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DEVELOPING ASEAN AUTOMOTIVE INDUSTRY'S FRAMEWORK USING BUSINESS INTELLIGENCE APPROACH

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ABSTRACT

This research investigates the potential of Business Intelligence Technology (BIT) to enhance the sustainability of the ASEAN automotive industry in the context of Society 5.0. Employing qualitative methods like focus groups, interviews, and document analysis, we developed a framework for leveraging BIT to address the challenges of balancing market demands with sustainability goals. Findings reveal that BIT empowers ASEAN nations to understand market dynamics, analyze consumer preferences for sustainable options, and explore market potential. However, the framework necessitates acknowledging and mitigating the environmental impact of industry practices to align with evolving consumer priorities. This research contributes valuable insights for policymakers and industry leaders in fostering a more sustainable automotive industry within ASEAN.

Keywords: automotive industry; Business Intelligence Technology; sustainable industry; Southeast Asian Countries.

INTRODUCTION

The phenomenon of globalizing the world economy empowers specific economies to concentrate on the provision of specific products and services. This provision facilitates their entry into the global market by expanding their access to increased capital flows, advanced technology, cost-effective imports, and expansive export markets. Consequently, specialization and the division of labor often manifest in industries situated in specific geographic regions (Atack et al., 2022; Bettiol et al., 2021). In the past three decades, there has been a notable surge in Foreign Direct Investment Flows (FDI) (UNCTAD, 2023). Governments globally, whether in developing or developed nations, are actively engaged in efforts to attract Multinational Enterprises (MNEs) to establish their operations within their borders. This endeavor involves the provision of substantial financial and fiscal incentives to encourage and facilitate the relocation of MNEs to their respective countries.

Many Southeast Asian countries have adopted an export-led growth strategy (Kumar et al., 2020; Lee et al., 2023). In this approach, the substantial contribution of multinational corporations (MNCs) and their manufacturing affiliates within the region, particularly in industries such as the expanding global automotive sector, is noteworthy. This trend is particularly prominent in developing countries like Southeast Asia. Numerous countries such as Indonesia, Malaysia, Thailand, and Vietnam continue to require significant efforts for the advancement of their automotive industry sector (McKinsey&Company, 2020; Saptioratri Budiono et al., 2021). In Asia, China stands out as a leader in the automotive component production (Smitka, 2016), while India focus on two-wheelers and small vehicles (Chakraborty et al., 2020). In the ASEAN region, Thailand specializes in the manufacturing of passenger cars and pick-up trucks (Natsuda et al., 2022; Pollio & Rubini,

2021). Thailand actively strengthens its exports within the Southeast Asian region, extending its reach to both Asian and developed countries.

Despite the diverse automotive industry landscape in Asia, Japan maintains a dominant position. Japanese Foreign Direct Investment (FDI) plays a pivotal role in driving this industry's growth, with Thailand, facilitated by Japanese firms, primarily concentrating on the export market. In Indonesia, domestic players collaborate with Multi-National Corporations (MNCs) in assembling operations, with a substantial presence of Japanese companies among them (Natsuda et al., 2022). The automotive industry in Indonesia is acknowledged as a crucial sector within the country's economy (Negara & Hidayat, 2021; Rasiah, 2004). Since the late 1990s, it has exhibited substantial growth, making notable contributions to GDP expansion, increased exports, enhanced labor productivity, and heightened employment levels (Verico & Pangestu, 2021). The government of Indonesia also acknowledges the promising outlook for the sector, both domestically and internationally. Consequently, introducing an innovative intervention is essential to lead the technological modernization of the automotive industry, reflecting a proactive stance towards enhancing its competitiveness and technological capabilities (Rasiah et al., 2016).

Most of the research related automotive industry in the Southeast Asian context focused on competitiveness, investments, and advanced manufacturing technology. For example, (Purwanto et al., 2023) found that the competitiveness of the automotive industry in Southeast Asian countries depends on organizational learning and industry practitioners' training to enhance foresight practices. (Artica et al., 2022) argue that Thailand has excelled in industrial expansion and trade because the country has supporting policies in promoting specific products and technologies, aligning with macroeconomic stability and industrial development goals. Boosting investment in the ASEAN region is dependent on connectivity, particularly in reducing transport costs as well as strategic policies to attract investment and enhance economic competitiveness (Elek & Findlay, 2021; Hamzah, 2012). Lastly, there was also a need for advanced technology development in manufacturing automotive vehicles that can save the row materials (Sarma & Srivastava, 2024)

However, little attention has been paid to how the Business Intelligence Technology (BIT) approach can be used for enhancing the competitiveness of ASEAN country member's automotive industry as well as for measuring the sustainability of its production and services. This study aims to propose the BIT approach that can be considered not only as an alternative framework for ASEAN nations to understand market dynamics and consumer needs but also as a way of addressing the environmental impacts of automotive practices to increase consumer preference for sustainability. In the next section, we introduce the BIT approach followed by the research method, findings of the research, and discussion where we reflect on our research findings with the theoretical framework of the BIT.

LITERATURE REVIEW

Rooted in evolutionary theory, the technological capability approach first emerged in the late 1970s and early 1980s through empirical studies examining the nature, intensity, and determinants of technological change in developing countries. However, in the contemporary context, technological advancements have propelled us into the era of Industry 4.0, characterized by artificial intelligence, and Society 5.0.

In the Industrial Era 4.0, the entirety of human activities across diverse sectors is underpinned by the utilization of advanced and intelligent technologies. This encompasses a wide array of cutting-edge tools and systems, including artificial intelligence (Ardito et al., 2019; Debora, 2019; Kamble et al., 2018; Muhammad Nizam, 2018; Oztemel & Gursev, 2020; Piccarozzi et al., 2018; Zhou et al., 2015), cloud computing (Hayes, 2008; Ratten, 2020; Velte et al., 2009), mobile applications (Charland & Leroux, 2011), advanced and autonomous robotics (Mistry et al., 2014), cognitive computing (Hurwitz et al., 2015; Modha et al., 2011), big data analytics science (Arockia et al., 2017; Maneth & Poulovassilis, 2017; Manoj et al., 2018; Sagiroglu & Sinanc, 2013) and data science, the Internet of Things (IoT), cybersecurity measures (Li et al., 2015; Wortmann & Fluchter, 2015), augmented and virtual reality (Isberto, 2018; Sowmya et al., 2015), integrated systems, 3D graphics, simulation, and additive manufacturing (Calignano et al., 2017; Niaki et al., 2019). These technologies collectively contribute to the transformation and optimization of various industries, marking a paradigm shift in the way human activities are conducted in the modern era.

In anticipation of Society 5.0, it becomes imperative to thoroughly prepare technological capabilities, particularly for the sustainable development of the automotive industry, especially in developing countries characterized by uneven technology penetration across sectors. A potential solution lies in the adoption of Business Intelligence Technology (BIT). BIT offers comprehensive insights into business operations by providing perspectives on the past, present, and future (predictive). This includes functionalities such as business performance management, competitive intelligence, intelligence reporting, benchmarking, online analytical processing, and predictive analysis (Chaudhuri et al., 2011; Han & Kamber, 2006; Niu et al., 2009). For example, Frolick & Ariyachandra (2006) have found that business performance management can leverage IT tools to help organizations develop, adjust, and execute strategies more efficiently. It integrates technology to systematically assess performance, monitor key indicators, and make informed decisions aligned with strategic goals.

BIT, leveraging artificial intelligence associated with the Industrial Era 4.0, proves instrumental in conducting effective market analyses. This capability supports the development of innovation and enhances productivity within the company (Sun, 2020). The integration of BI technology into the automotive industry can serve as a strategic step toward ensuring sustainability and competitiveness, particularly in regions where technological advancements vary across sectors.

In the Industrial Era 4.0, industries, including the automotive sector, are witnessing rapid and substantial developments in Business Intelligence (BI) and artificial intelligence. This phenomenon is more pronounced in developed countries, whereas developing nations are just beginning to embrace and develop these technologies. Previous research works have explored the integration of intelligent technologies such as Business Intelligence, artificial intelligence, and data science analytics in various industrial contexts. Some noteworthy studies include: 1. (Ahmad et al., 2020)examined the role of business intelligence for sustainable development in the textile and apparel industry within the Industrial Era 4.0; 2. (Hofmann et al., 2017) discussed and demonstrated how artificial intelligence and data science can enhance efficiency in processes within the automotive industry; 3. (Cruz & Llavori, 2018) proposed a framework for social Business Intelligence derived from Twitter social media, specifically for the automotive domain; 4. (Tian et al., 2016) explored the use of technology as a digital service in the automotive industry; 5. (Bordeleau et al., 2020) delved into factors associated with business intelligence and analytics for medium-sized manufacturing enterprises; 6. (Gusikhin et al., 2007) discussed applications and trends of intelligent systems within the automotive industry; 7. (Tubaro & Casilli, 2019) examined micro-work services as a discreet human activity supporting artificial intelligence in the extensive supply chain of the automotive industry. Given this background, the current research aims to investigate the utilization of Business Intelligence technology, addressing technological capabilities, for the sustainable development of the automotive industry in developing countries as they confront the challenges of Society 5.0

METHODOLOGY

Qualitative methods were key in this research, in which the data were collected through interviews, Focus Group Discussions (FGDs), and document analysis (Masadeh, 2012; Stewart et al., 2012). The interviews were carried out with 15 researchers and experts in the fields of Informatics, Information Technology, Information Systems, and Industrial Engineering from several universities in Indonesia, such as Pasundan University, Garut College of Technology, State Islamic University of Sunan Gunung Djati Bandung, and Bandung Institute of Technology. The interviews were conducted between September 4 and July 5, 2023, using a purposive sampling technique in which the informants had been decided before the interview because the researcher already knew their names and backgrounds of expertise. In the next stage, the FGDs were carried out with those 15 informants two times (November 10 and 20, 2023). Some archives documents such as regulations related to automotive industry policy from the ASEAN country members as well as the literature related to that issue were also collected to be analyzed.

Table 1. Distribution of Informants and FGD's participants

No	Informants' affiliations	Backgrounds of Expertise	N
1	Pasundan University	Informatics	2
2	Pasundan University	Information Technology	2
3	Garut College of Technology	Information System	2
4	Garut College of Technology	Industrial Engineering	1
5	State Islamic University of Sunan Gunung Djati Bandung	Informatics	2
6	State Islamic University of Sunan Gunung Djati Bandung	Information Technology	2
7	Bandung Institute of Technology	Information System	3
8	Bandung Institute of Technology	Industrial Engineering	1
N Total			**15**

The interviews and FGD were conducted to evaluate the proposed framework of Business Intelligence (BI) technology for the automotive industry within the context of Society 5.0. The FGD included multiple sessions with researchers from various Indonesian universities specializing in informatics, information systems, information technology, and industrial engineering. The discussions and interviews centered around the interrelationships among the framework's components and variables, its potential applicability beyond the automotive sector, and the role of BI technology in fostering industry sustainability under Society 5.0, particularly in developing countries. Meanwhile,

The interview and FGDs data were analyzed using the qualitative content analysis technique (see e.g., Williamson et al., 2018) with the help of https://www.wordclouds.com/ to see the dominant keywords of BIT framework that can support ASEAN member counties to understand market dynamics, consumer needs, and market potential and to mitigate the environmental impacts of the automotive industry. Following the Business Intelligence of the proposed framework based on the FGD results, industrial development pillars, firm-specific variables, technological capabilities, Business Intelligence, and Industry 4.0 technology are mapped for their impact on sustainable automotive industry development. This mapping process is conducted in the context of the sustainability issue within the automotive industry, serving as a benchmark for both developing and developed countries. The sustainability issue within the automotive industry is examined as a case study, elaborating on existing research and theory. In operations management research, a case study is considered an effective approach for generating new research propositions and facilitating a comprehensive understanding of the context when addressing 'how' questions.

DISCUSSION

The Overview of the Automotive Industry in ASEAN

In 2021, the global automotive industry experienced positive growth, with a 3.1% year-on-year increase in the production of four-wheel motor vehicles and a 5.0% year-on-year rise in global sales. This growth was driven by increased consumer demand for vehicles, particularly electric vehicles (EVs), as well as a shift towards personal transportation. However, in 2022, the industry faced challenges due to disruptions in the supply chain, particularly semiconductor shortages, leading to production cuts and increased costs. In the ASEAN region, there was a strong recovery following the economic downturn caused by the COVID-19 pandemic, with a region-average GDP expansion of 9.3% year-on-year in 2021. The four-wheel motor vehicle segment in ASEAN saw a substantial increase in production and sales, with Thailand, Indonesia, and Malaysia leading in production and domestic sales. China and India reported increases in domestic sales, while South Korea experienced a decline. In terms of vehicle types, there was an increase in the production of light commercial vehicles (LCVs) across several countries, with Indonesia and Malaysia experiencing significant rises. However, truck production in China declined due to weaker demand, while India, Indonesia, and Malaysia recorded annual increases. Bus production in China, Indonesia, and Malaysia saw declines as the pandemic continued to impact public transportation.

In Thailand, the automotive sector experienced continuous growth until 2018, reaching record highs in output, domestic sales, and export value. However, there was a decline in 2019 due to the global market and economic slowdown, followed by a deeper decline in 2020 due to the COVID-19 pandemic. The industry started to show signs of recovery in 2021, with motor vehicle output, domestic sales, and exports increasing. In Indonesia, the motor vehicle industry had been growing steadily until 2019 but experienced a significant decline in 2020 due to the pandemic. The sector showed signs of recovery in 2021, with increases in four-wheel motor vehicle output and sales, as well as motorcycle sales. Despite the challenges, Indonesia remains an important production and export hub for motor vehicles in the ASEAN region.

BIT Framework for the Development of the Automotive Industry in Southeast Asia

This study aims to develop a framework for enhancing the sustainability of the ASEAN automotive industry through the BIT. The main findings of this research can be seen in Figures 1 and 2. Figure 1 indicates that the interview and FGDs data have shown that the BIT emerges as a promising and robust framework for ASEAN countries to comprehensively engage with market dynamics, discern consumer preferences, and assess market viability. Meanwhile, Figure 2 shows a framework for enhancing the sustainability of the ASEAN automotive industry. Nonetheless, it is paramount to acknowledge and address the environmental ramifications inherent in automotive industry operations, particularly considering the escalating consumer demand for sustainable products and services. Therefore, integrating environmental considerations into automotive industry practices is essential to align with evolving consumer preferences and sustainability imperatives (see also Chaudhuri et al., 2011; Han & Kamber, 2006; Niu et al., 2009).

Figure 1. The cloud content analysis is based on the interview and FGD data

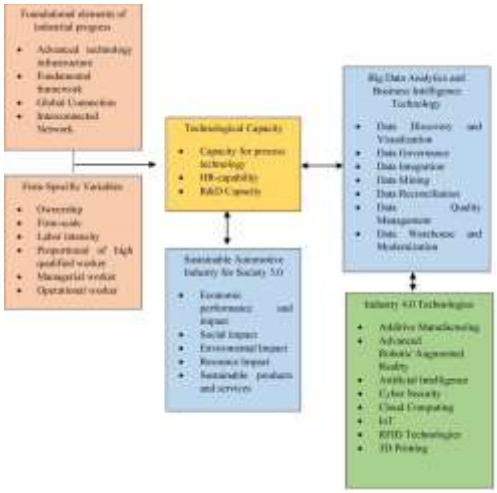

Figure 2. Business Intelligence Technology Framework for Automotive Industry in Facing Society 5.0.

Other findings from the FGD and interviews can be summarized as follows: Firstly, it is paramount to acknowledge the intricate dynamics present within the framework, where each constituent component exhibits either a direct or indirect relationship, characterized by nuanced roles and functions that intricately intertwine and harmoniously synergize with one another, thereby portraying a well-structured and interconnected framework that encompasses multifaceted aspects encompassing input, process, and output functionalities, all of which collectively contribute to its robust and holistic nature, facilitating comprehensive understanding and analysis. All FGD informants agreed that foundation elements of industrial progress can support the technological capacity of a country. At the same time, the technological capacity needs to be supported by big data analysis to discover the large market within the globe and to improve the quality management of the automotive industry. This finding confirms previous research by (Sun, 2020) that the importance of big data analysis to support the discovery of global markets and the improvement of quality management in the automotive industry cannot be overstated. The utilization of artificial intelligence in Business Intelligence Technology (BIT) is integral to this approach and represents a strategic step that can be implemented to enhance productivity and competitive advantage, aligning with previous findings regarding the significance of technology in advancing the automotive industry.

Secondly, the framework displays considerable promise for implementation within the automotive industry, given its robust alignment with the functions inherent in Business Intelligence (BI) technology, facilitating a comprehensive integration of modern technological solutions across various operational dimensions within companies. Furthermore, its versatility extends beyond the automotive sector, encompassing project-based industries like building construction services, albeit contingent upon the provision of comprehensive support from an integrated technology infrastructure to ensure seamless adoption and operational efficacy across diverse applications and sectors. For example, automotive companies use BI to analyze real-time production data, identify efficient production patterns, and optimize resource utilization (Hofmann et al., 2017). This can increase productivity and reduce production costs. These findings align with (Cruz & Llavori, 2018; Gusikhin et al., 2007; Hofmann et al., 2017; Tian et al., 2016) that the implementation of BIT in the automotive industry can provide a comprehensive integration of modern technological solutions across various operational dimensions within automotive companies. This also indicates that BI is not only relevant in the automotive industry but also in project-based industries such as building construction services, provided that it is supported by a comprehensive integrated technology infrastructure to ensure smooth adoption and operational effectiveness across diverse applications and sectors.

The feasibility of applying the framework in developing countries relies on adequate technological support, including connectivity, electricity, infrastructure, and trained personnel. Further investigation into its use in countries like Indonesia and ASEAN nations is needed, as some companies there may already be using it, requiring a detailed analysis of implementation challenges and opportunities. An interview with an industrial engineering expert emphasized the importance of technological support for successful implementation, noting that factors such as reliable connectivity, stable electricity, infrastructure, and trained human resources are crucial. This aligns with existing research indicating that these factors are essential for effective implementation. Supportive governmental policies also play a role in facilitating adoption(Tian et al., 2016). Therefore, further exploration of the BIT framework's use in developing countries is necessary to understand its potential impact..

The framework includes production capability, data reconciliation, and aligns with big data analytics. BI technology plays a crucial role in optimizing complex data structures(Ahmad et al., 2020; Bordeleau et al., 2020; Cruz & Llavori, 2018; Hofmann et al., 2017; Tian et al., 2016; Tubaro & Casilli, 2019). The study examines BI technology and big data analytics about the industry's technological capabilities. BI provides self-service business intelligence and supports the ability to adapt and use technology effectively. With BI, the automotive industry can achieve sustainability in Society 5.0. The proposed BI framework for the automotive industry is generally accepted and potentially applicable to other industries. Future research should incorporate quantitative analysis and identify key factors influencing the industry's sustainability.

CONCLUSION AND RECOMMENDATION

The feasibility of implementing the BIT framework in developing countries hinges on the availability of robust technological support, including connectivity, electricity, infrastructure, and skilled human resources. Further exploration into its application in countries like Indonesia and other ASEAN members is crucial, as some companies in these regions might already be utilizing its capabilities, necessitating a thorough analysis of potential opportunities and challenges. An interview with an industrial engineering expert underscored the importance of technological support, stating that factors such as reliable connectivity, stable electricity supply, adequate infrastructure, and well-trained personnel are essential for successful implementation. This finding is consistent with existing research, which highlights the critical role of these factors in enabling the effective use of the framework.

Moreover, supportive governmental policies are also instrumental in facilitating the adoption of advanced technologies like Business Intelligence. Therefore, a deeper investigation into the utilization of the BIT framework in countries such as Indonesia and other ASEAN nations is warranted to uncover the full spectrum of opportunities and challenges associated with its implementation. Understanding these dynamics is crucial for organizations and policymakers looking to leverage Business Intelligence in developing countries, as it can inform strategies for overcoming barriers and maximizing the benefits of this technology.

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