
Business model diversification through Product-Service Systems: Demand-relatedness perspective

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Abstract: Despite the prevalence of portfolio of business models, there remains a dearth of understanding regarding their dynamics, particularly in non-digital native firms. Operating multiple business model can be a challenging endeavour, as their intra- and inter- complementarities often necessitate active monitoring and restructuring to ensure alignment with other models within a firm's portfolio. Prior research has primarily emphasized the advantages of resource and capability complementarities, while undervaluing the significance of customer complementarities. In this research-in-progress, we conducted a longitudinal qualitative analysis of Epiroc's various business models to address this gap and identified their synergies using network effects. Specifically, we explored the role of product-service business models in the firm's growth and competitive advantage using four value drivers and mapped the resulting business model portfolio.

Keywords: Business model; Portfolio; Diversification; Network effect; Manufacturing industry; Working machines; Case study; Research-in-progress

1 Introduction

Firms are increasingly facing competition from disruptors offering new technologies, and/or business models (Markides, 2015; Teece, 2010; Tongur and Engwall, 2014). To address these challenges, companies need to restructure their business model portfolio (BMP) to align with disruptors or differentiate themselves by expanding their offerings that better satisfy their customer's needs (Visnjic et al., 2017).

In recent years, scholars and practitioners focused on redefining growth and decoupling it from negative impacts. This involves reducing material flows in production and consumption and developing products and services that provide the same functionality as before, but with a decreased environmental burden. The concept of

product-service systems (PSS) has been proposed as a dematerialization strategy and a potential solution to the sustainability challenge (Lieder and Rashid, 2016; Pieroni et al., 2019). This trend is also observable in some product companies, such as Bombardier Inc, Hitachi Rail, Caterpillar, and Rolls Royce, which have adopted a diversification strategy to restructure their BMP through the provision of PSS models.

Business models (BMs) play a vital role in translating customer needs into business opportunities. They are considered as frameworks for understanding how firms create and capture value (Baden-Fuller and Morgan, 2010; Zott et al., 2011). Literature on BMs has progressively shifted the focus towards a demand-based view that emphasizes the importance of customer interaction in value creation and monetization across firm boundaries. This approach recognizes that customers often have distinct ways of creating and capturing value, which can lead to diversified opportunities for firms. Therefore, firms are encouraged to explore these distinct approaches to develop a deeper understanding of customer needs and preferences. The demand-based view represents a transition from the traditional resource-based view of BMs with focuses on internal capabilities and resources. By shifting the attention to customer interaction and value co-creation, firms can better identify and capitalize on new business opportunities.

The current study seeks to contribute to the growing body of literature on business model portfolios by examining the impact of product-service business models (PSSBMs) on a firm's existing BMP. Given that firms often operate multiple BMs and increasingly use PSSBMs, it is important to understand how these models impact a firm's overall business strategy. Several studies have explored the PSS for Circular Economy (E.g., Fernandes et al., 2020) and the relationship within and between business model diversification and performance in native digital companies (E.g., Sohl et al., 2022). However, few scholars have empirically investigated the impact of PSSBMs on the performance of current BMs, more specifically, in the equipment manufacturing industry. In addition, while these dual BMs proved profitable, neither academics nor industry experts have been able to provide a generalizable justification of product-service businesses that introduce a "new" BM to diversify the existing BMP. Therefore, we ask: *What is the use of PSMs in diversifying a firm's offerings and how it affects the firm's business model portfolio?* By exploring these questions, we aim to contribute to the literature on business model portfolios and shed light on the strategic implications of adopting PSBMs for firms seeking to diversify their offerings while maintaining their competitive advantage.

2 Previous works on business model portfolio

Firms are increasingly operating multiple BMs within and across business units (Markides and Charitou, 2004). The adoption of multiple business models, or a business model portfolio (BMP), refers to the simultaneous deployment of distinct activity systems to create and capture value. This phenomenon occurs when an organization, for example, diversifies and engages in at least two different customer interaction mechanisms (Aversa et al., 2017; Deodhar et al., 2012). BMP emphasizes on utilization of several business model alternatives to fully pursue one strategy (Sabatier et al., 2010, Snihur and Tarzijan, 2018). Examples of BMPs include airlines that operate both full-service and low-cost carriers (Casadesus-Masanell and Tarzijan, 2012; Markides and Charitou, 2004),

newspapers that use both ad-sponsored and subscription-based BMs (Casadesus-Masanell and Zhu, 2010). A prominent example is Hewlett Packard, which until late 2015, sold personal computers through a product-oriented business model while simultaneously providing enterprise solutions based on a result-oriented business model.

Managers need to assess the trajectory of their business models while considering the existing synergies. Researchers in strategic management suggest that firms need to adopt a holistic perspective that looks beyond intra-relatedness and considers inter-relatedness across a portfolio of BMs (Zott and Amit, 2010; Snihur et al., 2022). Managing a portfolio of business models requires a thorough investigation of the health of current business models, an evaluation of their inter-synergies, and an examination of external pressures. By doing so, companies can make strategic choices that are grounded in a balanced portfolio of business models, which may include leveraging existing synergies, identifying potential business models, and isolating or integrating business models. In summary, the portfolio perspective is utilized both during the conceptualization phase, which involves identifying new business models that align with the “new” strategy and during the implementation phase, which involves managing the interdependencies and resource allocation between the different established business models.

Research on BMP is still in its infancy. The value drivers for having business model portfolios are still being established. One of these reasons is to diversify the business strategy (Aversa and Haefliger, 2021). Other potential reasons include responding to potentially disruptive technologies, seizing new market opportunities, commercializing product innovation, and managing risk and uncertainty (Heshmatisafa and Seppänen, 2022; Schwarz et al., 2017). However, currently, the management of business model portfolios has focused on value opportunities and synergies related to the demand-side of the business, leading to a more complex strategic intent and an overall positive impact on the business (Priem, Wenzel, and Koch, 2018; Aversa et al., 2021).

3 Research methodology

We conducted a single case study focused on an incumbent equipment manufacturing company, recognizing that a single rich case can provide a detailed and nuanced view that generates an in-depth and multi-faceted understanding of a complex issue in business model portfolio diversification (Crowe et al., 2011). Employing a qualitative longitudinal approach, we leveraged a 150-year (1873-2023) longitudinal archival database containing information on the development of the incumbent's BMP to gain valuable insights into the potential benefits and drawbacks of competitive advantage related to demand through business model diversification.

We used a five-step qualitative analytical procedure for data analysis, following Thomas (2006): raw file preparation, close reading of the text, category construction, overlap of coded and uncoded material, and ongoing revision and improvement of the category system. Our research supports the systematic, downstream evaluation of business model portfolios in terms of demand relatedness, in line with Priem's (2007) recommendations. In line with a study conducted by Aversa et al. (2017), we conducted an analysis of the positive and negative NE associated with each business model that arises from PSBMs, utilizing NE analysis. In addition, we leverage the activity system design themes of Zott et al., (2010) - novelty, lock-in, complementarities and efficiency – to categorise the underlying strategy of each BM.

4 Results

Starting from November 2013, Epiroc has implemented 11 business models with at least ten customer groups. Table 1 outlines the company's current business model portfolio, which aligns with common frameworks (Baden-Fuller and Haefliger, 2013; Baden-Fuller and Mangematin, 2013).

Epiroc has implemented two business models that serve as multi-sided business models, connecting various customer segments, while the remaining models are intended to interact with only one customer segment, and thus are dyadic business models. Furthermore, five of these business models are product-oriented, while three are use-oriented. Customers who engage in multi-sided business models benefit from the complementarities that exist within each model. There are also indirect complementarities between certain customer segments across different business models. This section will present current findings regarding the complementarities within and across the various business models. Figure 1 depicts the relationship between the business models (on the left) and the corresponding customer segments that interact with each model (on the right). Additionally, Figure 2 illustrates a map of complementarities among business models, with positive and negative NE complementarities.

4.1 *Intra-business Model complementarities*

The synergies within the business model appear weak in our data. So far, we have only identified two synergies within the renting and leasing business models. The eighth business model, "leasing", connects financial solutions to project-based, cost-conscious, and eco-conscious customers. The latter three segments enjoy positive NE and have a special incentive to use the leasing opportunity as the number of financial solutions increases, yielding customized solutions. Concurrently, an increase in leasing listings makes financial solutions providers more attracted. Thus, the growth in the number of financial solutions leads to a rise in project-based and cost-conscious customers, and vice versa.

Similarly, the renting or sharing business model serves as a connection between rental companies and project-based and cost-conscious customers. These customer segments are attracted to this business model due to its potential for positive NE. In particular, project-based, and cost-conscious customers are incentivized to use the sharing platform when the amount and variety of rental companies on the platform increase. A notable aspect of this business model is that significant demand on the rental platform leads to an increase in the number of rental companies offering their products and services for rent. This, in turn, provides customers with a greater variety of rental options, further enhancing the platform's appeal. Thus, the growth of the sharing platform is a self-reinforcing mechanism, where an increase in demand results in an increase in the supply of rental companies, leading to an even greater demand for the platform.

4.2 *Inter-business model complementarities*

As previously mentioned, our research findings demonstrate a significant positive correlation between financial solutions, renting/sharing, and leasing business models within the context of Product-Service System Business Models (PSSBMs). These

business models allow Epiroc to create a lock-in mechanism that guarantees exclusivity in the provision of products and services over an extended period, thereby securing revenue and safeguarding against market uncertainty. Furthermore, in addition to creating novel solutions through financial solutions, Epiroc leverages novelty strategies such as data-driven and emergent innovation. Leasing and renting or sharing BMs necessitate the active monitoring of machine prognostics and diagnostics. These data can be used to enhance value by optimizing performance, maintenance, and undertaking mitigation measures if system degradation is detected.

Moreover, we observed a strong positive relationship between Battery as a Service (BaaS) and zero emission BMs. These results suggest that PSSBMs offer customers a wide range of solutions that can help reduce Total Ownership Cost (TOC) while integrating them into novel business models such as financial solutions. BaaS BM is particularly noteworthy as they connect customers to related products and services, such as charging stations and charging design services. However, it is important to acknowledge that diversifying offerings through PSSBMs can potentially create negative synergies. While PSSBMs offer compelling value propositions, such as guaranteed availability, maintenance, and upgradability without the need for heavy upfront investments, they may also lead to a reduced sense of ownership of the products among customers. This, in turn, could have a negative impact on the corporate capital of the manufacturer.

Multi-substitute owner business models, such as remanufacturing and second-life, can exhibit both negative and positive network effects. These models are particularly appealing to service-driven customers and customer segments interested in circular economy practices, including eco-conscious and cost-conscious consumers. Employing these models can enable Epiroc to increase efficiency, retain control over the supply chain, and reduce dependency on third-party partners. In addition, they can help Epiroc to manage complementarities by creating a bundle of BMs that meet the needs of a broader customer base. However, these models can potentially have a negative impact on the sales of new parts.

The tightening of regulations governing noise levels, temperature, and emissions on mining and construction sites and rising fuel and transportation costs have driven greenfield companies to invest in zero-emission products. This trend has presented opportunities for Epiroc to deploy net-zero certification and zero-emission BMs. Furthermore, the shift towards electric working machines, with fewer physical components and more electric parts, has created a growing demand for a new generation of technicians. Epiroc has responded by developing a skill training BM to meet this emerging need. Both the skill training and net-zero certification initiatives positively impact the zero-emission BM. However, the increasing adoption of zero-emission products appears to have a negative impact on diesel machines and parts. Additionally, due to the high cost of zero-emission technologies and their newness, customers tend to lease or rent these machines, creating a synergy between zero-emission, leasing, renting, or sharing, and financial solution BMs. Epiroc appears to leverage zero-emission products to adopt a novelty-centred design approach, creating a new product line and innovative ways to address regulations and connect with early adopters.

Table 1a Business models of Epiroc (2013-2023)

	<i>BM1: Diesel products</i>	<i>BM2: Product-related Services</i>	<i>BM3: Zero emission</i>	<i>BM4: Remanufacturing</i>	<i>BM5: Second-life EV batteries</i>	<i>BM6: Battery as a Service</i>
Description	Mining and construction equipment and products such as loaders, drills, and ventilations.	Mining and construction tools and services such as traffic management, planning and rescheduling, and asset management	Battery-driven electric working machines	The Reman Program is an alternative to new components	Refurbishing batteries that have reached the end of their "automotive" life but still have a residual capacity of about 70-80%	Eliminating the risks of owning batteries and taking full responsibility for the batteries.
Customer segments	Brownfields; rental companies	Customers from BM1 and BM2	Greenfields; rental companies; financial institutions; cost-conscious; eco-conscious; Energy providers	Brownfields; cost-conscious; eco-conscious;	cost-conscious; eco-conscious;	Electric working machines customers; third-party Electric working machines providers; Greenfields.
Customer interaction	Dealers and providers are intermediates	Dealers and providers are intermediates	Direct contact with the customer	Direct contact	Dealers and providers are intermediates	Direct contact with the customer to define a battery plan that suits the needs of their operation.
Value proposition	Easy to maintain; Easy to reuse; Improved reliability	Prolonged lifetime of the product or service.	Zero-emission; cost reduction (e.g., fuel, ventilation); increase safety; decrease environmental pollution (e.g., air, noise, temperature); increase productivity; better recycling	Take ownership of core component; Lower cost; Complies with circular economy principles; increase life cycle; guarantee availability	Recycling and reusing	Take ownership; guarantee functionality; replace when needed; upgrade when needed; take maintenance; reduce downtime; certification; decrease TCO; customization
Monetization	Customer pays for physical product	Customer pays for tools and services	Customer pays for physical product	Contract-based (1-3 years); aggregated data	Customer pays for Second-life batteries; Customer pays for raw materials;	Customer payments monthly fees based on outcome units; aggregated data; services: charging stations, advice on the design of charging bays; charging monitor cloud service; lifting tools; Indirect revenue though increase sells of BM3.

Table 1b Business models of Epiroc (2013-2023)

	<i>BM7: Renting or sharing</i>	<i>BM8: Leasing</i>	<i>BM9: Net-zero certification</i>	<i>BM10: Skill training</i>	<i>BM11: Financial solutions</i>
Description	Short term contractual agreement between Epiroc and renter, facilitated by rental platforms.	Long term contractual agreement between Epiroc and lessee, facilitated by financial institutions.	Certification for the use of products that have achieved net-zero carbon emissions	Providing service and maintenance skillset of e-fleets	Operate just like a bank or lending institution
Customer segments	Project-based; greenfield; cost-conscious; financial institutions; rental companies	Project-based; greenfield; cost-conscious; eco-conscious; financial institutions	Electric working machines customers; third-party Electric working machines providers; Greenfields.	Greenfields	Project-based; cost-conscious
Customer interaction	Direct contact with the customer; rental companies are intermediates; 1 to 12 months	Direct contact with the customer; financial institutions are intermediates; 6 to 7 years	Direct contact with the customer to define a battery plan that suits the needs of their operation.	Direct contact; indirect contact through universities	Direct contact with the customer
Value proposition	Take ownership; guarantee functionality; guarantee availability; replace when needed; upgrade when needed; take maintenance; reduce downtime; certification; decrease TCO	Take ownership; guarantee functionality; guarantee availability; replace when needed; upgrade when needed; take maintenance; reduce downtime; certification; decrease TCO	Take ownership; guarantee functionality; replace when needed; upgrade when needed; take maintenance; reduce downtime; certification; decrease TCO; customization	Training new generation of service technicians; educating labor on new solutions;	Advice on purchase options based on customer needs and operations.
Monetization	Customer makes continuous variable monthly payments; aggregated data	Customer payments monthly fees based on outcome units; aggregated data; services: charging stations, advice on the design of charging bays; charging monitor cloud service; lifting tools.	Customer payments monthly fees based on outcome units; aggregated data; services: charging stations, advice on the design of charging bays; charging monitor cloud service; lifting tools.	Customer pays for the education; enhances the reputation; Indirect revenue though increase sells of BM3.	Indirect revenue through BM6, BM7, BM8

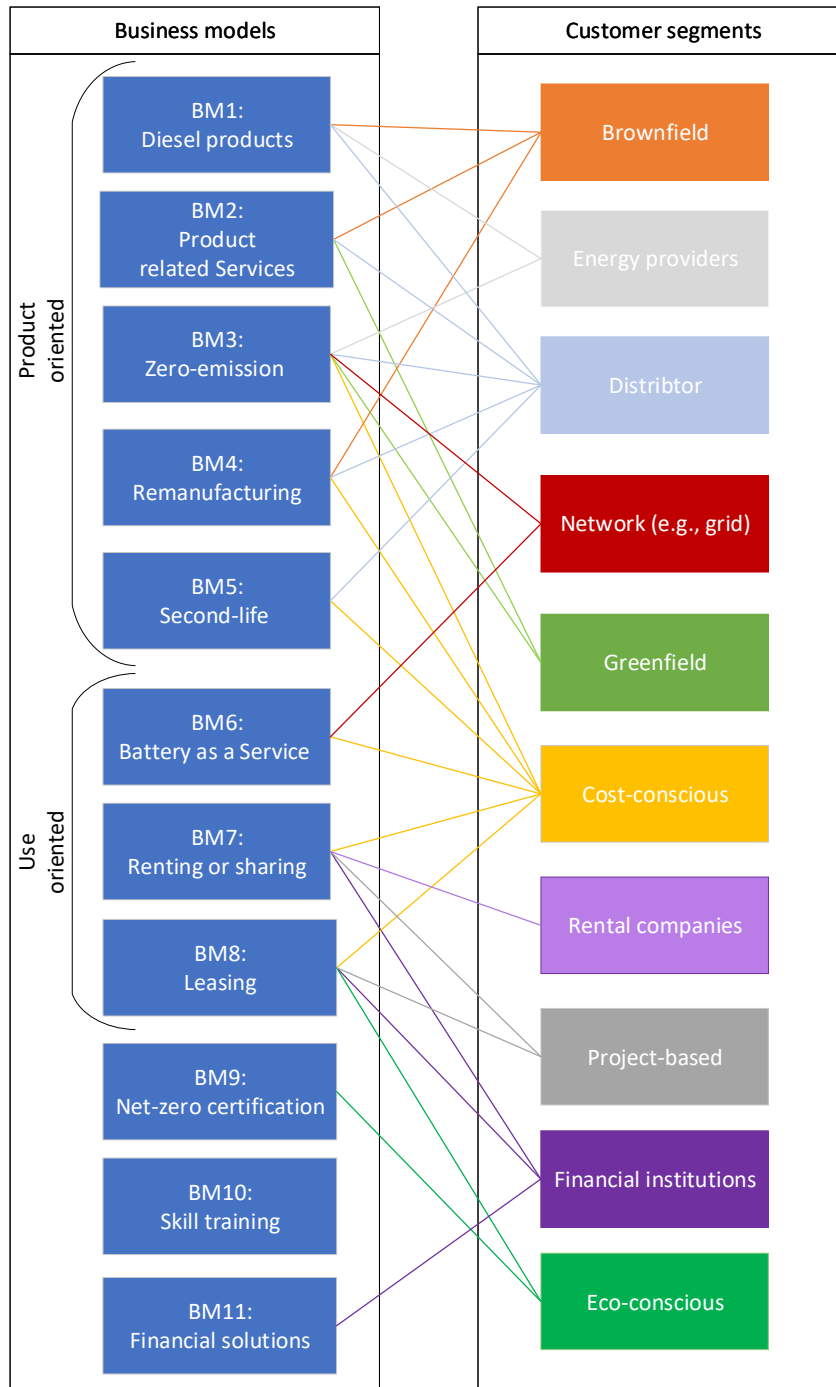


Figure 1 Business models and customer segments

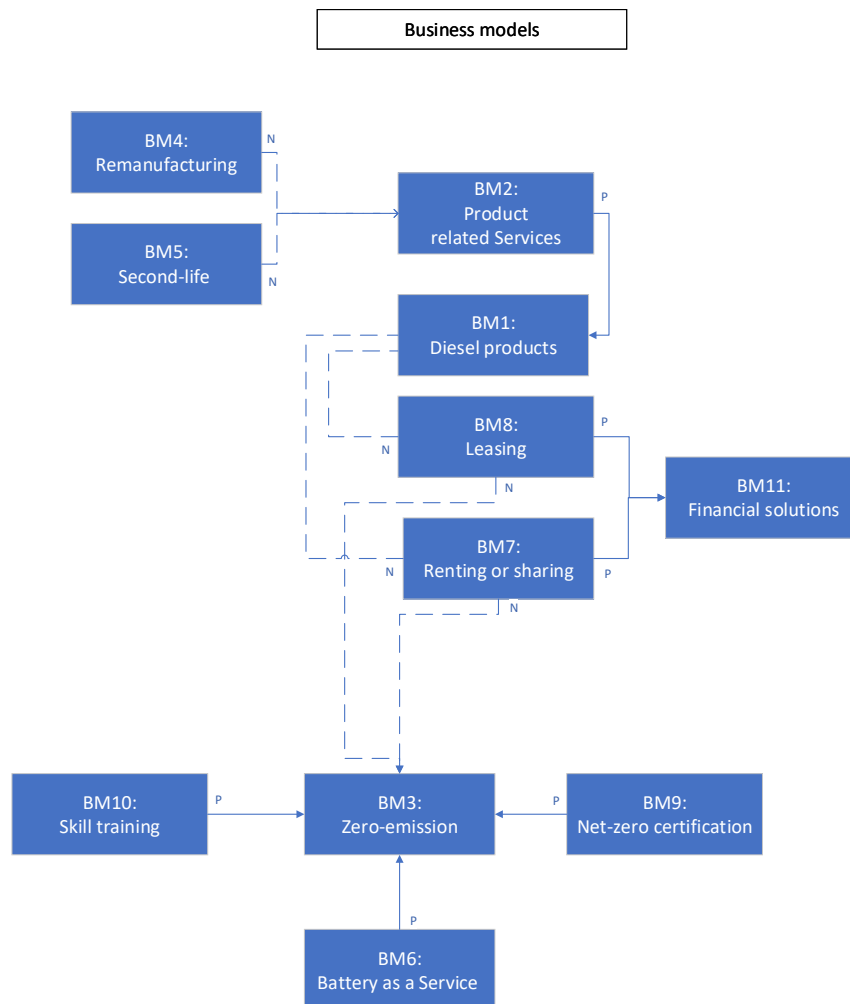


Figure 2 Business model synergies

5 Discussion and outlook

Our analysis of PSBMs suggest that the company's core business line may be its primary revenue driver, with the PSBMs serving as integrative elements. In other words, while it enables multiple business models, the additional business models enhancing and supplementing the core business rather than representing independent revenue streams. Thus, certain business models, particularly PSBMs, may not be inherently profitable on their own, but they create significant synergies that facilitate cross-selling across the portfolio of business models. Aversa et al. (2017) refer to these business models as integrative business models. Furthermore, an integrative business model reinforces and sustains firm competitive advantage as it hinders imitation and replicability, while standard business models usually focus on providing access to a larger range of products/services and prices.

It is noteworthy to mention that too much negative network effects (NE) may arise if there is cannibalization among the different business models. Conversely, if customer segments do not overlap, both positive and negative effects may occur. This can lead to substitution effects, where one customer group's products cannibalize that of another business model.

In light of these findings, manufacturers should carefully consider the potential trade-offs associated with adopting product-service system business models and develop strategies that balance the benefits and drawbacks of such models. Ultimately, understanding the nature of customer demand and the relationships between business models is crucial for developing a successful and sustainable business strategy.

6 Conclusion, limitations, and future research

In this research-in-progress, we have posed the question of how the utilization of product-service business models can facilitate diversification of a firm's offerings and impact its business model portfolio. We have identified 11 business models and 10 customer segments and have assessed demand-related mechanisms in the equipment manufacturing industry as key drivers of firm performance. These findings highlight the potential for leveraging synergies between business models over time.

While our study has limitations, it also presents opportunities for future research. By selecting a single organization, we were able to conduct an in-depth analysis, but this approach restricted examination of other factors such as competitive dynamics. Further studies should explore how contextual factors influence competition and how diversifying business models can generate benefits across customer segments. Additionally, we did not explore the interaction between supply-side and demand-side complementarities. Future research should integrate both perspectives to provide a more comprehensive understanding of the advantages of business model portfolio.

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Areas for feedback & development

The presented result in this research is currently under revision to have a more comprehensive version. Given that no research is perfect, we welcome any recommendations and inputs on envisaged theoretical and practical contributions to our tentative findings. It is also of interest to engage in discussions with both researchers and practitioners regarding potential alternative perspectives, lenses, or counterarguments to enrich the results beyond those already extracted and processed. Additionally,

In addition to the above, we welcome and highly appreciate all constructive feedback, recommendations, and inputs regarding future research and potential applications to advance the knowledge and understanding of the research area. Evaluating the logical consistency and coherence of the analysis or arguments presented in the paper is crucial to ensure the credibility and validity of our findings. We look forward to engaging in further discussions with researchers and practitioners and presenting our updated findings at the upcoming conference.