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RESEARCH ARTICLE

Applied of Resource Based View (RBV) Theory by Assessing Resource Heterogeneity in Relation to The Biomass Supply Chain in Malaysia

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ABSTRACT

Applied the Resource Based View (RBV) theory to the biomass supply chain in Malaysia involves analyzing the unique resources and capabilities within the context of the supply chain. Focus in assessing resource heterogeneity in relation to the biomass supply chain in Malaysia involves understanding the diversity and variability of biomass resources available across different regions or sources within the country. This study aims to identify the unique characteristics, strengths, and limitations of various biomass feedstocks, which can influence supply chain dynamics, technological choices, and strategic decision-making. The qualitative measure was conducted to find the potential criteria for assessing resource heterogeneity of biomass supply chain in Malaysia. Results show that biomass type, feedstock characteristics, sustainability aspects, technology compatibility, and logistics play crucial roles in assessing the comprehensive biomass supply chain. By conducting a systematic assessment of resource heterogeneity, stakeholders can gain valuable insights into the diversity and complexity of biomass feedstock availability and characteristics in Malaysia. This information can inform strategic decision-making, technology selection, supply chain optimization, and sustainability planning in the biomass sector.

INTRODUCTION

Malaysia remains steadfast in its commitment to strengthen the biomass sector, aligning with our nation's ambitions and aspirations. This research study was conducted in response to the National Biomass Action Plan (NBAP) 2023-2030 launched in December 2023. In line with this, the 12th Malaysia Plan has established an investment target for biomass as a strategic sector, foreseeing substantial contributions from oil palm biomass and forestry biomass. These sectors are highlighted for their mature ecosystems and abundant feedstock, which are integral to ongoing commercialization endeavors. This blueprint aligns seamlessly with the 12th Malaysia Plan (12MP), a comprehensive national development and advancement blueprint. By harnessing the latent potential of the biomass industry, our aim is to enhance the exports of biomass products while also addressing greenhouse gas (GHG) emissions through a circular economy framework tailored specifically for Agri commodities.

Applying the Resource-Based View (RBV) theory to the biomass supply chain in Malaysia entails conducting a thorough analysis of the distinctive resources and capabilities inherent within its complex network. Rooted in strategic management literature, RBV posits that a firm's competitive advantage stems from its internal resources and capabilities rather than external factors. Extending this framework to the biomass sector unveils a multifaceted exploration of Malaysia's biomass landscape, encompassing both tangible and intangible assets within the supply chain. Central to RBV analysis, is the assessment of resource heterogeneity, a critical dimension in understanding the diversity and variability of biomass resources available across different regions or sources within Malaysia. Unlike homogeneous resources, which are uniform in nature, heterogeneous resources exhibit variation in terms of quantity, quality, and accessibility. In the context of the biomass supply chain, resource heterogeneity manifests in the diverse array of feedstocks derived from agricultural residues, forestry products, and municipal waste, among others.

Therefore, there are need to conduct a study to identify the unique characteristics, strengths, and limitations of various biomass feedstocks, recognizing their pivotal role in shaping supply chain dynamics, technological choices, and strategic decision-making processes. By delving into the qualitative aspects of resource heterogeneity, we aim to establish essential criteria for assessing the comprehensive biomass supply chain in Malaysia. Our analysis encompasses a spectrum of factors, including biomass type, feedstock characteristics, sustainability aspects, technology compatibility, and logistics infrastructure. Significantly, the results of our qualitative measure underscore the critical role played by these factors in shaping the trajectory of the biomass sector in Malaysia. Biomass type and feedstock characteristics emerge as key determinants of energy yield, process efficiency, and environmental impact, influencing the selection of appropriate technologies and operational strategies. Moreover, sustainability considerations loom large in the decision-making process, with stakeholders increasingly prioritizing renewable and low-carbon solutions in alignment with global climate goals.

Furthermore, technology compatibility and logistics infrastructure are identified as pivotal enablers of supply chain efficiency and effectiveness. As the biomass sector transitions towards greater integration with advanced technologies such as bioenergy conversion, biorefining, and biomass gasification, the compatibility of these technologies with existing infrastructure becomes a critical consideration. Likewise, logistics infrastructure plays a central role in facilitating the movement of biomass feedstocks from source to processing facilities, influencing cost, timeliness, and reliability of supply. By conducting a systematic assessment of resource heterogeneity, stakeholders stand to gain valuable insights into the diversity and complexity of biomass feedstock availability and characteristics in Malaysia. This information serves as a foundation for informed strategic decision-making, technology selection, supply chain optimization, and sustainability planning within the biomass sector. In an era marked by increasing emphasis on renewable energy and sustainable development, understanding and leveraging the unique resources and capabilities within Malaysia's biomass supply chain are paramount for driving meaningful progress towards a greener future.

2 LITERATURE REVIEW

The pursuit of sustainable energy solutions has become an imperative in the face of global environmental challenges. Among the myriad renewable energy sources, biomass holds significant promise, leveraging organic materials to generate power while mitigating carbon emissions. Within this landscape, Malaysia emerges as a compelling case study, endowed with abundant biomass resources and a burgeoning renewable energy sector. However, harnessing the full potential of biomass necessitates a nuanced understanding of its supply chain dynamics, resource heterogeneity, and strategic implications. The review of literature in this study delves into the foundational principles of Resource-Based View (RBV) and the concepts of supply chain management. Within this framework, particular attention will be paid to the biomass supply chain in Malaysia, emphasizing the diverse nature of resources and the fundamental aspects of biomass products. There is important to link the RBV in principle to the resource heterogeneity in the biomass and its supply chain in Malaysia.

2.1 Resource-Based View (RBV)

The primary scholar associated with the development of the RBV of the firm is Jay Barney. In his seminal work, particularly the paper titled "Firm Resources and Sustained Competitive Advantage" published in the

Journal of Management in 1991 Barney, (1991) outlined the foundational concepts of RBV theory. In this paper, Barney delves into the idea that a firm's resources and capabilities are fundamental to achieving sustained competitive advantage. While other scholars like Prahalad and Hamel (1994) elaborated on the Resource-Based View (RBV) of the firm, which is a theoretical framework employed in strategic management to examine a firm's competitive advantage. This viewpoint proposes that a firm's resources and capabilities are the fundamental factors influencing its performance and enduring competitive advantage.

The RBV is foundation to strategic management, offering insights into how firms can achieve and sustain competitive advantage through the strategic deployment of their internal resources and capabilities (Madhani, 2010). Originating in the 1980s, RBV has since evolved into a prominent framework for understanding the sources of firm performance, innovation, and long-term success. Thus, comprehensive overview of RBV, exploring its theoretical foundations, key concepts, empirical applications, and practical implications for strategic decision-making has been discussed further.

RBV is rooted in the seminal works of Penrose (1959), Wernerfelt (1984), and Barney (1991), each of whom contributed to the development of the theory's core principles (Lockett, 2005). Penrose's theory of the firm emphasized the role of internal resources in driving organizational growth and diversification, highlighting the dynamic nature of resource accumulation and utilization. According to Wernerfelt (2016) resource-based perspective introduced the concept of resource heterogeneity and immobility, arguing that firms could achieve sustained competitive advantage by possessing unique, valuable, and non-substitutable resources. In addition, Barney (1991) refined RBV, introducing the notion of strategic resources or capabilities that are rare, valuable, imperfectly imitable, and non-substitutable (VRIN). The framework was later enhanced from VRIN to VRIO by incorporating the question: "Is a company organized to exploit these resources?" Rothaermel (2013) refined the VRIO framework by posing questions about the organization's resources and capabilities in terms of value, rarity, imitability, and organization.

Comprehensively, when considering the VRIO framework as a whole, sustainable competitive advantage is attained if the organization can effectively exploit valuable, rare, and imitable resources (Schneider & Spieth, 2013). Figure 1 illustrates the VRIO framework for achieving competitive advantage.

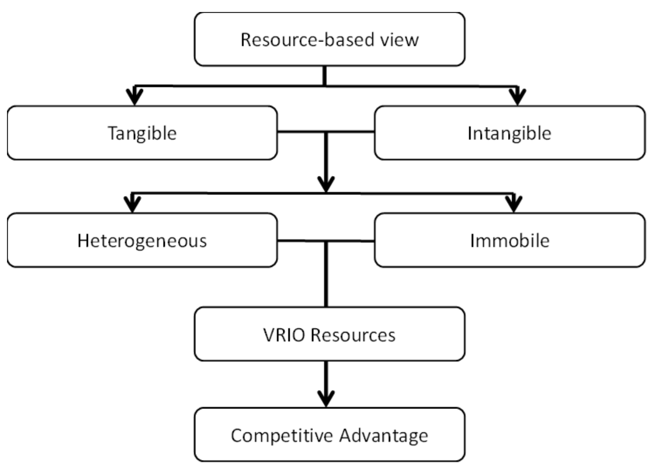

Figure 1: The VRIO framework.

At the heart of RBV lies the notion of resources and capabilities, which encompass tangible and intangible assets, knowledge, skills, and organizational routines that enable firms to achieve their strategic objectives. Resources can be categorized into physical, human, organizational, and intangible assets, each of which contributes to a firm's competitive advantage in different ways. Capabilities, on the other hand, refer to the firm's ability to deploy and integrate resources effectively to create value for customers and stakeholders (Wernerfelt (2016). RBV posits that firms can achieve sustained competitive advantage by leveraging their unique bundle of resources and capabilities to create value in ways that are difficult for competitors to replicate. This competitive advantage can manifest in various forms, including cost leadership, differentiation, innovation, customer responsiveness, and market positioning. Importantly, RBV emphasizes the role of firm-specific advantages rather than industry structure or market positioning in driving long-term success (Teece et al.1997).

Empirical research in strategic management has applied RBV to a wide range of industries and contexts, shedding light on its relevance and applicability in real-world settings. Studies have explored the role of RBV in explaining firm performance, competitive dynamics, strategic decision-making, and innovation across diverse sectors, including manufacturing, services, technology, and healthcare. Peteraf and Barney (2003) analyzed how firm-specific resources and capabilities contribute to creating a lasting competitive advantage within the pharmaceutical industry. The study found that firms with superior R&D capabilities, intellectual property portfolios, and strategic alliances were able to outperform competitors and maintain leadership positions in the market. Similarly, investigations by Teece et al. (1997) focused on the strategic management of intellectual property and technological innovation, highlighting the importance of dynamic capabilities in shaping firms' ability to adapt to changing market conditions, technological advancements, and competitive threats. The study emphasized the role of RBV in explaining differences in firms' innovation performance and long-term viability.

From a practical standpoint, RBV offers valuable insights for firms seeking to enhance their competitive position and achieve sustainable growth. Through a systematic analysis of their internal resources and capabilities, companies can discern their strengths, weaknesses, opportunities, and threats in comparison to competitors and market conditions. This process of strategic introspection enables firms to develop tailored strategies that leverage their unique assets and address areas of vulnerability. RBV also informs strategic decision-making processes such as resource allocation, investment prioritization, mergers and acquisitions, and strategic alliances. By aligning resource investments with strategic priorities and competitive advantages, firms can enhance their performance, profitability, and resilience in the face of market uncertainties and competitive pressures.

The RBV represents a powerful framework for understanding the sources of competitive advantage and long-term success in strategic management. Rooted in the seminal works of Penrose (1959), Wernerfelt (1984), and Barney (1991), RBV emphasizes the role of internal resources and capabilities in driving firm performance, innovation, and strategic adaptation. Empirical research has validated the relevance and applicability of RBV across diverse industries and contexts, highlighting its implications for firm strategy, competitive dynamics, and innovation management. Moving forward, continued research and application of RBV principles are essential for firms seeking to navigate complex and dynamic business environments and achieve sustainable growth in the long term.

2.2 Supply Chain Management

Supply chain management (SCM) has emerged as a critical discipline in contemporary business operations, playing a pivotal role in driving efficiency, resilience, and competitiveness across industries. This literature review aims to provide a comprehensive overview of SCM, exploring its conceptual foundations, key principles, empirical evidence, and practical implications for businesses and practitioners (Yuan & Xue, 2023). At its essence, Supply Chain Management (SCM) involves the design, planning, execution, control, and optimization of processes and activities related to the movement of goods, services, information, and finances from raw material suppliers to end customers (Cahyono et al., 2023). The concept of SCM originated in the 1980s as a response to the increasing complexity and globalization of supply chains, with scholars and practitioners seeking to develop frameworks and methodologies for managing interconnected networks of suppliers, manufacturers, distributors, and retailers Indeed, the SCM covers the sustainability of supply chain which is considering the balance of the elements such as environment, economy and social, as shown in Figure 2 (Carter & Easton, 2011).

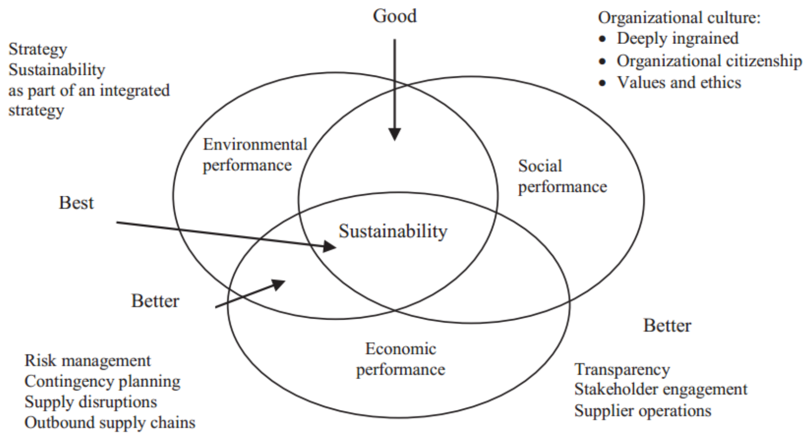

Figure 2: Sustainable supply chain management.

Several key principles underpin the discipline of SCM, including integration, coordination, collaboration, visibility, and agility. Integration refers to the seamless alignment of activities and processes across the supply chain, from procurement and production to distribution and customer service (Katsaliaki, et al. 2023). Coordination involves synchronizing the activities of various stakeholders to minimize bottlenecks, reduce lead times, and optimize resource utilization. Collaboration emphasizes the importance of partnerships and alliances among supply chain partners, fostering trust, information sharing, and joint problem-solving. Visibility entails the ability to track and monitor the flow of goods and information throughout the supply chain, enabling proactive decision-making and risk management. Agility refers to the ability to respond quickly and effectively to changes in customer demand, market conditions, or internal disruptions, leveraging flexibility, responsiveness, and innovation to maintain competitive advantage (Durugbo & Al-Balushi, 2023).

Empirical research in SCM has examined a wide range of topics and issues, including supply chain design, inventory management, transportation logistics, demand forecasting, and sustainability. Studies have investigated the impact of SCM practices on firm performance, customer satisfaction, and operational efficiency across diverse industries and contexts. As mentioned by Chopra and Meindl (2007) the role of supply chain design in achieving strategic objectives such as cost reduction, service differentiation, and risk mitigation. The study highlighted the importance of aligning supply chain design decisions with business strategy, market dynamics, and customer requirements to create competitive advantage. Meanwhile, research conducted by Lee et al. (2004) centered on the concept of supply chain agility, exploring methods through which companies can improve their ability to respond to shifting market conditions and customer preferences. The study identified organizational factors, such as leadership, culture, and information technology, as key determinants of supply chain agility, highlighting the importance of fostering a culture of innovation and continuous improvement.

From a practical standpoint, SCM offers valuable insights and tools for businesses seeking to enhance their supply chain performance and competitiveness. By adopting best practices in areas such as demand planning, inventory optimization, supplier relationship management, and logistics optimization, firms can streamline their operations, reduce costs, and improve customer satisfaction (Mahdavisharif et al. 2022). Moreover, SCM enables firms to identify and mitigate risks associated with supply chain disruptions, such as natural disasters, geopolitical events, or fluctuations in raw material prices. By developing robust risk management strategies, including contingency planning, supplier diversification, and supply chain mapping, firms can enhance their resilience and adaptability in the face of uncertainty (Zaverbnyj & Pushak, 2022).

The SCM plays a central role in driving operational excellence, customer satisfaction, and competitive advantage in today's globalized business environment (Orr & Jadhav, 2018). Drawing on conceptual foundations, key principles, empirical evidence, and practical implications, this literature review of SCM has provided a comprehensive overview of SCM, highlighting its significance for businesses, practitioners, and scholars alike. Moving forward, continued research and innovation in SCM are essential for addressing emerging challenges, seizing opportunities, and driving sustainable growth and prosperity in the years to come (Frederico et al. 2020).

2.3 Biomass

This literature review aims to provide a comprehensive overview of biomass, exploring its various forms, sources, applications, benefits, challenges, and implications for environmental sustainability and energy security. Biomass, originating from organic sources like plants, animal waste, and agricultural leftovers, offers substantial potential as a renewable and sustainable reservoir of energy, fuels, and materials (Bonechi et al., 2017). Biomass becomes a potential fuel for energy transition and contributes to the circular economy (Sherwood, 2020). The source of biomass is from nature. Biomass encompasses a wide range of organic materials, as shown in Table 1 below:

Table 1: Biomass encompasses.

Biomass	Source of biomass
Agricultural Residues	Crop residues such as straw, husks, stalks, and stems left after harvesting grains, fruits, and vegetables.
Forestry Products	Wood chips, sawdust, bark, and branches generated from forestry operations, timber processing, and forest management activities.
Animal Waste	Manure, litter, and byproducts from livestock farming, poultry production, and animal husbandry
Municipal Solid Waste	Organic components of household waste, including food scraps, yard trimmings, paper, and cardboard.

Each form of biomass has unique characteristics, composition, and potential applications, depending on its source, availability, and processing requirements (Bar-On et al. 2018). As mentioned by Bridgwater (2006), biomass can be converted into various forms of energy, fuels, and materials through processes such as combustion, gasification, fermentation, and biochemical conversion. Key applications of biomass as per Table 2 below.

Table 2: Biomass process and application

Process Biomass	Application
Bioenergy	Biomass is used as a feedstock for the production of biofuels such as bioethanol, biodiesel, and biogas, which can be used for transportation, heating, and electricity generation.
Biorefining	Biomass can be processed in biorefineries to produce a range of value-added products such as biochemicals, bioplastics, and biomaterials, offering alternatives to fossil-based materials and chemicals.
Biomass Power	Biomass power plants use combustion or gasification technologies to generate electricity from biomass feedstocks, providing a renewable and low-carbon source of power.
Biomass Heat	Biomass boilers and stoves utilize biomass fuels such as wood pellets, chips, and briquettes to provide space heating and hot water in residential, commercial, and industrial settings.

Biomass offers several benefits as a renewable and sustainable energy source such as Carbon Neutrality where the biomass combustion releases carbon dioxide (CO_2) into the atmosphere, but the carbon emitted is offset by the carbon absorbed during the growth of biomass feedstocks, making biomass a carbon-neutral energy source (Zhang et al. 2023). Biomass is renewable because it derived from organic materials that can be replenished through natural processes such as photosynthesis, making it a renewable and readily available source of energy and materials. In addition, biomass can reduce the waste by utilizing it and helps to divert organic waste from landfills, reducing methane emissions and environmental pollution while contributing to waste management and resource recovery efforts (Clauser et al. 2021). As potential fuel, biomass offers a domestic and locally available source of energy, reducing dependence on imported fossil fuels and enhancing energy security and resilience. Despite its benefits, biomass utilization faces several challenges and limitations:

Resource Availability: Biomass availability can be variable and seasonal, depending on factors such as crop yields, forestry practices, and waste generation rates, posing challenges for consistent and reliable supply.

Feedstock Quality: Biomass feedstocks vary in composition, moisture content, energy density, and impurities, which can affect the efficiency and performance of biomass conversion processes.

Technological Constraints: Biomass conversion technologies such as combustion, gasification, and fermentation require specialized equipment, infrastructure, and expertise, which may be lacking in certain regions or industries.

Environmental Impacts: The utilization of biomass can result in environmental consequences such as changes in land use, deforestation, air pollution, and water consumption. These impacts must be carefully monitored and mitigated to ensure sustainability.

Biomass utilization has significant implications for environmental sustainability, including:

Climate Change Mitigation: Biomass utilization can help reduce greenhouse gas emissions by displacing fossil fuels and sequestering carbon through sustainable forestry and land management practices.

Biodiversity Conservation: Sustainable biomass production and harvesting practices can enhance ecosystem resilience, protect biodiversity, and promote habitat conservation and restoration efforts.

Air Quality Improvement: Technologies for biomass combustion have the potential to decrease air pollution emissions like sulfur dioxide (SO_2), nitrogen oxides (NO_x), and particulate matter (PM), thereby enhancing air quality and public health.

Circular Economy: Biomass utilization contributes to the transition to a circular economy by promoting resource efficiency, waste valorization, and the closed-loop utilization of organic materials and nutrients.

Biomass represents a versatile and sustainable source of energy, fuels, and materials with significant potential for mitigating climate change, enhancing energy security, and promoting environmental sustainability (Nunes et al. 2020). By comprehending the diverse forms, sources, applications, benefits, challenges, and implications of biomass utilization, stakeholders can make informed decisions and formulate strategies to fully harness the potential of biomass for a more environmentally friendly and sustainable future. Continued research, innovation, and policy support are essential for advancing biomass technologies, improving biomass supply chains, and maximizing the environmental and socio-economic benefits of biomass utilization.

As of the status, the biomass industry in Malaysia is experiencing steady growth and increasing importance as the country seeks to diversify its energy sources, promote sustainable development, and reduce greenhouse gas emissions (Mekhilef et al. 2011). Malaysia, endowed with abundant biomass resources such as palm oil residues, forestry products, and agricultural residues, has positioned itself as a key player in the global biomass market (Rashidi et al. 2022). Here are some key aspects of the current status of the biomass industry in Malaysia:

Palm Oil Biomass Utilization: Malaysia is the world's second-largest producer of palm oil, generating significant amounts of biomass residues such as palm kernel shells (PKS), empty fruit bunches (EFB), and palm oil mill effluent (POME). These biomass residues are increasingly being utilized for energy production, biorefining, and value-added applications. Palm oil mills have been making investments in biomass boilers and biogas plants to produce electricity and heat, thereby decreasing reliance on fossil fuels and lessening environmental impacts.

Government Support and Policies: The Malaysian government has been supportive of the biomass industry, implementing policies and initiatives to promote biomass utilization, research and development, and investment in biomass technologies. The National Biomass Strategy 2020 aims to increase the contribution of biomass to Malaysia's energy mix, enhance sustainability in the palm oil industry, and create economic opportunities in rural areas.

Technological Advancements: Advancements in biomass conversion technologies have allowed for the more efficient and cost-effective use of biomass resources. Innovations in biomass gasification, biorefining, and waste-to-energy processes have expanded the range of biomass applications, including bioenergy, biofuels, biochemicals, and biomaterials. Research and development efforts are focused on improving process efficiency, product quality, and environmental performance.

Industry Collaboration and Partnerships: Collaboration between industry players, research institutions, and government agencies has been instrumental in advancing the biomass industry in Malaysia. Public-private partnerships, joint ventures, and technology transfer initiatives have facilitated the transfer and adoption of biomass technologies, knowledge sharing, and capacity building. Industry associations such as the Malaysian Biomass Industries Confederation (MBIC) promote networking, advocacy, and knowledge exchange among stakeholders.

Sustainability and Environmental Concerns: Sustainability considerations are increasingly important in the Malaysian biomass industry, with stakeholders focusing on sustainable sourcing practices, environmental management, and social responsibility. Efforts are underway to promote sustainable palm oil production practices, reduce greenhouse gas emissions from biomass utilization, and minimize environmental impacts such as deforestation, air pollution, and water contamination.

Market Opportunities and Challenges: The growing global demand for renewable energy, biofuels, and sustainable products presents market opportunities for the Malaysian biomass industry. However, challenges such as biomass resource variability, technological constraints, regulatory compliance, and market competition need to be addressed to unlock the full potential of the biomass sector. Investments in infrastructure, research and development, and skills development are needed to overcome these challenges and capitalize on market opportunities.

In conclusion, the biomass industry in Malaysia is poised for continued growth and development, driven by government support, technological advancements, industry collaboration, and market demand for sustainable solutions. By addressing challenges and leveraging opportunities, Malaysia can position itself as a leading player in the global biomass market, contributing to energy security, environmental sustainability, and economic prosperity.

2.4 Resource Heterogeneity in the Biomass Supply Chain

Resource heterogeneity stands as a cornerstone concept within strategic management literature, emphasizing the diverse and varied nature of resources possessed by organizations or industries. Within the context of the biomass supply chain, resource heterogeneity assumes heightened significance, shaping the dynamics of resource allocation, technological innovation, and strategic decision-making (Kokkinou & Artavani, 2017). This literature review aims to explore the theoretical underpinnings, empirical evidence, and practical implications of resource heterogeneity in the biomass sector, shedding light on its implications for sustainable energy development in Malaysia and beyond.

As explained before, the RBV provides a theoretical lens through which to analyze resource heterogeneity within the biomass supply chain. Originating in the field of strategic management, RBV posits that a firm's competitive advantage stems from its unique bundle of internal resources and capabilities (Priem & Swink, 2012). Meanwhile, according to Bell et al. (2013) resources are defined as tangible or intangible assets that enable firms to conceive and implement strategies that improve efficiency, effectiveness, and ultimately, performance. Heterogeneity, in this context, refers to the diversity and variability of resources across different firms or within the same firm over time (Ketokivi, 2016). Applying RBV to the biomass sector, resource heterogeneity manifests in the varied composition, quality, and accessibility of biomass feedstocks available for energy production. As mentioned before, the biomass resources consist of a diverse range of organic materials, such as agricultural residues, forestry products, animal waste, and municipal solid waste (Guang et al., 2012). The heterogeneity of these resources lies in their geographical distribution, chemical composition, moisture content, energy density, and availability throughout the year. Understanding and leveraging this resource heterogeneity are critical for optimizing supply chain efficiency, technological selection, and strategic decision-making in the biomass sector (Kotzab et al. 2015).

Empirical studies have explored resource heterogeneity within the biomass supply chain, elucidating its implications for technology adoption, supply chain management, and environmental sustainability. Goh (2020) examined the resource heterogeneity of palm oil biomass in Malaysia, highlighting the diverse characteristics and potential applications of palm oil mill effluent (POME), empty fruit bunches (EFB), and palm kernel shell (PKS) in bioenergy production. The study found that the heterogeneity of palm oil biomass necessitates tailored technological solutions and supply chain strategies to maximize value creation and minimize environmental impact. Similarly, investigations by Ho et al. (2019) focused on resource heterogeneity in agricultural biomass supply chains, analyzing the variability of feedstock characteristics, logistics infrastructure, and technological requirements across different agricultural regions in Malaysia. The study underscored the importance of considering resource heterogeneity in biomass supply chain planning, emphasizing the need for location-specific strategies to optimize feedstock sourcing, transportation, and processing.

From a practical standpoint, understanding resource heterogeneity is essential for stakeholders involved in biomass production, processing, and utilization. For policymakers, recognizing the diverse nature of biomass resources informs the development of supportive regulatory frameworks, financial incentives, and technological innovation initiatives (Alhashimi et al. 2023). By aligning policies with resource heterogeneity, governments can stimulate investment in biomass infrastructure, encourage research and development in biomass conversion technologies, and promote sustainable biomass cultivation practices. For biomass producers and processors, resource heterogeneity necessitates the adoption of flexible and adaptable supply chain strategies (Bell et al. 2013). This may involve diversifying feedstock sources, investing in technology platforms capable of handling multiple biomass types, and collaborating with stakeholders along the supply chain to optimize resource utilization and minimize waste. Moreover, understanding resource heterogeneity enables producers to identify niche markets and value-added opportunities, thereby enhancing competitiveness and profitability in the biomass sector.

Resource heterogeneity lies at the heart of strategic decision-making in the biomass supply chain, shaping the trajectory of technological innovation, supply chain management, and sustainability practices (Kunc & Morecroft, 2010). Drawing on the theoretical insights of RBV and empirical evidence from the literature, this review has elucidated the conceptual underpinnings, empirical findings, and practical implications of resource heterogeneity in the biomass sector. Looking ahead, ongoing research and partnerships are vital for unlocking the complete potential of biomass resources, promoting sustainable energy development, and fostering environmental stewardship in Malaysia and globally.

As deliberated, the SCM plays a crucial role in the efficient and effective operation of industries, including the biomass sector. In Malaysia, the biomass industry holds significant potential for renewable energy production, environmental sustainability, and economic development. Thus, the study to explore the application of supply chain management in the Malaysian biomass industry, highlighting its challenges, opportunities, and implications for sustainable growth and competitiveness. Moreover, the Malaysian biomass industry encompasses a diverse range of organic materials, including agricultural residues, forestry products, palm oil biomass, and municipal solid waste. These biomass resources hold immense potential for bioenergy production, biorefining, and value-added applications such as bio-based chemicals and materials. Malaysia's strategic geographical location, abundant natural resources, and supportive policy framework have positioned it as a key player in the global biomass market.

However, the development of the Malaysian biomass industry is not without challenges. These include issues related to resource availability and accessibility, technological readiness, infrastructure development, regulatory compliance, and market competitiveness. Effective supply chain management is essential for addressing these challenges and unlocking the full potential of the biomass sector in Malaysia.

3 METHODOLOGY

This study adopts a qualitative approach to comprehensively explore the RBV theory in relation to the biomass supply chain phenomena in Malaysia. Qualitative research entails selecting participants based on their firsthand experiences with the phenomenon under investigation, as advocated by Streubert and Carpenter (1999). Unlike quantitative studies, qualitative research does not prioritize random selection of individuals, as its focus lies more on understanding rather than manipulation, control, or generalization of findings (Silverman, 2011). Therefore, this study employs a small, purposive sample, with the sample size not predetermined. Additionally, the study will involve a select group of top management as participants, while employees attached to the operations department will be the focus of the quantitative research component.

3.1 Research Phase

As mentioned before, the study will be carried out in two phases utilizing a qualitative method. Table 3 outlines the research phases as proposed by the researcher. Phase one serves as the exploratory stage, dedicated to problem identification and enhancing the existing knowledge base through an in-depth review of supply chain management literature. Phase two consists of adaptation of information from Phase 1 and consequently formulating research questions and establishing research objectives. The third phase concentrates on qualitative analysis, employing various qualitative methods to gather information. During this phase, the researcher will conduct interview sessions with pertinent parties and individuals knowledgeable about the case. The results from these interviews will then be scrutinized and analyzed further.

Table 3: Exploratory stage (Qualitative Analysis)

Phase	Activities
1	Identify problem statement. Literature review
2	Establish research questions. Develop research objectives
3	Focus Group Interview Data Analysis

3.2 Interview and Focus Group

As discussed by Hennink et al. (2020) focus groups are commonly utilized in the business world, particularly in research within psychology and education fields. McMillan and Schumacher (2001) support this by noting that focus groups can generate and develop concepts or theoretical explanations based on participants' experiences and histories. Therefore, to ensure a comprehensive and precise data collection, the researcher strategically organizes the interview session with experienced employees within ten companies involves in this biomass supply chain industry in Malaysia. Group Interview 1 involves top management, specifically executives responsible for managing and the industry players involved in the biomass supply chain. Throughout the interview session, the focus group persistently examines observations, perspectives, and thoughts.

Following recommendations by Blackburn and Stokes (2000), each focus group comprises three to eight members, carefully recruited to ensure effective group management. Morgan et al. (1998) advises that smaller focus groups make it easier for researchers to capture information during discussions. Moreover, smaller groups encourage active participation as more time is allocated to individual sessions. Therefore, the researcher divides the focus groups into two different groups of suppliers with distinct participants. The composition of these focus groups is detailed in Table 4 below.

Table 4: Composition of the Focus Group

Participants	Focus Group	Number of Participants
Top Management	Interview	4
Executive	Group Interview	6
Total Participants		**10**

The session for Interview 1 will be conducted individually at a suitable workplace, while Group Interview 2 will take place in a group format. In total, ten members of biomass suppliers in Malaysia participated during the qualitative stage of data collection. All members received an invitation letter to participate in this study and have officially agreed to be involved. To ensure the interview sessions are well-managed, a discussion guide, topic agenda, and time allocation have been established as detailed in Table 5.

Table 5: Discussion Guideline

Agenda	Discussion topic
Introduction	Introduce the researcher and roles. Aim and format of the interview session. Conventions (confidentiality, speak one at a time, recordings, everybody's views, open debate, report of proceeding)
Contents	What types of biomass resources are currently being utilized in Malaysia? What are the main challenges in sourcing biomass for the supply chain? How do different regions in Malaysia vary in terms of biomass availability? Are there specific agricultural or industrial byproducts that could be utilized more effectively?
Recommendations & Closing Remarks	What is the personal view looking at the biomass market in Malaysia? How can the authority body/policy maker help the industries to growth?

During interviews or focus groups, take detailed notes of the responses and any insights provided by stakeholders. Pay attention to recurring themes, unique perspectives, and potential criteria that emerge from the discussions. Furthermore, the researcher developed a strategic mapping to organize all the information gathered. Additionally, the input is categorized accordingly for better clarity and understanding.

3.3 Insight Due Diligence

In addition to strengthening the data information, the researcher conducts the visit biomass to witness naturally. The activities covering the observation of the production sites, processing facilities, and relevant areas to observe firsthand the diversity of biomass resources. This can provide valuable insights into the availability, quality, and logistical aspects of different biomass sources.

Insight of conducting due diligence at a biomass factory plant, there are several key elements that have been observed and evaluated. These elements are to ensure that the factory is operating efficiently, ethically, and in compliance with relevant laws and standards. For this study, the elements that have been involved are shown in Table 6 below.

Table 6: Element for due diligence

Elements	**Description**
Production Capacity	Evaluate the factory's production capacity to ensure it can meet the demand for its products. Consider factors such as machinery, workforce, production schedules, and any constraints that may affect capacity.
Legal Compliance	Ensure that the factory is operating within the legal framework of the country, including labor laws, environmental regulations, health and safety standards, and any other relevant laws. Check for licenses and permits that are required for the operation of the factory.
Quality Control	Inspect the quality control processes in place to ensure that products meet required standards. Look for evidence of quality control documentation, testing procedures, and adherence to industry standards.
Financial Health	Review financial statements and records to assess the financial health of the factory. Look for any signs of financial distress, such as debt levels, cash flow issues, or irregularities in financial reporting.
Labor Practices	Evaluate working conditions, including safety measures, employee rights, working hours, and wages. Check for any history of labor violations or complaints.
Supply Chain Management	Assess the factory's supply chain, including sources of raw materials and any subcontractors. Look for risks related to supply chain disruptions, such as reliance on a single supplier or geopolitical factors.
Environmental Impact	Examine the factory's impact on the environment, including waste management, emissions, and pollution control measures. Ensure compliance with environmental regulations and standards.
Governance	Assess the management team and their experience in running the factory. Review corporate governance structures and policies.
Customer Relationships	Understand the factory's relationships with its customers, including any long-term contracts or partnerships. Assess customer satisfaction and any issues that may impact future business.
Intellectual Property	Ensure that the factory respects intellectual property rights, both in terms of its own products and any products it manufactures for others. Check for any history of intellectual property disputes.
Health and Safety	Inspect the workplace for adherence to health and safety regulations. Look for safety equipment, procedures, training programs, and incident records.
Technology and Innovation	Assess the factory's technological capabilities and innovation strategies.

	Look for investments in new technologies, research and development activities, and patents.
Social Responsibility	Consider the factory's impact on the local community and its social responsibility initiatives. Look for contributions to community development, education, or other social causes.

These are key elements to observe during due diligence at a factory of biomass production. It is crucial to conduct a thorough and comprehensive assessment to mitigate risks and make informed decisions regarding biomass production within the total supply chain of biomass production in Malaysia.

4 RESULTS AND FINDINGS

The study analyzes the input from the interview session as a tool in getting the information. The researcher categorizes the information and essential data to the group of independent and dependent variables. These fundamental concepts scrutinize the variable to ensure the importance of key variable in biomass supply chain.

4.1 Supply chain variables

For this study, the Independent Variable (IV) explained the variable that the experimenter deliberately changes or manipulates in the biomass supply chain. The variable cater for its variation is not influenced by other factors in the study. Meanwhile, the Dependent Variable (DV) for this study described the variable that responds to the changes in the IV of biomass supply chain. The DV was chosen because its variation depends on the changes in the IV of biomass supply chain. The DV is the outcome that is measured or observed in response to the manipulation of the IV of biomass supply chain. In addition to that, the relationship between the IV and DV is often explored to understand cause and effect. By manipulating the IV and observing changes in the DV, the researcher illustrated how the IV affects the DV for this study. Figure 3 below is presented the framework and relationship of IV and DV for biomass supply chain in Malaysia in relation to the RBV theory.

As for the independent variables, these could encompass various factors that influence the performance of the biomass supply chain in Malaysia. The independent variable for this study is:

Biomass Resource: Factors such as crop yields, land availability, and weather conditions impacting the quantity and quality of biomass feedstock. The quantity of biomass is primarily tied to its production and forecasting as a secondary product, whereas the quality of biomass is associated with the specifications required for it to become a secondary product.

Technological Innovation: Advancements in biomass conversion technologies, equipment efficiency, or process optimization techniques. Further investment for research and development is needed to support the biomass supply chain to be growth vastly.

Policy and Regulatory: Government policies, incentives, regulations, and support mechanisms affecting biomass production, processing, transportation, and utilization. These are the most pillars in support of biomass supply chain to be productive as all industries guided with standard regulation and policy.

Market Dynamics: Factors such as demand for biomass products, price fluctuations, competition from alternative energy sources, and international market trends. The balance of supply and demand for the biomass products contribute to the economic growth of the biomass industries.

Infrastructure Development: Investments in transportation networks, storage facilities, processing plants, and other supply chain infrastructure. Infrastructure development requires financial support and government intervention to ensure the biomass industries can contribute effectively to the country.

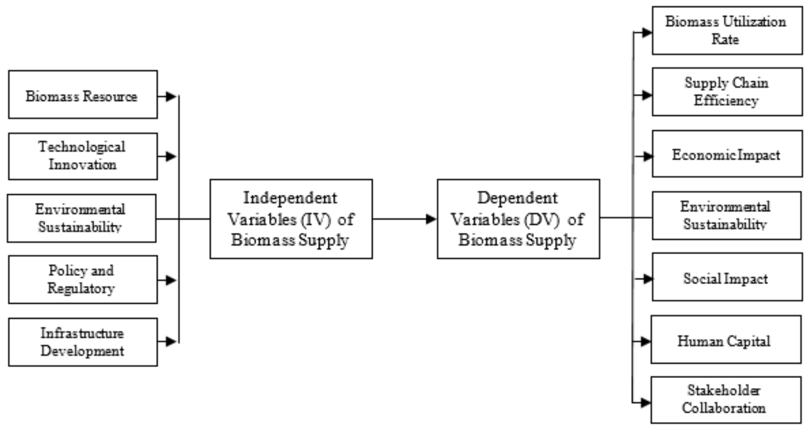

Figure 3: The framework and relationship of IV and DV for biomass supply chain in Malaysia

Thus, the independent variables could be considered as the key success factors to growth up the biomass industries in the market. Furthermore, the study discovered a connection within the biomass supply chain in Malaysia. Therefore, concerning the biomass supply chain in Malaysia, the dependent variable could encompass various performance metrics or outcomes associated with the effectiveness, efficiency, or sustainability of the supply chain. Thus, for this study, the dependent variables are including:

Biomass Utilization Rate: The percentage of available biomass resources effectively utilized within the supply chain. This related to the biomass supply and demand in the Malaysia market and industries.

Supply Chain Efficiency: Measures such as transportation costs per unit of biomass, inventory turnover, or lead time. The efficiency impacts the cost of operation and flexibility to bring in the biomass to the customers.

Economic Impact: Indicators concerning the economic impact of the biomass supply chain on Malaysia's Gross Domestic Product (GDP), employment creation, or value-added activities. Besides that, the economic growth from biomass industries directly contributes to the strong financial investment in biomass industries.

Environmental Sustainability: Indicators such as greenhouse gas emissions, energy consumption, or waste generation per unit of biomass processed. As part of the government's initiative to combat greenhouse gas emissions, it is essential to showcase a strong commitment to promoting carbon reduction efforts.

Social Impact: Metrics reflecting the social benefits or costs associated with the biomass supply chain, such as livelihood improvements for local communities, health impacts, or land use conflicts. The shift in lifestyle and social culture indirectly contributes to a positive trajectory for communities in the future.

Human Capital: Availability of skilled labor, research and development capabilities, and knowledge dissemination within the biomass industry. The expertise and experts in the biomass industry are crucial assets for Malaysia, as they play a significant role in promoting skilled work and competency within the sector.

Stakeholder Collaboration: Relationships and partnerships between government agencies, industry players, research institutions, and local communities involved in the biomass supply chain. The stakeholders involved in the biomass supply chain must come up with mutual understanding to meet the market and industry needs.

Input from the interview session and dialogue has been scrutinized and categorized accordingly. Applying the RBV theory to the biomass supply chain in Malaysia involves analyzing the unique resources and capabilities within the context of the supply chain. Thus, the related factors of the RBV relationship to the biomass supply chain in Malaysia as defines below:

Identify Key Resources: Begin by identifying the resources involved in the biomass supply chain in Malaysia. This includes biomass sources (such as palm oil, rice husks, and wood waste), processing facilities, transportation networks, and human capital.

Assess Resource Heterogeneity: Evaluate the heterogeneity of these resources compared to other regions or countries. For instance, Malaysia may have unique biomass resources due to its tropical climate and agricultural practices.

Examine Resource Immobile: Consider the immobility of certain key resources within the supply chain. Some resources, like biomass feedstock, may be location-specific, necessitating the development of supply chain infrastructure in specific regions of Malaysia.

Analyze Resource Tangibility and Intangibility: Assess the tangible resources is described the physical assets of the biomass supply chain and intangible resources related to knowledge, patents, and relationships within the biomass supply chain. Tangible resources may include processing plants and transportation infrastructure, while intangible resources could be expertise in biomass conversion technologies or relationships with local farmers.

Evaluate Resource Durability: Consider the durability of these resources over time. For example, Malaysia's abundant agricultural land and favorable climate ensure a consistent supply of biomass feedstock, providing a sustainable resource base for the biomass supply chain.

Identify Competitive Advantage: Determine how these resources and capabilities contribute to the competitive advantage of firms operating within the biomass supply chain in Malaysia. This may include lower production costs, access to unique biomass feedstock, or technological expertise in biomass conversion processes.

Strategic Implications: Finally, consider the strategic implications of these resource-based advantages for firms operating in the biomass supply chain. This could involve investments in technology development, partnerships with local stakeholders, or vertical integration to secure critical resources and capabilities.

By applying the RBV theory to the biomass supply chain in Malaysia, stakeholders can gain insights into the sources of competitive advantage and develop strategies to enhance their position in the market. These variables interact in complex ways to shape the performance and sustainability of the biomass supply chain in Malaysia, highlighting the multidimensional nature of the system and the importance of holistic analysis and strategic planning.

Furthermore, by assessing resource heterogeneity in relation to the biomass supply chain in Malaysia involves understanding the diversity and variability of biomass resources available across different regions or sources within the country. This exercise aims to identify the unique characteristics, strengths, and limitations of various biomass feedstocks, which can influence supply chain dynamics, technological choices, and strategic decision-making. Consequently, the study created the category of the resource heterogeneity to the diversification factors in relation to the biomass supply chain in Malaysia. Thus, the researcher proposes detailed steps for identified types and dimensions of variation, which create categories to classify the heterogeneity for this study. In addition to that, the basic category of resource heterogeneity is divided into two categories which are nature categories and non-nature categories, as presented in Table 7 and Table 8.

Table 7: Nature category of resource heterogeneity

Nature categories	
Biomass Resources	**Environment**

Identifying biomass feedstock variability involves gathering comprehensive data on available feedstock and the various types of biomass feedstock utilized in the Malaysian biomass supply chain. This may include palm oil residues, rice husks, wood waste, agricultural residues, and energy crops. Quantify the biomass availability with collect data on the quantity, quality, and seasonal availability of biomass feedstocks in different regions of Malaysia. This may involve conducting surveys, literature reviews, field assessments, or leveraging existing databases and statistical reports. Assess feedstock characteristics by evaluating the physical, chemical, and biological properties of different biomass feedstocks. Consider factors such as moisture content, energy content, density, ash content, particle size, and chemical composition. These characteristics can impact biomass handling, storage, processing, and conversion technologies.	Evaluate the sustainability aspects in assessing the environmental, social, and economic sustainability of biomass feedstock production and utilization practices. Geographic distribution of biomass must be map out the geographic distribution of biomass feedstock sources across Malaysia. Identify regions or states known for specific types of biomass production. Consider factors such as climate, soil conditions, land use patterns, and agricultural practices influencing biomass availability and productivity. Stakeholder engagement through involvement of relevant stakeholders, including biomass producers, processors, researchers, policymakers, and local communities, in the assessment process to meet environmental requirement. Gather insights, perspectives, and local knowledge to better understand resource heterogeneity and its implications for the biomass supply chain in Malaysia.

Table 8: Non-nature category of resource heterogeneity

Non-nature categories			
Human	**Finance**	**Technology**	**Infrastructure**
Refers to the people within the system, including their skills, knowledge, and labor. The necessity for a competent person with expertise when involving the biomass factory must be carefully considered to prevent a lack of work quality in meeting market requirements.	Consider factors such as land use change, biodiversity impacts, water usage, greenhouse gas emissions, labor requirements, and socio-economic benefits for local communities. The support of financial in the industries, especially for investment to increase the production.	Analyze technological compatibility by evaluating the suitability of biomass feedstocks for different conversion technologies and end-use applications. Consider factors such as feedstock compatibility, processing requirements, conversion efficiency, and product yields. Certain biomass types may be better suited for biofuels, biopower, biochemicals, or bioproducts based on their characteristics.	Identify supply chain implications by analyzing the implications of resource heterogeneity on supply chain logistics, infrastructure requirements, and operational challenges. Consider factors such as transportation distances, storage needs, handling equipment, and processing capacity utilization

By conducting a systematic assessment of resource heterogeneity, stakeholders can gain valuable insights into the diversity and complexity of biomass feedstock availability and characteristics in Malaysia. This information can inform strategic decision-making, technology selection, supply chain optimization, and sustainability planning in the biomass sector.

4.2 Apply of SCM and RBV

Looking forward, the researcher considering the establishment of Sustainable Supply Chain Management (SSCM) aspects of future research, including its evaluation, include issues related to logistics, reverse logistics, performance assessment, production, supplier selection and relations, human resource management, IT systems. Panigrahi and et al. (2018) highlight that future advancements in SCM should involve integrating social issues into the environmental and economic aspects of SSCM, applying lifecycle analysis and closed-loop SC concepts to enhance sustainability in SCM, and addressing inventory management challenges within sustainable SCM. Therefore, the vast majority of research and practice regarding sustainable supply chains has predominantly followed an instrumental logic (Montabon et al. 2016). This approach has often prioritized economic interests over environmental and social considerations for firms and supply chain managers, as shown in Figure 4 new logic of SSCM.

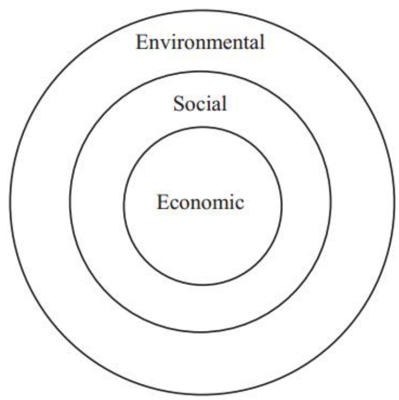

Figure 4: The new logic of SSCM.

Application of Supply Chain Management in the Malaysian Biomass Industry can be adapted in various area. Supply chain design, inventory and logistics, supplier relationship, technology, and governance.

Supply Chain Design and Planning:

The design and planning of biomass supply chains in Malaysia involve the identification of biomass sources, transportation networks, processing facilities, and market outlets.

Studies have explored various supply chain design models, optimization techniques, and decision-support tools to improve the efficiency and sustainability of biomass supply chains.

Factors such as biomass availability, transportation costs, storage capacity, and market demand influence supply chain design decisions, highlighting the need for integrated and holistic approaches.

Inventory Management and Logistics:

Inventory management plays a critical role in balancing biomass supply and demand, minimizing stockouts, and optimizing inventory levels throughout the supply chain.

Logistics optimization involves the efficient movement of biomass feedstocks from source to processing facilities, minimizing transportation costs, lead times, and environmental impacts.

Technologies such as Geographic Information Systems (GIS), Global Positioning Systems (GPS), and Radio-Frequency Identification (RFID) are utilized to track and monitor biomass shipments, enhance visibility, and improve decision-making.

Supplier Relationship Management:

Supplier relationship management focuses on developing strategic partnerships with biomass suppliers, fostering trust, collaboration, and long-term commitment.

Studies have examined the role of contract farming, cooperative agreements, and joint ventures in enhancing supplier relationships and ensuring a stable and reliable supply of biomass feedstocks.

Sustainable sourcing practices, including certification schemes, traceability systems, and ethical procurement policies, are increasingly important for ensuring environmental responsibility and social equity in the biomass supply chain.

Technology Adoption and Innovation:

Technology adoption and innovation are key drivers of competitiveness and sustainability in the Malaysian biomass industry.

Research and development efforts focus on improving biomass conversion technologies, increasing process efficiency, and diversifying product portfolios.

Supply chain management practices, such as technology scouting, open innovation, and collaborative research initiatives, facilitate the transfer and diffusion of new technologies within the biomass sector.

Regulatory Compliance and Sustainability:

Regulatory compliance with environmental, health, and safety standards is essential for ensuring the sustainability and social responsibility of biomass supply chains in Malaysia.

Studies have examined the implications of regulatory frameworks, certification schemes, and sustainability standards on biomass industry practices and performance.

Sustainable supply chain management practices, including carbon footprint reduction, waste minimization, and ecosystem conservation, are increasingly integrated into biomass industry operations.

The application of supply chain management in the Malaysian biomass industry faces several challenges and opportunities. Challenges include issues related to biomass resource variability, transportation infrastructure, technology adoption, regulatory compliance, and market access. Meanwhile, the opportunities arise from the country's abundant biomass resources, growing demand for renewable energy, technological advancements, supportive policy environment, and strategic collaborations with international partners.

Supply chain management plays a vital role in shaping the competitiveness, sustainability, and growth of the Malaysian biomass industry. By applying SCM principles and practices, stakeholders can overcome challenges, capitalize on opportunities, and unlock the full potential of biomass resources for renewable energy production and environmental stewardship. Moving forward, continued research, innovation, and collaboration are essential for advancing supply chain management practices and driving sustainable development in the Malaysian biomass sector.

5 CONCLUSION

Applied of the RBV theory in practice involves several steps to leverage a firm's internal resources and capabilities to achieve sustainable competitive advantage. Here's a practical guide to implementing RBV:

Identify Key Resources and Capabilities: Conduct a thorough internal analysis to identify the firm's unique resources and capabilities. This includes tangible assets such as physical infrastructure, technology, and financial resources, as well as intangible assets such as intellectual property, brand reputation, and human capital.

Assess Resource Heterogeneity: Evaluate the heterogeneity of the identified resources and capabilities compared to competitors. Determine whether these resources are rare, valuable, difficult to imitate, and non-substitutable (VRIN criteria), as these are key attributes that contribute to competitive advantage according to RBV.

Internal Alignment: Ensure that the firm's resources and capabilities are aligned with its strategic objectives and competitive positioning. This may involve reallocating resources, investing in core competencies, or divesting non-core assets that do not contribute to competitive advantage.

Continuous Improvement: Foster a culture of continuous improvement and innovation to enhance the firm's resources and capabilities over time. This could involve investing in research and development, training and development programs, process optimization, and technology upgrades.

Strategic Resource Allocation: Allocate resources strategically based on the firm's competitive priorities and market opportunities. Prioritize investments in resources and capabilities that offer the greatest potential for sustainable competitive advantage and long-term value creation.

Dynamic Capabilities: Develop dynamic capabilities that enable the firm to adapt and respond to changing market conditions, customer preferences, and competitive threats. This includes the ability to quickly reconfigure resources, innovate new products or services, enter new markets, and forge strategic alliances or partnerships.

Performance Measurement: Establish key performance indicators (KPIs) to monitor the effectiveness and impact of the firm's resources and capabilities on competitive performance. This could include financial metrics (e.g., profitability, market share), operational metrics (e.g., efficiency, quality), and strategic metrics (e.g., innovation, customer satisfaction).

Strategic Flexibility: Maintain strategic flexibility to reallocate resources and adjust capabilities in response to evolving market dynamics and competitive pressures. This may involve scenario planning, contingency planning, and risk management strategies to mitigate potential threats and capitalize on emerging opportunities.

By following these steps and integrating RBV principles into strategic decision-making processes, firms can leverage their internal resources and capabilities to achieve sustainable competitive advantage and drive long-term success in their respective markets. Thus, the biomass supply chain in Malaysia is a critical component of the nation's renewable energy strategy and sustainable resource management. It involves the collection, pre-processing, transportation, conversion, and utilization of various organic materials for energy production and other applications. In conclusion, Malaysia's biomass supply chain supports renewable energy development, efficient resource utilization, and sustainable waste management, aligning with global efforts towards a greener future.

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