 1 List of interviewees

The interviews were conducted online, with each session lasting between 30 to 90 minutes, depending on the depth and breadth of topics discussed. At the beginning of each interview, a pitch deck outlining the BLRSynRM technology and its potential business applications was presented to provide participants with a clear understanding of the technology's context and the intentions of the study. During the presentation, interviewees were encouraged to ask questions, which were answered in real time to ensure they had a comprehensive grasp

of the technology and its commercialization goals. This interactive introduction helped establish a shared understanding and set the stage for a more informed and focused discussion.

Following the presentation, the interviews proceeded with a series of triggering and thought-provoking questions, designed to elicit insights on both the industry landscape and the specific implications of BLRSynRM technology. The open-ended nature of the interviews allowed discussions to naturally evolve based on the interviewees' areas of expertise and focus. While some conversations emphasized market dynamics and adoption barriers, others delved into topics such as prototype suitability, regulatory challenges, strategic partnerships, and etc. This adaptive approach ensured that each interview captured data that was both relevant and actionable for developing the commercialization roadmap.

To analyse the interviews, the Thematic Analysis method was employed in this thesis to systematically analyze and interpret the qualitative data collected through interviews (Braun and Clarke, 2006). This approach was chosen for its rigor and adaptability, allowing for a structured yet flexible framework that aligns closely with the research objectives. Thematic Analysis is particularly well-suited for identifying, organizing, and interpreting patterns within qualitative data, providing a comprehensive understanding of the critical dimensions of the BLRSynRM motor's commercialization process.

The analysis followed the six-phase framework outlined by Braun and Clarke (2006), a widely recognized methodology in qualitative research. This framework ensures a systematic and replicable process for deriving meaningful insights. The first phase, familiarization with the data, involved repeated reading of the interview transcripts to immerse ourselves in the content, allowing initial ideas and patterns to emerge. In the second phase, generating initial codes, key elements of the data were systematically coded based on their relevance to the research objectives. This coding, was performed both inductively, to capture emergent insights, and deductively, using pre-determined research questions as a guide (Braun and Clarke, 2006).

Q 11	**INTERVIEWER:** Among these OEMs, who do you think are better positioned to adopt new motor technologies?	**Codes**	**Theme/s**
	INTERVIEWEE: OEMs with existing electrification platforms and experience are much more likely to quickly adopt and test new motor technology. They've already learned valuable lessons from their previous prototyping work, so their adoption curve is faster. They can use simulation models to quickly evaluate the new motor technology. This allows them to assess factors like demand, scalability, weight, and dimensions, all critical for their applications, without needing a physical prototype of the actual machine.	Technology adoption	customer integration
		prototyping	Real-life testing
		Simulation models, demand analysis, scalability	partner engagement
	In addition, It's also very important for the motor to come as a packaged solution, one that's highly compatible with existing powertrain components like inverters. This would significantly increase OEM interest and adoption. Traditionally, motor companies provided just the engine, while transmission companies supplied the other powertrain components. But now, things are changing. Transmission companies have started acquiring electric machine suppliers and developing their own electric powertrain solutions.	Packaged solution, compatibility, integrated powertrain components	Supply chain
		integrated powertrain components, supply chain integration	Supply chain

Figure 3 Sample of Thematic Analysis Method Utilized in This Research

In the third phase, searching for themes, the codes were examined and grouped into broader thematic categories. This process involved identifying relationships between codes and ensuring that the resulting themes provided a comprehensive representation of the data. A sample of third and fourth step is shown in Figure 3. The fourth phase, reviewing themes, focused on refining and validating these themes to ensure internal consistency and alignment with the data. Themes were cross-checked against the original interview content to confirm their relevance and coherence.

The fifth phase, defining and naming themes, involved articulating the specific aspects captured by each theme, providing clarity and focus for subsequent analysis. Finally, in the sixth phase, producing the report, the themes were integrated into a cohesive narrative that addressed the research questions and objectives of the study. The findings were

contextualized within the broader literature on commercialization and deployment strategies, ensuring both depth and relevance.

The analysis is organized around the following key themes. These themes were designed to capture the diverse dimensions of the commercialization process and provide a framework for analyzing and synthesizing the data collected.

- **Real-Life Testing:** Exploring the practical performance and applicability of the BLRSynRM motor in real-world conditions.
- **Market Validation**: Assessing market demand and verifying the commercial potential of the technology.
- **Partner Engagement**: Identifying and fostering relationships with key industry stakeholders for support and collaboration.
- **Customer Integration**: Understanding customer needs and ensuring the technology aligns with end-user expectations.
- **Supply Chain**: Identification, evaluation, and planning for a sustainable and efficient supply chain to support production and distribution.
- **Manufacturing Planning**: Developing strategies for scalable and cost-effective production.
- **Partnership Development**: Building strategic alliances to enhance market reach and technical support.
- **Go-to-Market Strategy and Marketing**: Crafting a targeted approach for launching the technology and promoting its adoption in key markets.

4 Practical Insights

From reviewing the literature, interview insights, and other materials gathered throughout this research, it has become evident that transitioning the BLRSynRM technology from its current stage to a market-ready product requires a focused and systematic approach. By synthesizing these inputs, I have identified the key activities that must be prioritized. These activities are organized under main headlines that represent the critical areas of work required to successfully commercialize the technology.

These headlines are the product of both a structured analysis of the academic and industry materials I reviewed and my practical understanding of what it takes to bring a technology to market. While they serve as high-level categories, their details must be crafted through step-by-step analysis of the materials at hand, including interview insights and the extensive literature reviewed in this thesis. The purpose is to create a roadmap for the commercialization process, ensuring that each step aligns with the overall goals and addresses the challenges identified.

The main headlines of the commercialization plan are as follows:

1. **Market Validation and Partner Engagement**

This involves building relationships with industry partners, engaging potential customers, and ensuring the technology aligns with real-world needs. The goal is to validate the market potential and secure collaborations that support the commercialization process.

2. **Real-Life Testing and Customer Integration**

Conducting pilot tests under real-world conditions is crucial for refining the technology and demonstrating its value to potential customers. This stage focuses on integrating customer feedback to make the technology viable for widespread adoption.

3. **Supply Chain and Manufacturing Planning**

Planning for the supply chain and manufacturing processes is essential to ensure scalability and cost-efficiency. This includes identifying key suppliers, exploring outsourcing options, and developing strategies for transitioning to large-scale production.

4. **Partnership Development (OEMs, Integrators, etc.)**

Developing strategic partnerships with original equipment manufacturers (OEMs), distributors, and integrators will play a pivotal role in scaling the technology and accessing broader markets.

5. **Building a Skilled Team**

A capable and dynamic team is vital for navigating the challenges of commercialization. This includes defining critical roles, attracting skilled individuals, and fostering a culture of innovation and adaptability.

6. **Funding and Financial Planning**

Securing financial resources is crucial to bridge the gap between development and market entry. This involves creating compelling financial projections, preparing investor-ready materials, and approaching potential funding sources.

7. **Legal and Administrative Compliance**

Ensuring the technology meets industry regulations and securing necessary certifications are non-negotiable steps for successful commercialization. This requires navigating legal and administrative processes efficiently.

8. **Go-to-Market Strategy**

Defining the initial market entry strategy, including market segments, pricing, branding, and promotion, will set the stage for a successful launch. This also involves building relationships with early adopters and key influencers.

By structuring the roadmap around these headlines, I aim to ensure that each area receives the attention it requires. The next step is to delve deeper into each headline, systematically analyzing the insights from interviews to develop detailed action plans. This approach will provide a practical framework for transferring the BLRSynRM technology to the market while addressing the complexities and challenges identified in this study.

4.1 Market Validation and Partner Engagement

The process of market validation and partner engagement for the BLRSynRM technology hinges on creating strategic collaborations and ensuring alignment between technological capabilities and market demands. Insights from industry interviews provide a nuanced understanding of how to navigate this critical phase of commercialization.

The interviews underscore that building meaningful relationships with industry partners requires a dual focus: addressing immediate technical requirements and aligning with long-term market trends. For instance, the marine industry emphasizes the demand for robust, integrated solutions tailored to harsh environments, with a preference for systems that simplify development for boat builders. Companies like Torqeedo and Oceanvolt prioritize complete systems rather than individual components, highlighting a strategic avenue for positioning BLRSynRM as part of an integrated powertrain. By aligning with such preferences, BLRSynRM can overcome significant barriers to adoption and secure early partnerships.

Similarly, the mobile machinery and automotive industries reveal the importance of scalability and compatibility with existing systems. The insights point to the value of targeting mid-sized OEMs and system integrators, as these entities often seek innovative solutions to differentiate themselves from dominant players like ABB or Danfoss. The motor's adaptability for integration with standard power electronics and modular design emerges as a key selling point, as it reduces the risk and cost for potential partners. Engaging such stakeholders in early conversations about the technology's capabilities can help establish trust and set the stage for collaborative testing.

In industries like public transport and retrofitting, cost sensitivity and performance benchmarks play a decisive role in partner engagement. Feedback from companies such as Company 5 and Company 3 emphasizes the importance of offering cost-effective solutions that align with operational needs. For instance, retrofitting diesel buses to electric systems requires motors that are not only competitively priced but also adaptable to existing vehicle configurations. Here, a pragmatic approach involving pilot projects and co-funded testing initiatives with potential adopters can significantly lower entry barriers. For example, Company 5 expressed willingness to test BLRSynRM, provided funding is secured, signaling the critical role of financial arrangements in catalyzing partnerships.

Market validation is equally about understanding nuanced regional and segment-specific demands. For example, Nordic public transport operators like Company 12 and Company 11 highlight the limited viability of retrofitting due to cost and regulatory challenges but point toward opportunities in new electric bus systems, particularly in underserved vehicle configurations. This insight shifts the strategic focus from retrofitting toward new integrations where BLRSynRM's adaptability can address specific market gaps, such as 15-meter-long buses currently dominated by non-European suppliers.

Across all interviews, a common thread emerges: the need for performance validation through rigorous testing. Prospective partners, whether in marine, automotive, or public transport sectors, prioritize reliability, compatibility, and operational proof before committing to full-scale adoption. For example, Company 1's insistence on concrete test results underscores the importance of presenting data-driven evidence of the motor's performance. Collaborative pilot testing not only demonstrates the technology's capabilities but also builds confidence among stakeholders, fostering deeper engagement.

In conclusion, the insights from the interviews reveal that successful market validation and partner engagement for BLRSynRM must balance technical excellence with strategic collaboration. By proactively addressing specific industry needs, emphasizing compatibility and cost-effectiveness, and engaging in pilot projects to validate performance, the groundwork for sustainable partnerships and market readiness can be effectively laid. This strategic engagement will ultimately ensure the technology aligns with real-world demands while securing the collaborative arrangements necessary for its testing and piloting phases.

4.2 Real-Life Testing and Customer Integration

The real-life testing and customer integration phase is pivotal for refining BLRSynRM technology, ensuring its market alignment, and establishing credibility through successful demonstration cases. Insights gathered from industry interviews reveal a rich tapestry of considerations, challenges, and opportunities that inform how this phase can be executed effectively.

Across the interviews, a recurring theme is the importance of replicating real-world operational conditions during testing. This is especially evident in the marine and public

transport sectors, where the environments impose unique technical and regulatory demands. For instance, the marine industry's emphasis on corrosive environments and power scalability necessitates rigorous pilot tests to demonstrate durability and efficiency. Collaborating with established companies like Torqeedo, E-Propulsion, or Oceanvolt to conduct tests in actual maritime operations could not only validate BLRSynRM's capabilities but also generate data critical for further refinement. Additionally, such partnerships position the technology within established ecosystems, reducing perceived adoption risks among potential customers.

Similarly, the heavy-duty and automotive sectors underscore the need for exhaustive reliability testing. Feedback from Company 8 and Company 7 highlights how field tests involving thousands of operational hours are essential to proving the technology's long-term dependability. By focusing on accelerated lifetime testing and incorporating advanced monitoring systems during pilots, BLRSynRM can identify potential vulnerabilities and iterate solutions before full-scale commercialization. Such data-driven validation ensures that the technology not only meets but exceeds industry benchmarks, fostering confidence among OEMs and integrators.

Customer feedback during real-life testing serves as a cornerstone for aligning the technology with market needs. This iterative approach is especially crucial in industries with stringent cost-performance expectations, such as public transport and mobile machinery. Insights from Company 5 emphasize the value of tailoring pilots to address specific use-case requirements, such as seamless integration with existing drivetrain configurations or addressing retrofitting complexities in older vehicles. Similarly, Company 3's openness to testing BLRSynRM within its fleet within a short timeline underscores the need to act swiftly and collaboratively in addressing partner-specific challenges, such as cost competitiveness and modularity.

Moreover, the creation of compelling demonstration cases during real-life testing plays a strategic role in market penetration. Successful pilots not only validate the technology but also provide tangible evidence of its value, which can be leveraged to attract new customers. For example, Company 1 emphasized the need for data-driven decisions, insisting that only robust performance data could convince their stakeholders of the motor's viability. This insight underscores the importance of framing demonstration cases not merely as technical validations but as strategic narratives showcasing the motor's impact on performance, cost

savings, and environmental benefits. These narratives, when shared through industry events or publications, can accelerate adoption by appealing to a broader audience of potential customers.

The complexity of real-life testing also necessitates strategic partnerships with testing facilities or organizations capable of creating tailored testing environments. Proposals from companies like Company 8 suggest collaborating with entities experienced in drivetrain optimization and testing. Such partnerships can streamline the testing process, ensuring that scenarios closely mimic operational realities and yield actionable insights. Additionally, these collaborations reduce the resource burden on BLRSynRM's internal team, allowing them to focus on iterative development and alignment with market needs.

The insights also highlight the value of aligning real-life testing with emerging market trends. For instance, public transport operators such as Company 12 and Company 11 emphasize sustainability goals, which align with BLRSynRM's rare-earth-free design. Demonstrating the motor's role in reducing environmental impact during testing can serve as a persuasive argument for potential customers who prioritize ESG (Environmental, Social, and Governance) compliance. Similarly, industries like mining and marine, where regulatory and operational challenges are significant, offer opportunities to showcase the motor's adaptability to stringent conditions, thereby enhancing its market appeal.

Real-life testing and customer integration are not merely technical milestones but strategic engagements that shape the trajectory of BLRSynRM's commercialization. By collaborating with industry leaders for rigorous pilots, incorporating iterative feedback to refine the technology, and crafting compelling demonstration cases, BLRSynRM can align its development closely with market needs. These efforts will not only validate its performance under real-world conditions but also position the motor as a transformative solution capable of addressing complex industry challenges.

4.3 Supply Chain and Manufacturing Planning

Supply chain and manufacturing planning are critical elements in the commercialization journey of BLRSynRM, particularly as the technology transitions from development to large-scale production. Insights from the interviews, particularly the discussion with

Company 7, shed light on the challenges and strategic considerations associated with scaling production to meet market demands while maintaining cost-efficiency and quality.

The conversation with Company 7 underscores the complexities involved in scaling manufacturing for high-volume markets. While BLRSynRM demonstrates strong alignment with niche applications such as off-highway machinery and heavy-duty equipment, the leap to large-scale production poses challenges in balancing cost-efficiency with the performance benchmarks expected by the market. For example, the company highlights the high sensitivity to price, with motors needing to fall within a range of €5,000–€10,000 to remain competitive. Achieving this cost target requires meticulous planning in sourcing materials and components, especially given the motor's reliance on advanced manufacturing processes and rare-earth-free design.

A key insight from the Company 7 interview is the importance of a localized and robust supply chain. The increasing geopolitical focus on reducing reliance on foreign supply chains, particularly those involving critical materials, aligns with the strengths of BLRSynRM's rare-earth-free design. Establishing partnerships with reliable suppliers who can ensure consistent quality and timely delivery is paramount. Company 7 suggests prioritizing collaborations with trusted global manufacturers who may have regional production capabilities, such as factories in Europe or Asia. This approach not only enhances supply chain resilience but also aligns with market expectations for environmentally and socially responsible sourcing practices.

Another critical element in supply chain planning is dual-sourcing to mitigate risks and enhance reliability. As indicated by several interview participants, OEMs and system integrators favor suppliers who can provide contingency plans, such as dual-supplier assurances. For BLRSynRM, this means identifying secondary suppliers for critical components like laminations, cooling systems, and power electronics, ensuring that disruptions in one region or supplier do not stall production. Moreover, maintaining high-quality standards while diversifying supply sources will be instrumental in sustaining customer confidence and meeting industry certifications.

The scalability of manufacturing is another prominent theme, particularly in the transition from small-scale pilot production to full-scale manufacturing. Company 7 highlights the value of leveraging existing manufacturing ecosystems to achieve scalability. For

BLRSynRM, this could involve exploring outsourcing options for non-core components while retaining control over critical manufacturing processes that differentiate the motor in terms of performance and reliability. This hybrid model not only reduces capital expenditure but also accelerates the production timeline by utilizing established facilities and expertise.

Additionally, the insights suggest the importance of aligning manufacturing strategies with market segmentation. For instance, niche applications like off-highway machinery or mining equipment provide an opportunity to start with low-volume, high-value production before scaling to broader markets. By targeting these segments initially, BLRSynRM can refine its production processes and address any operational challenges in a controlled manner. Over time, learnings from these initial efforts can inform strategies for high-volume production, such as for public transport or general automotive applications.

Company 7 also emphasizes the role of continuous process optimization in maintaining cost competitiveness. This includes reducing material wastage, streamlining assembly processes, and exploring innovative manufacturing techniques such as additive manufacturing for specific components. By integrating these practices early in the production roadmap, BLRSynRM can achieve operational efficiencies that translate into competitive pricing without compromising on quality or performance.

In conclusion, while the interviews provide a foundation for understanding the broader supply chain and manufacturing landscape, the insights from Company 7 are particularly illuminating. They highlight the need for strategic supplier partnerships, dual-sourcing for risk mitigation, and a phased approach to scaling production. By leveraging these insights, BLRSynRM can create a manufacturing strategy that balances cost-efficiency, scalability, and market responsiveness, ensuring a successful transition from development to commercialization.

4.4 Partnership Development (OEMs, Integrators, etc.)

Strategic partnerships with OEMs, integrators, and distributors play a crucial role in scaling BLRSynRM technology and meeting market demands. Insights from interviews reveal that many customers prioritize comprehensive drivetrain solutions over standalone motors, driven by factors such as limited expertise in drivetrain configuration, resource constraints,

or the perception that performance optimization is secondary to cost and convenience. These dynamics underscore the importance of developing partnerships that align with the preferences and operational realities of different market segments.

Discussions with companies like Company 8 and Company 5 highlight the growing trend of customers seeking integrated drivetrain solutions. Many OEMs and system integrators prefer ready-to-install packages that include inverters and gearboxes, as this simplifies their operations and minimizes the risk of configuration errors. For instance, Company 8 emphasizes the value of partnering with integrators experienced in drivetrain optimization to streamline BLRSynRM's market entry. Such collaborations not only reduce the technical burden on OEMs but also position the motor as part of a turnkey solution that appeals to a broader customer base.

In the marine and public transport sectors, the preference for integrated solutions is further accentuated by the challenges associated with individual component sourcing and assembly. Insights from the marine industry, such as opportunities with companies like Torqeedo or Oceanvolt, suggest that aligning BLRSynRM with established integrated system providers can significantly enhance its appeal. By offering compatibility with existing battery systems or propeller configurations, BLRSynRM can tap into markets that value seamless integration and operational simplicity.

The interviews also emphasize the importance of positioning BLRSynRM within established supply ecosystems to leverage existing market channels. For example, Company 7 and Company 9 point to the advantage of partnering with powertrain manufacturers that have well-established relationships with OEMs and access to key industry segments. Collaborations with such entities allow BLRSynRM to enter the market through trusted intermediaries, reducing the adoption barriers typically associated with new technologies.

Another key insight is the opportunity to co-develop drivetrain packages with OEMs. Companies like Company 5 and Company 1 highlight the potential for partnerships where BLRSynRM becomes an integral part of custom drivetrain solutions tailored to specific applications. For instance, Company 1's focus on high-performance systems aligns with BLRSynRM's ability to deliver scalable torque and power levels. By engaging in joint development projects with OEMs, BLRSynRM can align its technology with the precise needs of high-value customers, further demonstrating its adaptability and market relevance.

In addition to the technical and market alignment benefits, partnerships with OEMs and integrators also provide opportunities for scaling production and improving cost efficiencies. By collaborating with experienced manufacturers or distributors, BLRSynRM can optimize its supply chain, leverage shared production facilities, and access larger economies of scale. These partnerships are particularly critical in competitive markets, such as heavy-duty machinery and public transport, where cost sensitivity drives purchasing decisions

The interviews also reveal that partnerships can serve as a mechanism for overcoming resource constraints, especially for smaller or mid-sized OEMs. Feedback from Company 3 and Company 5 underscores the value of BLRSynRM presenting itself as a plug-and-play option that minimizes the need for significant in-house R&D. This approach not only accelerates market adoption but also positions BLRSynRM as a preferred partner for OEMs looking to innovate without incurring substantial development costs.

Finally, successful partnerships rely on a clear demonstration of value and reliability. The interviews consistently highlight the importance of pilot projects and rigorous testing as prerequisites for forming deeper collaborations. For example, Company 5's openness to testing BLRSynRM in its fleet reflects the significance of performance validation in establishing trust. By delivering data-driven evidence of the motor's capabilities, BLRSynRM can strengthen its position as a reliable partner for long-term collaborations.

In conclusion, the development of strategic partnerships with OEMs, integrators, and distributors is not just a pathway to market entry but a cornerstone for scaling BLRSynRM technology. By aligning with the growing demand for integrated drivetrain solutions, collaborating with established powertrain providers, and engaging in co-development projects, BLRSynRM can position itself as a transformative solution in various industries. These partnerships will not only simplify adoption for customers but also enhance the technology's market presence and scalability, paving the way for sustainable growth.

4.5 Building a Skilled Team

The commercialization of BLRSynRM requires a team that balances deep technical expertise with market-facing skills. Insights from industry conversations emphasize the importance of expertise in electric motor design, drivetrain integration, and system optimization. For

example, the discussions with Company 7 and Company 8 underscore the need for engineers skilled in scalability, performance testing, and reliability assurance. These areas are critical for ensuring that BLRSynRM meets the rigorous standards expected by OEMs and end-users. A team proficient in power electronics and thermal management will be particularly valuable, given the recurring emphasis on motor efficiency and effective cooling systems in high-power applications.

In addition to technical roles, the team must include individuals adept at stakeholder engagement and strategic partnership development. The insights highlight the need to engage with system integrators, OEMs, and testing facilities to establish the credibility and market presence of BLRSynRM. This requires professionals with strong communication skills, an understanding of customer needs, and the ability to translate technical features into compelling business value propositions.

Furthermore, fostering a culture of innovation and adaptability is vital for navigating the iterative development process. As emphasized in the interviews, real-life testing and customer integration will involve continuous feedback loops requiring rapid adjustments to the motor's design and performance. A team that embraces a mindset of learning and collaboration will be better equipped to address such challenges effectively. Insights from Company 1, for instance, suggest that building trust with industry leaders depends on showcasing a commitment to precision and quality—a standard that can only be met by a team aligned in its vision and execution.

Finally, attracting and retaining talent in a competitive market necessitates not only defining critical roles but also offering opportunities for professional growth and engagement in cutting-edge innovation. While the interviews do not explicitly discuss organizational strategies, the emphasis on collaboration with industry leaders and advanced testing facilities points to the need for a team motivated by a shared mission to transform electric motor technology.

4.6 Funding and Financial Planning

Funding and financial planning are indispensable components of the commercialization process for BLRSynRM, serving as the bridge between the motor's development phase and

its entry into the market. While the interviews do not extensively discuss funding strategies, the recurring emphasis on building trust with industry stakeholders and demonstrating performance provides valuable insights into what investors prioritize and how funding can be effectively secured.

A compelling vision underpinned by clear, demonstrable evidence of the motor's potential is a cornerstone for attracting investment. Several interviewees, including Company 1 and Company 5, stress the importance of data-driven validation during pilot projects. These insights suggest that presenting concrete, measurable outcomes—such as improved efficiency, scalability, and cost-effectiveness during real-world tests—can significantly enhance investor confidence. Success in pilot demonstrations not only showcases the technology’s viability but also reduces perceived risks for investors, making the case for funding more persuasive.

In addition to technical proof points, having a skilled and cohesive team is essential for securing investments. Investors often evaluate the competence and adaptability of the team, as highlighted indirectly in discussions about the iterative nature of development and market alignment. A team capable of responding to market demands, refining the technology based on feedback, and building strong industry partnerships demonstrates the organizational strength required to translate funding into tangible market outcomes.

The financial planning process also requires a clear articulation of the commercialization roadmap. Interview insights from OEMs and integrators frequently emphasize the need for strategic collaboration and scaling plans, which are resource-intensive endeavors. From securing pilot partners to managing manufacturing transitions, the entire commercialization process depends heavily on human capital. Funding is therefore critical to support the high costs of research and development, engineering efforts, and partnership engagements that cannot be substituted or delayed.

4.7 Legal and Administrative Compliance

Legal and administrative compliance is a fundamental aspect of the commercialization process for BLRSynRM, ensuring that the technology meets the necessary industry regulations and certification requirements to enter diverse markets. While not all interviews

delve deeply into this topic, key conversations, particularly with Company 14 in the marine sector, underline the critical importance of meeting stringent regulatory standards as a prerequisite for adoption. These insights can be extrapolated to other industries, highlighting the universal need for compliance in enabling market entry.

The marine industry's emphasis on durability in corrosive environments and compliance with safety standards exemplifies the non-negotiable nature of certification processes. For example, Company 14 highlights that marine-grade motors must adhere to rigorous testing and certification to demonstrate reliability under harsh operational conditions. This includes showcasing resistance to corrosion, maintaining operational integrity at specified voltages, and meeting power efficiency benchmarks. These requirements underscore the necessity for BLRSynRM to undergo a similar level of scrutiny to establish credibility and trust among industry stakeholders.

This focus on certification in the marine industry serves as a lens through which the broader need for compliance can be understood. In other industries, including automotive, heavy machinery, and public transport, adherence to local and international regulatory standards is equally essential. Certifications such as IP ratings for dust and water resistance, safety certifications for high-voltage operations, and compliance with emission or environmental standards are often mandatory. For instance, the interview with Company 7 points to the critical role of scalable and reliable supply chains, which are inherently tied to the ability to meet production standards that align with industry regulations.

The insights also suggest that securing certifications is not merely a technical exercise but a strategic process that supports market positioning. Demonstrating compliance with rigorous standards can differentiate BLRSynRM from competitors, especially in industries where trust in new technology is paramount. This is particularly relevant in markets like public transport and marine, where safety and reliability are key decision-making factors for adoption.

Moreover, navigating these legal and administrative processes efficiently requires collaboration with industry experts and certification bodies. Establishing early partnerships with regulatory agencies or experienced testing facilities, as suggested by entities like Company 8 and Company 5 Industries, can streamline the certification process and reduce

delays. Such partnerships ensure that the motor's design and testing align with certification requirements from the outset, minimizing costly redesigns or failures during validation.

4.8 Go-to-Market Strategy

Designing an effective go-to-market strategy for BLRSynRM is critical for translating its technological promise into tangible market success. While the interviews do not explicitly discuss traditional marketing techniques, they provide valuable insights into the nuanced approach required for selecting initial market segments, pricing strategies, and building relationships with early adopters. These insights emphasize the importance of strategic market entry, niche selection, and leveraging partnerships to establish credibility and gain momentum.

A recurring theme in the interviews is the importance of targeting specific niches that align with BLRSynRM’s unique value proposition. For example, discussions with Company 7 and Company 8 highlight opportunities in industries where high torque, power scalability, and efficiency are essential but where adoption barriers may be lower due to unmet needs or gaps in available solutions. Off-highway machinery, marine applications, and certain public transport segments present such niches. These markets, characterized by low-to-medium volume demand, provide a testing ground for the technology while reducing the financial and operational risks associated with large-scale deployment.

Strategic pricing is another critical consideration that emerged indirectly from the interviews. Many participants, such as Company 5 and Company 3, underscore the cost-sensitive nature of their respective markets. For instance, the African public transport market prioritizes affordability over peak efficiency, while marine applications may tolerate higher costs for high-performance integrated systems. These insights suggest that BLRSynRM’s pricing strategy should be adaptable, offering competitive rates where cost is a primary factor and emphasizing unique benefits—such as the elimination of rare-earth materials and lifecycle savings—where innovation and sustainability are valued.

The choice of initial market segments should also account for the ability to build strong partnerships with early adopters. Collaborations with mid-sized OEMs, as highlighted in the interviews, present an opportunity to align BLRSynRM with established systems and

distribution channels. By focusing on integrators and system providers who value seamless drivetrain packages, BLRSynRM can position itself as a turnkey solution that reduces integration complexity for customers. Such partnerships not only simplify the adoption process but also serve as endorsements of the motor's reliability and performance.

Branding and promotion strategies should reflect BLRSynRM's core strengths and market relevance. The emphasis on sustainability and cost-efficiency in the interviews suggests that messaging should highlight the motor's alignment with environmental goals, such as reducing reliance on rare-earth materials, while also addressing industry pain points like scalability and compatibility. Showcasing successful pilot projects, as suggested by Company 1, provides a powerful narrative for promotional efforts, demonstrating BLRSynRM's capabilities in real-world scenarios and fostering trust among potential customers.

Another critical aspect of the go-to-market strategy is building relationships with key influencers and early adopters. The interviews underscore the importance of trust and credibility in fostering these relationships, particularly in industries like public transport and heavy-duty machinery, where performance validation is paramount. Engaging early adopters through pilot programs and leveraging their feedback to refine the product can create a network of advocates who champion the technology within their sectors. This iterative process not only strengthens BLRSynRM's market position but also generates valuable case studies that can be used to attract a broader audience.

In conclusion, the go-to-market strategy for BLRSynRM should focus on strategic niche selection, adaptable pricing, and building strong partnerships with early adopters and integrators.

4.9 Critical Analysis Of Misalignments and Gaps In Interviews

While the interviews conducted for this study provide valuable insights into various facets of the commercialization process for BLRSynRM, a critical analysis reveals certain misalignments and gaps that could hinder a fully comprehensive approach to each strategic area. This section examines these misalignments, identifying areas where the insights

gathered do not entirely address the headline objectives or fall short in scope, with the intent of offering a balanced retrospection.

Market Validation and Partner Engagement emerges as a critical area where the insights, though rich in emphasizing partnerships, do not adequately cover the broader process of market validation. The discussions center on aligning with industry partners and addressing their needs, particularly through collaboration and technical compatibility. However, this focus on individual partnerships overshadows systematic approaches such as market surveys, competitive analyses, or tools to benchmark BLRSynRM's performance against existing alternatives. These methodologies are crucial for rigorously assessing market readiness and customer willingness to adopt the technology, especially in a competitive landscape. Addressing these gaps would ensure a more robust market validation process that extends beyond anecdotal insights.

In Supply Chain and Manufacturing Planning, while the interviews shed light on key elements such as dual-sourcing, supply chain resilience, and cost-sensitive manufacturing strategies, they fail to address the operational intricacies of supply chain management. Discussions focus on high-level strategies like partnerships and scalability but overlook critical considerations such as lead time reduction, logistics optimization, and risk mitigation in the face of geopolitical challenges. These operational details are essential for ensuring the supply chain's robustness and responsiveness to dynamic market needs, and their absence leaves a notable gap in the planning narrative.

The analysis of Building a Skilled Team captures the technical expertise and cross-functional collaboration needed for commercialization, but it misses critical organizational strategies for talent acquisition and retention. The interviews emphasize adaptability and technical acumen but do not delve into how BLRSynRM could create a culture that fosters innovation, collaboration, and professional growth. Moreover, there is no discussion of practical incentives or strategies for attracting top-tier talent in competitive industries. These omissions dilute the depth of this section, leaving room for improvement in addressing the broader headline objective.

In Funding and Financial Planning, the interviews highlight key factors such as the importance of pilot success and team credibility in securing investments, but they lack detail on financial mechanisms. While the emphasis on data-driven validation and investor

confidence is valid, there is little exploration of how funding strategies align with commercialization milestones or how specific approaches—such as phased funding or structured investor pitches—could be implemented. This gap leaves the section incomplete in terms of addressing the practicalities of financial planning and its critical role in bridging the development-to-market gap.

Finally, Go-to-Market Strategy, while addressing niche selection and pricing strategies effectively, falls short in covering promotional and branding elements. The interviews focus heavily on market entry barriers and partnerships but offer limited discussion on the tactical aspects of building visibility, engaging distributors, or leveraging case studies for wider adoption. This narrow focus misses an opportunity to provide a more comprehensive strategy that encompasses both market entry and sustained growth through branding and promotion.

On the other hand, several headlines are fully addressed by the insights gathered from the interviews. Real-Life Testing and Customer Integration, Partnership Development, and Legal and Administrative Compliance are comprehensively covered, with actionable and strategically aligned insights. These sections effectively capture the core objectives of their respective headlines, presenting strong recommendations for implementation without notable gaps or misalignments.

5 Discussion

Synthesizing practical insights and theoretical frameworks into a cohesive commercialization strategy has been a challenging yet rewarding endeavor. The complexity of bridging academic innovation with market applicability requires meticulous integration of diverse knowledge domains. This task demands not only a thorough understanding of the literature but also the application of practical knowledge, which is time-intensive and necessitates unwavering dedication. This chapter reflects on the outcomes of these efforts, outlining the conclusions drawn and proposing recommendations that pave the way for the successful adoption of innovative technologies in real-world scenarios.

The roadmap presented in this section is the culmination of insights gained from my six years of experience in building businesses and conducting extensive research into this

specific technology. It is important to emphasize that this roadmap is not a definitive or prescriptive solution. Instead, it is a strategic framework shaped by the unique context of the BLRSynRM project and informed by the knowledge and challenges encountered throughout its development.

The true value of this roadmap lies in its dual role as a communication tool and a guiding framework. As a communication tool, it is essential for fostering a shared vision among all stakeholders—team members, industry collaborators, and other contributors—ensuring that everyone is aligned toward common goals. Effective communication of the roadmap strengthens collaboration, builds trust, and harmonizes efforts across diverse teams and disciplines.

Equally critical is the roadmap's function as a dynamic guide. Real-world scenarios often diverge from theoretical plans, making it essential to adopt an iterative approach. This involves continually evaluating and refining the roadmap to address emerging challenges, integrate feedback, and seize new opportunities. Such adaptability ensures that the roadmap remains relevant and effective throughout the project's lifecycle.

It is also crucial to note that the phases outlined in this roadmap should not always be viewed as a strictly linear sequence. Many phases are interrelated and contribute to each other in parallel, necessitating a timely overlap of activities. This interdependence reflects the complex and multifaceted nature of the commercialization process, where progress in one area often informs and accelerates progress in another. Adopting this parallel approach enhances the efficiency and cohesiveness of the overall strategy.

By serving as both a clear strategy for stakeholders and a flexible framework for navigating the complexities of commercialization, the roadmap becomes a cornerstone of the BLRSynRM's journey from research to market.

The following presents the proposed roadmap for BLRSynRM technology, designed to scale this innovation from the laboratory to widespread market adoption.

5.1 Phase 1: Technical Development

Milestones:

- Completion of pilot unit manufacturing and testing with at least one industry partner.
- Comprehensive documentation of manufacturing workflows and quality standards.

Timeline: 6–18 months

The journey to commercializing the BLRSynRM begins with laying a robust technical foundation. This phase focuses on transforming a cutting-edge innovation into a tangible, pilot-ready product, paving the way for eventual market entry.

Step 1: Identifying Suitable Piloting Partners

In the first step, the spotlight shines on collaboration. Targeted outreach to industries such as electric vehicles, marine, and heavy equipment is crucial. These sectors, marked by their openness to early adoption, offer fertile ground for co-development. Building trust and forging agreements with these stakeholders will set the stage for meaningful engagement. This step requires strategic vision and meticulous partner evaluation, ensuring alignment of goals and resources. Expected duration: 6–9 months.

Step 2: Manufacturing Limited Pilot Units

With partners identified, the next action is manufacturing a small batch of 10–20 motors. These units are destined for rigorous field testing under both controlled and real-world conditions. The goal is not merely production but meticulous crafting, ensuring that each unit meets high standards of quality and performance. This step serves as a critical proving ground for the BLRSynRM's technical prowess. Expected duration: 6–12 months.

Step 3: Documenting Manufacturing Know-How

Parallel to production, detailed documentation takes center stage. Every nuance of the manufacturing process—tooling requirements, quality control benchmarks, and workflow optimizations—must be recorded with precision. This documentation is the blueprint for future scaling efforts, ensuring that lessons learned at the pilot stage translate into seamless full-scale production. Expected duration: 12–18 months.

Step 4: Iterative Testing and Validation

Technical excellence is honed through iterative testing. Laboratory analyses and real-world evaluations form a feedback loop, refining performance metrics such as efficiency, safety, and reliability. Challenges unearthed during testing provide opportunities for enhancements,

reinforcing the BLRSynRM's readiness for commercialization. Expected duration: 12–18 months.

Step 5: Launching Demonstration Projects

The phase concludes with demonstration projects in collaboration with selected partners. These initiatives showcase the BLRSynRM's capabilities, blending technical achievements with market-facing narratives. The projects serve dual purposes: validating the motor's commercial viability and generating invaluable real-world data for subsequent phases. Expected duration: 12–18 months.

Closing the Phase:

This foundational phase is the bedrock of the commercialization roadmap. By the end of this stage, the BLRSynRM should stand validated in its technical and functional promise, backed by robust partnerships and comprehensive documentation. This preparatory effort ensures a seamless transition into the subsequent phases of intellectual property management and market validation.

5.2 Phase 2: Intellectual Property (IP) Management

Milestones:

- Filing additional patents to cover key innovations and manufacturing methods.
- Establishment of licensing agreements with at least one OEM or industry partner.

Timeline: 6–18 months

After laying the technical groundwork, the next critical phase involves safeguarding the innovation through robust intellectual property (IP) management. This phase not only protects the unique aspects of the BLRSynRM but also lays the foundation for lucrative partnerships and long-term commercial viability.

Step 1: Strengthening IP Protections

This step focuses on fortifying the IP portfolio to secure the proprietary aspects of the BLRSynRM. Filing additional patents to protect new innovations and manufacturing processes ensures exclusivity and prevents imitation by competitors. Confidentiality

agreements with collaborators are also pivotal, fostering trust while guarding against IP leakage during partnerships. This comprehensive protection strategy reinforces the BLRSynRM's position as a market leader. Expected duration: 6–9 months.

Step 2: Developing a Licensing Framework

To monetize the intellectual property effectively, this step involves crafting a tailored licensing framework. The licensing model should address diverse partnership needs, ranging from Original Equipment Manufacturer (OEM) agreements to technology leasing arrangements. These frameworks should be designed to incentivize adoption while ensuring sustainable revenue streams for future growth. Establishing these agreements requires careful negotiation, balancing the interests of all stakeholders to foster mutually beneficial relationships. Expected duration: 12–18 months.

Step 3: Establishing Strategic Licensing Agreements

The culmination of this phase lies in securing licensing deals with at least one OEM or strategic industry partner. These agreements will not only validate the BLRSynRM's commercial potential but also open new channels for market entry. Licensing partners act as champions of the technology, accelerating its adoption across industries while providing a steady flow of revenue. The agreements must include clear terms for royalties, usage rights, and exclusivity clauses, ensuring a balanced partnership. Expected duration: 12–18 months.

Closing the Phase:

By the end of Phase 2, the BLRSynRM's intellectual property should be comprehensively protected, with clear legal frameworks to guide its commercialization journey. The successful establishment of licensing agreements will signal industry confidence, setting the stage for broader market validation and adoption in subsequent phases. This strategic consolidation of IP management underpins the long-term sustainability and profitability of the innovation.

5.3 Phase 3: Market Validation

Milestones:

- Completion of a market segmentation study identifying three primary target industries and their specific needs.
- Execution of a pilot project with measurable performance metrics such as efficiency and cost savings.

Timeline: 6–18 months

The third phase shifts focus from technical and legal groundwork to understanding and engaging the market. This stage ensures that the BLRSynRM aligns with market demands, paving the way for its successful adoption. Through targeted research and early adopter collaboration, this phase validates the motor's commercial potential while refining its market fit.

Step 1: Conducting Detailed Market Research

Market validation begins with an in-depth segmentation study to identify the most promising industries for the BLRSynRM. This step examines growth opportunities, competitive landscapes, pricing benchmarks, and unmet customer needs in sectors such as electric vehicles, heavy equipment, and marine applications. The insights gained will shape the go-to-market strategy, ensuring the technology is positioned effectively. Expected duration: 6 months.

Step 2: Engaging Early Adopters

In this step, collaboration with early adopters takes center stage. Partnerships are formed with forward-thinking customers willing to test and integrate the BLRSynRM into their operations. These partnerships provide critical feedback on usability, performance, and cost savings while generating real-world data. Early adopters also become ambassadors for the technology, lending credibility and driving interest in the broader market. Expected duration: 12–18 months.

Step 3: Conducting Competitor Analysis

To solidify the BLRSynRM's unique selling propositions, a thorough competitor analysis is conducted. This involves benchmarking the motor against rival technologies in terms of efficiency, cost, and sustainability. Highlighting the BLRSynRM's relative advantages

through data-driven comparisons reinforces its appeal and positions it as a superior alternative to existing solutions. Expected duration: 6–12 months.

Step 4: Executing Pilot Projects with Measurable Metrics

Pilot projects serve as the cornerstone of this phase. These real-world tests validate the BLRSynRM's technical and economic benefits, focusing on metrics like efficiency gains, cost reductions, and operational reliability. The results from these projects not only provide evidence for marketing campaigns but also help refine the technology for broader adoption. Expected duration: 12–18 months.

Closing the Phase:

By the conclusion of Phase 3, the BLRSynRM will have established a clear and compelling value proposition grounded in market research and real-world validation. This phase provides the data and partnerships needed to inform scaling strategies and build market confidence. The foundation laid here ensures a smooth transition to stakeholder engagement and production planning in subsequent phases.

5.4 Phase 4: Stakeholder Engagement

Milestones:

- Formation of a consortium involving academia, industry, and public sector.
- Hosting at least one multi-stakeholder workshop to align goals and demonstrate the technology.

Timeline: 6–12 months

Stakeholder engagement is a pivotal phase where the foundation of collaboration is built to accelerate the BLRSynRM's commercialization. By aligning the interests of academia, industry, and government, this stage fosters an ecosystem that supports funding, scaling, and widespread adoption.

Step 1: Building Partnerships

The first step focuses on the creation of a consortium. This involves integrating academic research, industry expertise, and government incentives into a cohesive partnership model. Academic institutions contribute innovation and technical depth, industry partners bring market insights and commercialization pathways, while government support ensures regulatory alignment and funding. This synergy addresses technical, financial, and strategic gaps, enabling a unified approach to scaling the BLRSynRM. Expected duration: 6–12 months.

Step 2: Organizing Stakeholder Workshops

With the consortium established, multi-stakeholder workshops become the focal point. These sessions bring together representatives from academia, industry, and government to align objectives, share insights, and collaboratively refine the commercialization roadmap. Demonstrating the BLRSynRM's technical capabilities during these workshops builds trust and excitement among stakeholders, while feedback collected from these sessions helps address any potential misalignments in goals or expectations. Expected duration: 9–12 months.

Step 3: Demonstrating the Technology's Potential

Workshops also serve as an opportunity to showcase the BLRSynRM in action. Live demonstrations of its efficiency, sustainability, and performance create a tangible understanding of its value, helping to secure buy-in from skeptical stakeholders. By combining technical validation with practical insights, this step ensures stakeholders remain actively invested in the project's success. Expected duration: 6–12 months.

Closing the Phase:

By the end of Phase 4, the BLRSynRM will have a strong network of engaged stakeholders unified by a shared vision for its commercialization. These partnerships, bolstered by active dialogue and aligned interests, create a collaborative ecosystem ready to drive the innovation into production and market readiness. This phase ensures the foundation is laid for seamless scaling and operational execution in the following stages.

5.5 Phase 5: Production and Supply Chain

Milestones:

- Establishment of a pilot-scale production line with validated workflows and material sourcing strategies.
- Securing contracts with at least two reliable suppliers for critical components.

Timeline: 12–18 months

This phase transitions the BLRSynRM from concept to tangible production, building the infrastructure and processes needed to manufacture at scale. By focusing on efficient production workflows and a resilient supply chain, this stage ensures operational readiness for broader commercialization.

Step 1: Developing Pilot-Scale Manufacturing Processes

The first step establishes a small-scale production facility to validate manufacturing workflows. This involves designing and implementing processes that balance efficiency, quality, and scalability. Pilot-scale production serves as a testbed to optimize assembly lines, tooling setups, and quality control measures, ensuring readiness for high-volume manufacturing. Expected duration: 12–18 months.

Step 2: Sourcing Sustainable Materials

Material sourcing is a cornerstone of this phase. Partnerships with local and global suppliers are established to ensure the availability of cost-effective and environmentally sustainable components. This step prioritizes suppliers who can reliably deliver critical materials, reducing risks of supply chain disruptions and aligning with the BLRSynRM's sustainability goals. Expected duration: 9–12 months.

Step 3: Optimizing Production Lines

With pilot production underway, lean manufacturing principles are applied to minimize waste, improve efficiency, and ensure cost-effective operations. This step refines workflows based on data from initial production runs, addressing bottlenecks and implementing iterative improvements. The goal is to ensure that production processes meet quality standards while being scalable for larger volumes. Expected duration: 12–18 months.

Step 4: Creating a Supply Chain Network

The phase concludes with the establishment of a robust supply chain network. Relationships with suppliers, logistics providers, and distributors are formalized to create an end-to-end system capable of supporting scaling efforts. This network ensures smooth procurement, production, and delivery as the BLRSynRM transitions to full-scale commercialization. Expected duration: 9–12 months.

Closing the Phase:

By the end of Phase 5, the BLRSynRM will have a functional and efficient production line complemented by a reliable supply chain network. These foundational elements ensure operational stability and scalability, enabling the innovation to meet growing market demands in subsequent phases. This phase solidifies the BLRSynRM's readiness for large-scale manufacturing and distribution, marking a critical step towards commercial success.

5.6 Phase 6: Funding and Financials

Milestones:

- Securing multi-stage funding to transition from medium-scale to full-scale manufacturing.
- Approval of a comprehensive financial plan by stakeholders, including cost projections and revenue forecasts.

Timeline: 6–12 months

Securing adequate financial resources is the lifeblood of any commercialization effort. In this phase, the focus shifts to building a solid financial framework that supports the BLRSynRM's transition from pilot production to full-scale manufacturing. This phase ensures the project's financial health through meticulous planning, stakeholder buy-in, and multi-stage funding acquisition.

Step 1: Developing a Comprehensive Financial Plan

The first step entails crafting a detailed financial plan that outlines budgets for medium-scale and full-scale manufacturing. This plan includes cost projections, expected revenues, risk

assessments, and contingency strategies. The financial blueprint not only provides a roadmap for funding requirements but also reassures stakeholders of the project's fiscal responsibility and potential for profitability. Expected duration: 6 months.

Step 2: Preparing Investor Pitch Decks

Once the financial plan is in place, the next task is creating compelling pitch decks tailored for investors and funding bodies. These presentations showcase technical achievements, market validation, and revenue potential. Highlighting the BLRSynRM's competitive advantages, environmental sustainability, and market readiness ensures it appeals to both venture capitalists and institutional investors. Expected duration: 6 months.

Step 3: Securing Multi-Stage Funding

Armed with a solid financial strategy and persuasive pitch materials, this step involves engaging investors, government bodies, and funding agencies. Multi-stage funding proposals are presented, emphasizing risk mitigation and milestone-based disbursements. This approach ensures continued financial support while demonstrating accountability and progress. Expected duration: 6–12 months.

Step 4: Gaining Stakeholder Approval

The financial plan is finalized with input from key stakeholders, including industry partners and board members. Their approval validates the proposed budgets and funding strategies, fostering confidence among investors and collaborators. This collaborative refinement process ensures that the financial framework aligns with both technical and business objectives. Expected duration: 6 months.

Closing the Phase:

By the end of Phase 6, the BLRSynRM will have secured the financial backing necessary for scaling its operations. With a comprehensive financial plan and multi-stage funding in place, this phase ensures that the innovation's transition to large-scale production is financially viable and strategically sound. This solid financial foundation sets the stage for achieving regulatory compliance and implementing a go-to-market strategy in the subsequent phases.

5.7 Phase 7: Regulatory Compliance

Milestones:

- Certification of the BLRSynRM under relevant international standards (e.g., CE marking).
- Development of a regulatory compliance roadmap for expansion into three key markets.

Timeline: 12–18 months

Regulatory compliance is a critical gateway to market entry. In this phase, the focus lies on aligning the BLRSynRM with international standards and navigating complex regulatory landscapes. This ensures the innovation is legally, environmentally, and operationally ready for global commercialization.

Step 1: Aligning with International Standards

The first step involves ensuring compliance with key international standards such as CE marking, which certifies that the BLRSynRM meets health, safety, and environmental protection requirements. Third-party certifications are sought to validate these claims, bolstering trust among potential partners and customers. This step requires meticulous testing, documentation, and adjustments to meet stringent regulatory criteria. Expected duration: 12–18 months.

Step 2: Developing a Compliance Roadmap

A detailed compliance roadmap is crafted to guide the BLRSynRM's regulatory journey. This roadmap outlines the specific environmental, safety, and operational regulations applicable in three key target markets. The roadmap ensures the technology is adapted to meet region-specific requirements, facilitating smoother market entry and avoiding costly delays. Expected duration: 12 months.

Step 3: Partnering with Regulatory Experts

Navigating the complexities of international regulations often requires specialized knowledge. Partnerships are formed with regulatory consultants and industry bodies to ensure that all certifications and compliance measures are met effectively. These

collaborations streamline the approval process and provide insights into emerging regulatory trends. Expected duration: 9–12 months.

Step 4: Implementing Compliance Testing

Rigorous compliance testing is conducted to validate the BLRSynRM's adherence to standards. This involves functional testing, safety evaluations, and environmental assessments under simulated and real-world conditions. These tests provide the evidence needed for regulatory approval and bolster confidence among stakeholders. Expected duration: 12–18 months.

Closing the Phase:

By the end of Phase 7, the BLRSynRM will be fully certified and compliant with relevant international standards, ready for deployment in key markets. This phase ensures regulatory barriers are addressed proactively, paving the way for a seamless market entry. With compliance assured, the project is poised to launch targeted marketing campaigns and establish distribution channels in the next phase.

5.8 Phase 8: Go-to-Market Strategy

Milestones:

- Launch of a targeted marketing campaign highlighting pilot project success and sustainability benefits.
- Signing distribution agreements with at least two major OEMs or distributors.

Timeline: 18–24 months

The go-to-market phase is where the BLRSynRM transitions from preparation to action, making its debut in the commercial landscape. This phase focuses on crafting a compelling narrative around the innovation, building strong market presence, and establishing distribution channels to drive adoption.

Step 1: Defining Target Applications

The first step involves pinpointing specific market applications where the BLRSynRM can deliver the greatest impact. Initial sales efforts target sectors such as electric buses, heavy-

duty vehicles, and marine applications, where its superior efficiency and sustainability offer clear advantages. This targeted approach ensures resources are focused on high-potential opportunities. Expected duration: 6–9 months.

Step 2: Building Customer Outreach Campaigns

A robust marketing campaign is launched to generate excitement and awareness. Highlighting success stories from pilot projects and emphasizing the motor's sustainability, efficiency, and cost-saving benefits, the campaign is designed to resonate with decision-makers in key industries. Outreach efforts include digital content, case studies, and participation in industry trade shows to engage potential customers directly. Expected duration: 9–12 months.

Step 3: Establishing Distribution Channels

Securing distribution agreements with at least two major Original Equipment Manufacturers (OEMs) or distributors is a priority in this step. These partners play a crucial role in expanding the BLRSynRM's market reach. By leveraging their established networks and customer bases, the technology can quickly penetrate target markets and achieve scalability. Expected duration: 12–18 months.

Step 4: Leveraging Sustainability as a Selling Point

Throughout this phase, sustainability remains a key selling proposition. The BLRSynRM's reduced reliance on rare-earth materials and enhanced energy efficiency aligns with global trends favoring eco-friendly technologies. Positioning these attributes at the forefront of marketing efforts helps differentiate the motor from competitors and appeals to environmentally conscious customers. Expected duration: Ongoing.

Closing the Phase:

By the end of Phase 8, the BLRSynRM will have established a strong market presence through targeted campaigns and strategic partnerships. With distribution agreements in place and customer interest ignited, this phase ensures the innovation is positioned for widespread adoption. The groundwork laid here paves the way for scaling operations and achieving long-term commercial success in the subsequent phases.

5.9 Phase 9: Organizational Capacity

Milestones:

- Recruitment and onboarding of a cross-functional team with expertise in commercialization, manufacturing, and sales.
- Implementation of a knowledge management system to capture R&D, piloting, and feedback insights.

Timeline: 6–12 months

Organizational capacity is the engine that drives sustainable growth. In this phase, the focus is on building a high-performing team and establishing robust systems to manage knowledge and streamline operations, ensuring the BLRSynRM's commercialization journey is supported by capable and cohesive leadership.

Step 1: Building a Multi-Disciplinary Team

This step focuses on recruiting and onboarding a team with diverse expertise in engineering, manufacturing, commercialization, regulatory compliance, and sales. Each team member brings unique skills essential for scaling the BLRSynRM effectively. The emphasis is placed on creating a collaborative environment where cross-functional teams can align on goals and execute strategies efficiently. Expected duration: 6–9 months.

Step 2: Implementing Knowledge Management Systems

A centralized knowledge management system is established to capture and organize data from R&D, piloting, and market feedback. This system ensures that valuable insights are not lost but are instead used to refine processes and inform strategic decisions. Tools such as digital dashboards and shared repositories are implemented to facilitate seamless communication and decision-making across teams. Expected duration: 12 months.

Step 3: Fostering a Culture of Innovation and Accountability

Beyond structural elements, this step focuses on cultivating a culture of innovation, adaptability, and accountability within the organization. Regular training sessions, workshops, and team-building exercises are introduced to empower team members, foster innovation, and align the organization's values with its goals. Expected duration: Ongoing.

Step 4: Aligning Organizational Goals with the Commercial Roadmap

The final step ensures that the newly built organizational structure aligns with the commercialization roadmap. This involves defining clear roles, responsibilities, and milestones for each team, ensuring a unified focus on achieving the BLRSynRM's strategic objectives. Expected duration: 6–9 months.

Closing the Phase:

By the end of Phase 9, the BLRSynRM will be supported by a capable and well-coordinated organization, equipped with the tools and talent to drive its commercialization. With a strong team and effective knowledge systems in place, this phase ensures the innovation is ready to scale efficiently and respond to evolving market demands. This organizational foundation is key to executing the final phases of scaling and full-scale manufacturing successfully.

5.10 Phase 10: Feedback and Refinement

Milestones:

- Establishment of a customer feedback loop with actionable insights from at least three pilot projects.
- Integration of iterative improvements into the production process based on real-world testing results.

Timeline: 12–24 months

Continuous improvement is the hallmark of successful commercialization. This phase focuses on collecting, analyzing, and acting upon customer feedback to refine the BLRSynRM's design, performance, and manufacturing processes. By embedding iterative refinement into the development cycle, this phase ensures the technology evolves in line with market demands and operational realities.

Step 1: Establishing Customer Feedback Loops

The first step involves creating structured mechanisms to gather feedback from customers and pilot project stakeholders. This includes regular surveys, interviews, and performance reports. The data collected focuses on areas such as usability, efficiency, and durability,

providing actionable insights to inform future iterations. Feedback loops also strengthen relationships with early adopters by demonstrating a commitment to meeting their needs. Expected duration: 12–18 months.

Step 2: Refining Manufacturing Processes

Using insights from customer feedback and pilot production, the next step targets enhancements in the manufacturing process. Iterative improvements focus on optimizing workflows, reducing costs, and addressing any technical or quality issues identified during testing. These refinements ensure the BLRSynRM is not only market-ready but also scalable for larger production volumes. Expected duration: 18–24 months.

Step 3: Incorporating Real-World Testing Insights

Real-world testing results are systematically analyzed to identify areas where the motor's performance can be enhanced. Adjustments may involve refining materials, upgrading components, or improving control systems. This step ensures that the BLRSynRM continues to exceed expectations and remains competitive in dynamic market environments. Expected duration: 18–24 months.

Step 4: Strengthening Customer Engagement

Throughout this phase, customer engagement is prioritized. Sharing updates on refinements and demonstrating how feedback has influenced changes fosters trust and builds long-term partnerships. This proactive approach turns customers into advocates, helping to generate positive word-of-mouth and attract new adopters. Expected duration: Ongoing.

Closing the Phase:

By the end of Phase 10, the BLRSynRM will have undergone targeted refinements, driven by real-world feedback and testing. These improvements ensure the motor meets or exceeds customer expectations while streamlining production for efficiency and scalability. This phase solidifies the BLRSynRM's position as a market-ready product and lays the groundwork for successful ecosystem integration and full-scale manufacturing in the final phases.

5.11 Phase 11: Ecosystem Integration

Milestones:

- Investment in R&D infrastructure for the development of the next generation of motors.
- Creation of at least one collaborative research agreement with an external R&D partner.

Timeline: 18–24 months

Ecosystem integration ensures that the BLRSynRM not only thrives in the present market but also evolves alongside future innovations. This phase focuses on embedding the technology within a broader innovation ecosystem, fostering partnerships, and investing in R&D to secure long-term competitiveness and sustainability.

Step 1: Strengthening R&D Capabilities

This step involves expanding the research and development infrastructure to lay the foundation for the next generation of motor technologies. Investments are directed toward advanced facilities, cutting-edge tools, and hiring specialized talent. This effort ensures that the BLRSynRM remains a leader in innovation, adapting to emerging trends and challenges in the electric motor industry. Expected duration: 18–24 months.

Step 2: Establishing Collaborative Research Agreements

To leverage external expertise and resources, at least one formal collaborative research agreement is established with an external R&D partner. These collaborations enable knowledge sharing, accelerate innovation, and enhance the BLRSynRM's technological edge. The partnerships focus on areas such as material advancements, efficiency improvements, and integration with evolving applications like autonomous vehicles and renewable energy systems. Expected duration: 18–24 months.

Step 3: Educating Industry Stakeholders

Proactive outreach to industry stakeholders is key to ensuring the BLRSynRM's seamless integration into the market ecosystem. Hosting seminars, webinars, and workshops helps demonstrate the motor's technical advantages and future potential, while fostering trust and

alignment with industry trends. This step strengthens the motor's position as a core innovation within its ecosystem. Expected duration: 12–18 months.

Step 4: Creating a Network of Advocates

A well-integrated ecosystem thrives on collaboration and shared goals. Engaging partners, customers, and academic institutions as advocates ensures that the BLRSynRM's benefits are widely recognized and supported. This network becomes instrumental in driving adoption, influencing policies, and fostering an environment conducive to innovation. Expected duration: Ongoing.

Closing the Phase:

By the end of Phase 11, the BLRSynRM will be fully embedded within a thriving ecosystem of innovation. The enhanced R&D capabilities and collaborative partnerships established during this phase secure its position as a future-ready technology. This phase ensures the technology remains at the forefront of industry advancements, setting the stage for full-scale manufacturing and sustained market leadership in the final phase.

5.12 Phase 12: Full-Scale Manufacturing

Milestones:

- Establishment of a high-volume production facility with a capacity of at least 10,000 units annually.
- Completion of the first full-scale production batch with verified quality and cost-efficiency metrics.

Timeline: 24–36 months

The final phase marks the transition of the BLRSynRM from a pilot-scale innovation to a commercially scaled product. This stage focuses on developing a robust manufacturing infrastructure, implementing advanced production practices, and creating a global supply chain to meet growing market demand.

Step 1: Establishing a Large-Scale Production Facility

The first step is building a dedicated production facility capable of manufacturing at least 10,000 units annually. This facility is equipped with advanced tools, streamlined workflows, and a trained workforce to ensure efficient, high-quality output. The facility's design accommodates scalability to meet future increases in demand. Expected duration: 24–30 months.

Step 2: Implementing Advanced Manufacturing Practices

To maximize efficiency and reduce costs, advanced manufacturing practices are introduced. These include automation technologies, digital monitoring systems, and lean production methods. These practices enhance production accuracy, minimize waste, and ensure the BLRSynRM is produced at a competitive price point. Expected duration: 18–24 months.

Step 3: Developing a Global Supply Chain

A resilient and efficient global supply chain is established to support the distribution of BLRSynRM units to diverse markets. This involves partnerships with international suppliers, logistics providers, and distributors, ensuring timely delivery while optimizing costs. The supply chain is designed to be sustainable, aligning with the technology's eco-friendly ethos. Expected duration: 24–36 months.

Step 4: Conducting Regular Operational Reviews

Throughout the production ramp-up, regular operational reviews are conducted to evaluate performance against key metrics such as quality, cost-efficiency, and delivery timelines. These reviews identify areas for improvement, ensuring the facility maintains optimal operational standards and aligns with market demands. Expected duration: Ongoing.

Closing the Phase:

By the end of Phase 12, the BLRSynRM will be in full-scale production, with a high-capacity manufacturing facility and a global supply chain in place. The first large-scale batch will serve as a testament to the technology's quality, cost-effectiveness, and readiness for mass adoption. This phase ensures the BLRSynRM is poised for sustained commercial success, cementing its position as a leading innovation in the electric motor industry.

6 Conclusion

The findings from Chapter 4, Practical Insights, both confirm and challenge the theories discussed in Chapter 2, Literature Review, while also extending several frameworks to address the unique complexities of commercializing the BLRSynRM technology. The practical insights, drawn from expert interviews, provide a nuanced perspective on how theoretical expectations align—or diverge—from real-world applications in the technology commercialization process. Thus by reviewing them, ideas for future researches emerge.

6.1 Alignment and Divergence: Comparing Practical Insights with Theory

Several aspects of the findings validate existing theoretical frameworks. For instance, the Open Innovation framework, highlighted in the literature review as a means of integrating external resources and knowledge to reduce commercialization risks, finds substantial support in the interview data. As suggested by the interviewees, collaboration with original equipment manufacturers (OEMs), integrators, and industry partners is pivotal to addressing the challenges associated with real-life testing and scaling. Partnership suggestions with companies like Torqeedo and Oceanvolt underscore the practical utility of Open Innovation, enabling BLRSynRM to leverage external expertise for product development and ecosystem building. This approach not only aligns with the theory but also highlights its practical relevance in bridging the "valley of death" during early commercialization stages.

The Resource-Based View (RBV), which emphasizes the strategic importance of leveraging unique and inimitable resources, is similarly validated by the practical insights. The interviewees frequently emphasized the distinctive characteristics of BLRSynRM, such as its rare-earth-free design and patent-protected technology, as critical differentiators in attracting partners and establishing a competitive advantage. By highlighting these unique resources, the interview findings confirm RBV’s assertion that distinctive capabilities are integral to creating value and achieving successful commercialization.

The Absorptive Capacity Theory (ACT) also finds strong alignment with the practical insights. The literature underscores the importance of a firm's ability to assimilate and apply external knowledge, and this was reinforced through interview feedback. Several

interviewees stressed the need for relational and cultural alignment in collaborations, particularly with suppliers and testing facilities. For example, partnerships with regional suppliers were identified as crucial for ensuring a resilient supply chain while simultaneously fostering trust and operational alignment. These findings not only validate ACT but also extend its scope by emphasizing the relational dynamics of knowledge transfer, suggesting that trust and shared goals are as important as technical readiness in effective collaborations.

The Diffusion of Innovations theory, which focuses on the factors influencing adoption is likewise supported by the interview findings. According to the interviewees, BLRSynRM's rare-earth-free design offers a clear relative advantage by addressing environmental and supply chain vulnerabilities, while its modular design enhances compatibility with existing systems. Real-life testing, as emphasized by several participants, serves to demonstrate the motor's capabilities under operational conditions, thus addressing the theory. These elements collectively align with the theoretical framework, affirming the importance of addressing these factors to facilitate adoption.

However, the findings also challenge certain theoretical assumptions, particularly those posited by the Theory of Planned Behavior (TPB). While TPB suggests that positive attitudes, subjective norms, and perceived behavioral control strongly influence stakeholders' intentions to adopt new technologies, the practical insights reveal a more complex reality. Despite expressing favourable attitudes toward BLRSynRM, several interviewees noted that unresolved concerns around funding and long-term performance validation remained significant barriers to adoption. This highlights a limitation of TPB, as it underestimates the impact of external uncertainties, such as financial and technical risks, on decision-making processes.

Beyond confirming and challenging theoretical expectations, the findings also extend several frameworks by incorporating practical insights from the interviews. The Absorptive Capacity Theory, for example, is extended to account for the importance of relational alignment in collaborative efforts. Interviewees repeatedly emphasized that successful partnerships depend not only on technical capabilities but also on shared objectives and trust between stakeholders. This relational dimension adds a critical layer to ACT, underscoring the need for alignment at both operational and cultural levels.

The Diffusion of Innovations theory is similarly expanded. While the literature primarily focuses on individual adoption decisions, the findings from the interviews highlight systemic barriers that influence entire market segments. For instance, several interviewees identified cost benchmarks and regulatory challenges as significant obstacles to adoption, suggesting that macroeconomic and industry-wide factors play a pivotal role in shaping adoption patterns. These insights extend the theory by incorporating broader systemic influences alongside individual-level considerations.

6.2 Contributions of This Study

This thesis makes academic contributions by addressing gaps in the commercialization of university-invented technologies, advancing theoretical frameworks, and providing a novel roadmap for practical application. While existing studies largely focus on commercialization in industrial or corporate contexts, they often overlook the unique challenges faced by academic innovations. The integration and extension of theoretical frameworks and studies, including Open Innovation, Resource-Based View (RBV), Absorptive Capacity Theory (ACT), and the Theory of Planned Behavior (TPB), stand as the core academic contribution of this thesis. By answering **Research Question 1 (RQ1)**—*How can the BLRSynRM technology be effectively commercialized to meet the demands of the industry?*—the research consider these studies and extends them to account for relational dynamics, trust, and systemic barriers that influence commercialization processes. Grounded in both theory and empirical findings, this study offers a perspective on how academic innovations can successfully transition to market-ready technologies.

In response to **Research Question 2 (RQ2)**—*What commercialization theories and technology transfer models are applicable to the BLRSynRM?*—this thesis bridges existing models with new insights derived from practical challenges. The study aligns theoretical concepts with real-world complexities, enhancing the applicability of frameworks like Open Innovation and RBV to academic commercialization contexts.

Furthermore, the development of a 12-phase commercialization roadmap answers **Research Question 3 (RQ3)**—*What specific steps and strategies should be taken to develop a comprehensive commercialization plan for the BLRSynRM?*—by providing a step-by-step guide for navigating the commercialization process.

The contributions of this research go further by showing how the theories discussed earlier align with or differ from the practical insights gathered from the interviews, providing actionable guidance for future researches.

6.3 Limitations of The Study, and Recommendations for Future Researches

While this thesis provides a structured and theoretically grounded roadmap for the commercialization of the BLRSynRM, it is important to acknowledge its limitations to provide context for the findings and pave the way for future research. One notable limitation lies in the practical implementation of the proposed roadmap, particularly in areas related to scaling production and addressing logistical challenges. Without detailed operational guidance rooted in real-world scenarios, there is a risk that the roadmap may require significant refinement when applied in practice. Real-life incidents and unforeseen complexities may necessitate iterative adjustments that this study has not fully anticipated.

Another key limitation is the specificity of the research to the BLRSynRM, a university-invented technology with its distinct development trajectory. While the findings are highly relevant to this particular case, the generalizability of the proposed strategies to other technologies or industries remains uncertain. The unique characteristics of the BLRSynRM, including its technical, institutional, and developmental context, may not fully translate to broader commercialization efforts, potentially limiting the applicability of the study's conclusions.

The thesis also does not comprehensively address the impact of external factors such as regulatory frameworks, market readiness, and competitive dynamics, all of which are critical in real-world commercialization. These external influences play a pivotal role in determining the success of innovative technologies, and their absence from a detailed analysis poses a limitation in creating a holistic commercialization strategy. Without deeper exploration of these aspects, the roadmap may fall short in navigating the complexities of market integration.

Financial viability and economic scalability are additional areas where the study's scope may be constrained. While the roadmap assumes that financial resources can be secured as needed, this may not reflect the realities of funding acquisition, especially in resource-

constrained environments. The lack of detailed exploration into financial modeling and economic feasibility could pose challenges in translating the roadmap into a sustainable business model. This assumption about financial availability may undermine the roadmap's utility in practical contexts where funding is limited or uncertain.

Furthermore, the roadmap and strategies presented in this study have not been empirically validated through extensive stakeholder feedback. While the findings are grounded in theoretical insights and preliminary data, their practical utility remains speculative without validation from a broader range of industry partners, policymakers, and potential customers. Empirical testing and stakeholder engagement are critical to refine the roadmap and confirm its applicability in diverse scenarios.

Lastly, while the thesis draws upon a wide body of literature, it does not fully incorporate perspectives from certain relevant frameworks, such as Strategic Niche Management and other emerging theories that could enrich the roadmap. Integrating these approaches in future research could provide deeper insights into fostering technology adoption within specialized market contexts and managing systemic transitions.

In light of the identified limitations and the comparison between practical insights and theoretical frameworks, future research should focus on empirically validating the proposed commercialization roadmap through real-world applications and stakeholder feedback. Expanding its scope to include financial modeling, external regulatory and market influences, and broader interdisciplinary frameworks will strengthen the roadmap's robustness and enhance its generalizability. A promising direction for future exploration lies in applying the roadmap to diverse technological sectors. Comparative studies across fields could help refine and adapt the roadmap to different technologies and industry landscapes.

Additionally, the findings of this thesis underscore systemic challenges, including cost benchmarks, regulatory barriers, and market-specific requirements. Further research could investigate how these barriers differ across regional and industrial contexts, with particular attention to public funding structures, geopolitical dynamics, and local regulatory frameworks. Furthermore, longitudinal studies on technology adoption also represent a valuable avenue for future inquiry. Tracking technologies like BLRSynRM over extended periods would provide deeper insights into the long-term effectiveness of commercialization strategies and roadmaps, particularly in improving the success rate of university-invented

technologies in transitioning to market adoption. These studies could illuminate how challenges and opportunities evolve as technologies mature, offering critical insights for sustaining their market relevance.

Finally, future research should explore the interplay between behavioral factors and external conditions in shaping technology adoption. While the Theory of Planned Behavior partially explains stakeholder decision-making, this thesis highlights the significant role of external uncertainties, such as financial and technical risks, in influencing adoption processes. Investigating how these external factors interact with behavioral elements, such as attitudes and perceived control, could offer a more nuanced understanding of stakeholder behavior. Examining decision-making frameworks under varying market conditions would provide actionable insights for academia and industry, aiding the development of more effective commercialization strategies.

7 References

Abdul Razak, A., Murray, P.A., Roberts, D., 2014. Open Innovation in Universities: The Relationship Between Innovation and Commercialisation. Knowl. Process Manag. 21, 260–269. https://doi.org/10.1002/kpm.1444

Abimbola Oluwatoyin Adegbite, Chinedu Nnamdi Nwasike, Nwabueze Kelvin Nwaobia, Joachim Osheyor Gidiagba, Oseluole Tobi Enabor, Samuel Onimisi Dawodu, Adedayo Adefemi, Chinedu Alex Ezeigweneme, 2023. Modern electric motors: A review of sustainable design and maintenance principles: scrutinizing the latest trends focusing on motor efficiency, sustainability, recyclability, and reduced maintenance. World J. Adv. Res. Rev. 20, 1198–1211. https://doi.org/10.30574/wjarr.2023.20.3.2560

Ajzen, I., 1991. The theory of planned behavior. Organ. Behav. Hum. Decis. Process. 50, 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Allahyari, A., Petrov, I., Pyrhönen, J.J., Aarniovuori, L., Lindh, P., Parviainen, M., 2024. Design and Optimization of a Bridgeless Rotor for Synchronous Reluctance Machines. IEEE Access 12, 65825–65837. https://doi.org/10.1109/ACCESS.2024.3398798

Aloulou, W.J., 2016. Predicting entrepreneurial intentions of final year Saudi university business students by applying the theory of planned behavior. J. Small Bus. Enterp. Dev. 23, 1142–1164. https://doi.org/10.1108/JSBED-02-2016-0028

Andrade, F.L.D., Carvalho, L.M.C., 2023. Entrepreneurial Intention of University Students under the Perspective of the Theory of Planned Behaviour: Integrative Literature Review. Adm. Sci. 13, 242. https://doi.org/10.3390/admsci13110242

Artetxe, G., Caballero, D., Prieto, B., Martinez-Iturralde, M., Elosegui, I., 2021. Eliminating rare earth permanent magnets on low-speed high-torque machines: A performance and cost comparison of synchronous reluctance machines, ferrite permanent magnet-synchronous reluctance machines and permanent magnet synchronous machines for a direct-drive elevator system. IET Electr. Power Appl. 15, 370–378. https://doi.org/10.1049/elp2.12032

Azizah, N.S., Adriyanto, F., Saputro, J.S., 2023. Development of Control and Monitoring of BLDC Motor Speed without Sensor with Back Emf Detection. J. Electr. Electron. Inf. Commun. Technol. 5, 1. https://doi.org/10.20961/jeeict.5.1.66698

Babina, T., He, A.X., Howell, S., Perlman, E.R., Staudt, J., 2020. The Color of Money: Federal vs. Industry Funding of University Research (No. w28160). National Bureau of Economic Research, Cambridge, MA. https://doi.org/10.3386/w28160

Bazan, C., 2019. “From lab bench to store shelves:” A translational research & development framework for linking university science and engineering research to commercial outcomes. J. Eng. Technol. Manag. 53, 1–18. https://doi.org/10.1016/j.jengtecman.2019.05.001

Bercovitz, J., Feldman, M., 2008. Academic Entrepreneurs: Organizational Change at the Individual Level. Organ. Sci. 19, 69–89. https://doi.org/10.1287/orsc.1070.0295

Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. Qual. Res. Psychol. 3, 77–101. https://doi.org/10.1191/1478088706qp063oa

Bruneel, J., D’Este, P., Salter, A., 2010. Investigating the factors that diminish the barriers to university–industry collaboration. Res. Policy 39, 858–868. https://doi.org/10.1016/j.respol.2010.03.006

Cavallo, A., Cosenz, F., Noto, G., 2024. Business model scaling and growth hacking in digital entrepreneurship. J. Small Bus. Manag. 62, 2058–2085. https://doi.org/10.1080/00472778.2023.2195463

Chen, W.-C., Chang, J.-C., Fang, S.-C., 2019. University-Industry Collaboration: A Value-Based-View, in: 2019 Portland International Conference on Management of Engineering and Technology (PICMET). Presented at the 2019 Portland International Conference on Management of Engineering and Technology (PICMET), IEEE, Portland, OR, USA, pp. 1–8. https://doi.org/10.23919/PICMET.2019.8893885

Chesbrough, H., 2003. Open innovation: the new imperative for creating and profiting from technology, Nachdr. ed. Harvard Business School Press, Boston, Mass.

Cohen, W.M., Levinthal, D.A., 1990. Absorptive Capacity: A New Perspective on Learning and Innovation. Adm. Sci. Q. 35, 128. https://doi.org/10.2307/2393553

Daniel, A.D., Alves, L., 2020. University-industry technology transfer: the commercialization of university's patents. Knowl. Manag. Res. Pract. 18, 276–296. https://doi.org/10.1080/14778238.2019.1638741

Debackere, K., Veugelers, R., 2005. The role of academic technology transfer organizations in improving industry science links. Res. Policy 34, 321–342. https://doi.org/10.1016/j.respol.2004.12.003

Dzakiy, U.N., Simatupang, T.M., Prasetio, E.A., 2023. Factors, Routes, and Existing Theories of Technology Commercialization in University: A Conceptual Framework. STI Policy Manag. J. 8. https://doi.org/10.14203/STIPM.2023.365

East, R., 1993. Investment decisions and the theory of planned behaviour. J. Econ. Psychol. 14, 337–375. https://doi.org/10.1016/0167-4870(93)90006-7

Fortune Business Insights, 2024. Electric Motor Market Size, Share, and Industry Analysis.

Foster, C., Heeks, R., 2013. Innovation and Scaling of ICT for the Bottom-Of-The-Pyramid. J. Inf. Technol. 28, 296–315. https://doi.org/10.1057/jit.2013.19

Franklin, S.J., Wright, M., Lockett, A., 2001. Academic and Surrogate Entrepreneurs in University Spin-out Companies. J. Technol. Transf. 26, 127–141. https://doi.org/10.1023/A:1007896514609

González, J.V., Zambalde, A.L., Grützmann, A., Furtado, T.B., 2018. Critical Success Factors (CSF) to Commercializing Technologies in Universities: The Radar Framework, in: Kő, A., Francesconi, E. (Eds.), Electronic Government and the Information Systems Perspective, Lecture Notes in Computer Science. Springer International Publishing, Cham, pp. 123–135. https://doi.org/10.1007/978-3-319-98349-3_10

Gudivada, V.N., Rao, D.L., Gudivada, A.R., 2018. Information Retrieval: Concepts, Models, and Systems, in: Handbook of Statistics. Elsevier, pp. 331–401. https://doi.org/10.1016/bs.host.2018.07.009

Gulbranson, C.A., Audretsch, D.B., 2008. Proof of concept centers: accelerating the commercialization of university innovation. J. Technol. Transf. 33, 249–258. https://doi.org/10.1007/s10961-008-9086-y

Harman, G., 2010. Funding of University Research, in: International Encyclopedia of Education. Elsevier, pp. 279–285. https://doi.org/10.1016/B978-0-08-044894-7.00878-2

Jensen, R., Thursby, M., 2001. Proofs and Prototypes for Sale: The Licensing of University Inventions. Am. Econ. Rev. 91, 240–259. https://doi.org/10.1257/aer.91.1.240

Kenney, M., Patton, D., 2009. Reconsidering the Bayh-Dole Act and the Current University Invention Ownership Model. Res. Policy 38, 1407–1422. https://doi.org/10.1016/j.respol.2009.07.007

Kirchberger, M.A., Pohl, L., 2016. Technology commercialization: a literature review of success factors and antecedents across different contexts. J. Technol. Transf. 41, 1077–1112. https://doi.org/10.1007/s10961-016-9486-3

Lee, K.-J., Yun, Y.-J., 2020. Reconciling Resource-Based View and Competency-Based View of Start-Up Formation in Universities. IEEE Access 8, 143274–143284. https://doi.org/10.1109/ACCESS.2020.3014213

Litan, R.E., Mitchell, L., Reedy, E.J., 2007. Commercializing University Innovations: Alternative Approaches. Innov. Policy Econ. 8, 31–57. https://doi.org/10.1086/ipe.8.25056198

Loganayaki, A., Kumar, R.B., 2019. Permanent Magnet Synchronous Motor for Electric Vehicle Applications, in: 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS). Presented at the 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS), IEEE, Coimbatore, India, pp. 1064–1069. https://doi.org/10.1109/ICACCS.2019.8728442

Ma, C.-A., Xiao, R., Chang, H.-Y., Song, G.-R., 2022. Founder Management and Innovation: An Empirical Analysis Based on the Theory of Planned Behavior and Fuzzy-Set Qualitative Comparative Analysis. Front. Psychol. 13, 827448. https://doi.org/10.3389/fpsyg.2022.827448

Maresova, P., Stemberkova, R., Fadeyi, O., 2019. Models, Processes, and Roles of Universities in Technology Transfer Management: A Systematic Review. Adm. Sci. 9, 67. https://doi.org/10.3390/admsci9030067

Markman, G.D., Gianiodis, P.T., Phan, P.H., Balkin, D.B., 2005. Innovation speed: Transferring university technology to market. Res. Policy 34, 1058–1075. https://doi.org/10.1016/j.respol.2005.05.007

Mohammad, K.S., Jaber, A.S., 2022. Comparison of electric motors used in electric vehicle propulsion system. Indones. J. Electr. Eng. Comput. Sci. 27, 11. https://doi.org/10.11591/ijeecs.v27.i1.pp11-19

Mouterde, P., 2024. Rare-earth mining in Myanmar: “An extreme example of widespread destruction.” Gd. View Res.

Mowery, D.C., Nelson, R.R., Sampat, B.N., Ziedonis, A.A., 2001. The growth of patenting and licensing by U.S. universities: an assessment of the effects of the Bayh–Dole act of 1980. Res. Policy 30, 99–119. https://doi.org/10.1016/S0048-7333(99)00100-6

Munari, F., Sobrero, M., Toschi, L., 2018. The university as a venture capitalist? Gap funding instruments for technology transfer. Technol. Forecast. Soc. Change 127, 70–84. https://doi.org/10.1016/j.techfore.2017.07.024

Munari, F., Sobrero, M., Toschi, L., 2017. Financing technology transfer: assessment of university-oriented proof-of-concept programmes. Technol. Anal. Strateg. Manag. 29, 233–246. https://doi.org/10.1080/09537325.2016.1241874

Nam, D.-W., Lee, K., Song, S.-W., Kim, W.-H., Lee, J.-J., 2024. Study on Performance Improvement through Reducing Axial Force of Ferrite Double-Layer Spoke-Type Permanent Magnet Synchronous Motor with Core Skew. Machines 12, 280. https://doi.org/10.3390/machines12040280

Nieto Cubero, J., Gbadegeshin, S.A., Consolación, C., 2021. Commercialization of disruptive innovations: Literature review and proposal for a process framework. Int. J. Innov. Stud. 5, 127–144. https://doi.org/10.1016/j.ijis.2021.07.001

Olawore, Wong, 2022. Factors that Influence Successful Technology Commercialization, in: Proceedings of the International Conference on Industrial Engineering and Operations Management. Presented at the The 3rd Asia Pacific Conference on Industrial Engineering and Operations Management in Jahor Baru, Malaysia, IEOM Society International, Jahor Baru, Malaysia, pp. 118–129. https://doi.org/10.46254/AP03.20220022

Osano, H.M., 2023. Global scaling by SMEs: Role of innovation and technology. J. Int. Counc. Small Bus. 4, 258–281. https://doi.org/10.1080/26437015.2023.2201896

O'Shannassy, T., 2008. Sustainable competitive advantage or temporary competitive advantage: Improving understanding of an important strategy construct. J. Strategy Manag. 1, 168–180. https://doi.org/10.1108/17554250810926357

Owen, R., Vedanthachari, L.N., Hussain, J., 2024. The role of the university entrepreneurial ecosystem in entrepreneurial finance: case studies of UK innovation knowledge centres. Venture Cap. 26, 351–375. https://doi.org/10.1080/13691066.2023.2205606

Pries, F., Guild, P., 2005. Build, rent or sell: options for commercializing new technologies arising from university research, in: A Unifying Discipline for Melting the Boundaries Technology Management: Presented at the A Unifying Discipline for Melting the Boundaries Technology Management:, IEEE, Portland, OR, USA, pp. 470–479. https://doi.org/10.1109/PICMET.2005.1509726

Pujotomo, D., Syed Hassan, S.A.H., Ma'aram, A., Sutopo, W., 2023. University–industry collaboration in the technology development and technology commercialization stage: a systematic literature review. J. Appl. Res. High. Educ. 15, 1276–1306. https://doi.org/10.1108/JARHE-11-2022-0344

Raut, R.K., 2020. Past behaviour, financial literacy and investment decision-making process of individual investors. Int. J. Emerg. Mark. 15, 1243–1263. https://doi.org/10.1108/IJOEM-07-2018-0379

Rodríguez-Pinto, J., Carbonell, P., Rodríguez-Escudero, A.I., 2011. Speed or quality? How the order of market entry influences the relationship between market orientation and new product performance. Int. J. Res. Mark. 28, 145–154. https://doi.org/10.1016/j.ijresmar.2011.02.001

Santoro, M.D., Gopalakrishnan, S., 2001. Relationship Dynamics between University Research Centers and Industrial Firms: Their Impact on Technology Transfer Activities. J. Technol. Transf. 26, 163–171. https://doi.org/10.1023/A:1007804816426

Sayed, K., Aref, M., El-Zohri, H., Ahmed, A., 2023. Enhancing Real-Time Control of Brushless DC Motors for More Electric Aircraft. https://doi.org/10.20944/preprints202310.1234.v1

Scoltock, J., 2023. Magnet and rare-earth-free motors offer route to true EV sustainability [WWW Document]. Inst. Mech. Eng. URL https://www.imeche.org/news/news-article/magnet-and-rare-earth-free-motors-offer-route-to-true-ev-sustainability (accessed 11.14.24).

Shane, S., 2004. Academic Entrepreneurship: University Spinoffs and Wealth Creation. Edward Elgar Publishing. https://doi.org/10.4337/9781843769828

Sharma, P., 2020. Contingent firm factors and possible modes of university-developed technology acquisition: A conceptual model. J. High Technol. Manag. Res. 31, 100386. https://doi.org/10.1016/j.hitech.2020.100386

Siegel, D.S., Veugelers, R., Wright, M., 2007. Technology transfer offices and commercialization of university intellectual property: performance and policy implications. Oxf. Rev. Econ. Policy 23, 640–660. https://doi.org/10.1093/oxrep/grm036

Siegel, D.S., Waldman, D.A., Atwater, L.E., Link, A.N., 2003. Commercial knowledge transfers from universities to firms: improving the effectiveness of university–industry collaboration. J. High Technol. Manag. Res. 14, 111–133. https://doi.org/10.1016/S1047-8310(03)00007-5

Silva, M.D., Eriksson, S., 2022. On the Mitigation of Leakage Flux in Spoke Type Permanent Magnet Synchronous Machines, in: 2022 International Conference on Electrical Machines (ICEM). Presented at the 2022 International Conference on Electrical Machines (ICEM), IEEE, Valencia, Spain, pp. 302–308. https://doi.org/10.1109/ICEM51905.2022.9910669

Sørheim, R., Øystein Widding, L., Oust, M., Madsen, Ø., 2011. Funding of university spin-off companies: a conceptual approach to financing challenges. J. Small Bus. Enterp. Dev. 18, 58–73. https://doi.org/10.1108/14626001111106433

Tabora, J.M., De Lima Tostes, M.E., Bezerra, U.H., De Matos, E.O., Filho, C.L.P., Soares, T.M., Rodrigues, C.E.M., 2021. Assessing Energy Efficiency and Power Quality Impacts Due to High-Efficiency Motors Operating Under Nonideal Energy Supply. IEEE Access 9, 121871–121882. https://doi.org/10.1109/ACCESS.2021.3109622

Tabora, J.M., De Lima Tostes, M.E., De Matos, E.O., Bezerra, U.H., Soares, T.M., De Albuquerque, B.S., 2020. Assessing Voltage Unbalance Conditions in IE2, IE3 and IE4 Classes Induction Motors. IEEE Access 8, 186725–186739. https://doi.org/10.1109/ACCESS.2020.3029794

Tweheyo, G., Abaho, E., M Verma, A., 2022. The Commercialisation of University Research Outputs: A Review of Literature. Texila Int. J. Manag. 8, 144–162. https://doi.org/10.21522/TIJMG.2015.08.02.Art012

Vasudevan, H., 2021. RESOURCE-BASED VIEW THEORY APPLICATION ON THE EDUCATIONAL SERVICE QUALITY. Int. J. Eng. Appl. Sci. Technol. 6, 174–186. https://doi.org/10.33564/IJEAST.2021.v06i06.026

Wach, D., Kruse, P., Costa, S., Antonio Moriano, J., 2023. Exploring Social and Commercial Entrepreneurial Intentions from Theory of Planned Behaviour Perspective: A Cross-Country Study among Namibian and German Students. J. Soc. Entrep. 14, 226–247. https://doi.org/10.1080/19420676.2020.1863250

Wang, M., Cai, J., Soetanto, D., Guo, Y., 2023. Why do academic scientists participate in academic entrepreneurship? An empirical investigation of department context and the antecedents of entrepreneurial behavior. J. Small Bus. Manag. 61, 1497–1528. https://doi.org/10.1080/00472778.2020.1844486

Wang, Tsai, 2007. Absorptive Capacity as Fit in Interorganizational Technology Transfer Context. Pan-Pac. Manag. Rev. 10. https://doi.org/10.30166/PPMR.200707.0001

Winkelbach, A., Walter, A., 2015. Complex technological knowledge and value creation in science-to-industry technology transfer projects: The moderating effect of absorptive capacity. Ind. Mark. Manag. 47, 98–108. https://doi.org/10.1016/j.indmarman.2015.02.035

Wirsich, A., Kock, A., Strumann, C., Schultz, C., 2016. Effects of University–Industry Collaboration on Technological Newness of Firms. J. Prod. Innov. Manag. 33, 708–725. https://doi.org/10.1111/jpim.12342

Wonglimpiyarat, J., Yuberk, N., 2005. In support of innovation management and Roger's Innovation Diffusion theory. Gov. Inf. Q. 22, 411–422. https://doi.org/10.1016/j.giq.2005.05.005

Wright, M., Clarysse, B., Lockett, A., Knockaert, M., 2008. Mid-range universities' linkages with industry: Knowledge types and the role of intermediaries. Res. Policy 37, 1205–1223. https://doi.org/10.1016/j.respol.2008.04.021

Wright, P.M., Dunford, B.B., Snell, S.A., 2001. Human resources and the resource based view of the firm. J. Manag. 27, 701–721. https://doi.org/10.1177/014920630102700607

Yin, R.K., 2018. Case study research and applications: design and methods, Sixth edition. ed. SAGE, Los Angeles London New Delhi Singapore Washington DC Melbourne.

Zhou, C., Huang, X., Li, Z., Cao, W., 2021. Design Consideration of Fractional Slot Concentrated Winding Interior Permanent Magnet Synchronous Motor for EV and HEV Applications. IEEE Access 9, 64116–64126. https://doi.org/10.1109/ACCESS.2021.3073743

Zhou, X., Yang, J., Wang, J., Li, J., 2022. Model and simulation of the fuzzy reliability assessment of the electric vehicle motor. Adv. Mech. Eng. 14, 16878132221120406. https://doi.org/10.1177/16878132221120406