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Assessment of Lean, Agile, Resilient, and Green (LARG) Implementation in the Indonesian Electric Motorcycle Industry using Bayesian Best Worst Method

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Abstract
This study evaluates the implementation of the Lean, Agile, Resilient, and Green (LARG) approach in the electric motorcycle industry in Indonesia using the Bayesian Best Worst Method (BWM). The main focus of the study is to identify and determine the weight of the most relevant LARG indicators to improve the competitiveness and sustainability of the industry. From the analysis results, the Resilience indicator has the highest weight, while the Lean indicator has the lowest weight. Important sub-indicators identified include the ability to take corrective action when disruptions occur, waste management according to regulations, flexibility in collaboration with industry partners, and component quality testing. Recommended priority strategies include developing a standards-based safety system, consistent technology transfer, and provision of adequate infrastructure. The results of this study provide data-based strategic guidance to improve efficiency, flexibility, durability, and environmental sustainability in the electric automotive industry in Indonesia.

Keywords
LARG, BWM, Electric, Motorcycle, Industry.

Introduction

The transition period from using fuel-powered vehicles to zero-emission electric vehicles is in Indonesia. Specifically for electric motorcycle consumers, one of the main targets for the transition to environmentally friendly vehicles is to sell 4.5 million units by 2035; in addition to the plan to build 32 thousand units of public battery charging or exchange stations, Indonesian electric motorcycle manufacturers' readiness needs to be improved to be competitive. Automotive companies need to anticipate changes in the operational system of electric motorcycle production, which differs from conventional combustion engines that use fuel. Conducting an assessment of implementing lean, agile, resilient, and green in the automotive industry is strategic in increasing each LARG index (Aisyah et al., 2021). The automotive industry has a long production process chain involving many machines and equipment, so the application of lean, which focuses on streamlining and reducing waste, has become a practical activity that is widely carried out. Analysis of the application of lean and green generally dominates research conducted in the manufacturing industry, including the automotive industry, while implementing LARG as a whole is relatively not widely carried out. Lean manufacturing is an important tool implemented in many manufacturing sectors (Palange & Dhatrak, 2021). The other studies also show that the application and analysis of LARG aspects in the automotive industry have not been widely carried out. The European automotive market can be positioned as a resilient and strong market player for the future, where the essential prerequisite

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for this is a uniform and coordinated view of risk-based factors in each company (Britsche & Fekete, 2024). Research by Sonar et al., (2022) successfully presented a model that can be assessed as a strategic tool for selecting suppliers that consider lean, agile, resilient, green, and sustainable criteria simultaneously to improve supply chain efficiency and effectiveness. A study conducted in the manufacturing industry in Pakistan confirmed that Industry 4.0 technologies significantly impact all practices. At the same time, agile and resilient supply chain approaches partially mediate the relationship with supply chain performance (Piprani et al., 2024). A specific study in the agri-food industry conducted by Sahu et al., (2022) stated that supply chain practitioners struggle to improve agri-food supply chain (AFSC) performance due to a lack of understanding of the reciprocal impacts of lean, agile, resilience, and green practices in improving AFSC performance. Lean and green efforts are carried out independently in an organization without general agreement that the two can be integrated, as their constructs may differ. However, they have specific synergies and share features (Salvador et al., 2017). Mohammadzadeh et al., (2020) research aims to design a closed-loop supply chain network by considering the LARG strategy using multi-objective modeling with uncertain demand where the objective functions are total profit, customer satisfaction, and total pollution. The resulting model is formulated to determine which facility locations should be selected and the optimal number of components and products in the network (Mohammadzadeh et al., 2020). Green supply chain management practices among the "average" group of UK manufacturing organizations focus on higher-risk internal descriptive activities rather than proactive external engagement processes (Holt & Ghobadian, 2009).

Research by Khot and Thiagarajan (2019) confirmed that in developing countries like India, the automotive industry needs to have proper management commitment to the sustainability and resilience of the supply chain rather than rules and regulations. Implementing lean and green practices in the automotive component industry in the UK impacts increasing productivity and reducing operational costs (Sunmola et al., 2024). Lean and green are appropriate and recommended strategies for competitiveness and sustainability, where a green supply chain is an available option but needs to be linked with lean practices to find a competitive advantage with benefits for the organization and contribution to nature (Sharma et al., 2019). Lean production positively influences green production and sustainable performance, and green production acts as a mediator between the two variables (Maldonado-Guzmán & Toro, 2024; Haddach et al., 2017). Research by Pombal et al., (2019) implemented a lean methodology for managing consumables in the maintenance workshop of an industrial company by reducing the volume of materials and arranging the placement of equipment used. Increasing the efficiency of the assembly line as an impact of the spread of COVID-19 in the automotive industry can be done by strengthening resilience (El Ahmadi & El Abbadi, 2022). Research conducted by Cabral et al., (2012) showed that the implementation of a series of LARGs in companies could make the supply chain more competitive, able to respond to customer demand with agility, and able to respond to unexpected disruptions effectively, along with environmental responsibility and the need to eliminate non-value-added processes. Several studies have been conducted using the application of LARGs in the automotive and manufacturing industries, especially (Azevedo et al., 2013; Carvalho & Cruz-Machado, 2011; Carvalho et al., 2011). Research Carvalho and Cruz-Machado (2011) stated that the conflict between the management paradigms of lean, agile, resilience, and green is an actual issue that can help the supply chain in the automotive industry become more efficient and sustainable.

The application of LARG is not limited to the operational aspects of manufacturing production but also to the supply chain aspects that ensure the availability of raw materials for the distribution of products to consumers. Research by Carvalho et al., (2011) was conducted by analyzing the practical implications of a model proposed by researchers, which is the basis for further research in the lean, agile, resilient, and green paradigms, which contribute to a sustainable and competitive lean supply chain with the agility needed to provide a fast response, resilience to disruption, and harmony with environmental aspects. The most important parts that must be considered in the competitiveness of the supply chain in the automotive industry are lean, agile, resilient, and green Azevedo et al., 2012). The thriving research developed a framework based on the enterprise 2.0 approach for the global supply chain to assess the LARG index to evaluate the industry's leanness, agility, resilience, and greenness (Fazendeiro et al., 2013).

This study adopts a systematic framework that combines the Multi-Criteria Decision Making (MCDM) approach based on the Bayesian Best Worst Method (BWM) to assess the implementation of LARG in the Indonesian electric motor industry. This framework consists of four main stages: (1) identification of LARG indicators and sub-indicators through literature review and Focus Group Discussion (FGD) with industry experts; (2) collection of priority preference data through questionnaires filled out by key stakeholders (associations, industry players, academics, and government);

(3) calculation of indicator and sub-indicator weights using probabilistic BWM to accommodate the uncertainty of respondents' preferences; and (4) determination of priority strategies by mapping the relationship between policy alternatives and LARG sub-indicators. This model not only assesses the relative weight of each LARG aspect but also integrates a Bayesian perspective to strengthen statistical validity in the context of limited data while providing measurable and contextual recommendations for policymakers.

Literature review

The thriving research created a lean, agile, and agile supply chain framework by Soni and Kodali (2012), which evaluated the reliability and validity of the lean, agile, and agile supply chain construct in the manufacturing industry. Soni and Kodali (2012) continued the research by conducting a component analysis of the construct to determine the pillars of each type of supply chain and then by evaluating the reliability and validity to establish the underlying construct. Paradigms in Supply Chain Management, including lean, agile, resilience, green, and sustainable, have an important role in the success of the performance and competitive advantage, where the contribution of this research is an integrated model of the LARG supply chain paradigm and sustainable supply chain performance (Anvari, 2021). In this study, an assessment of LARG Implementation in the Indonesian Electric Motorcycle Industry using BWM was conducted. Assessment of the implementation of new technology was conducted using the Bayesian Best Worst method. A study by Munim et al., (2022) proposed a multi-criteria decision-making framework to assess blockchain adoption strategies built on four adoption strategies: single-use, localization, substitution, and transformation. The Bayesian Best Worst (BWM) method and multi-criteria Decision-Making (MCDM) method were used for the analysis, which showed that three sub-criteria, namely lack of expertise in technology, lack of supply chain partner collaboration, and reduction of operating costs, had the most significant impact on the adoption process, in the context of the Norwegian oil and gas industry. The research by Debnath et al., (2023a) was conducted in several stages; with the help of a literature review and consultation with experts, a total of sixteen most significant critical success factors for implementing sustainable lean manufacturing, then the identified CSFs were grouped into three clusters (organization and governance cluster, supply chain, inventory, resource management cluster, and performance and technology cluster, based on expert suggestions), ending with the use of the BWM method to evaluate the importance of these CSFs. Specifically, this study encourages implementing lean manufacturing practices in the manufacturing industry in developing countries such as Bangladesh Debnath et al., 2023a). The study by Debnath et al., (2023b) aimed to analyze the potential CSFs for adopting I4.0 to improve all aspects of sustainability in the pharmaceutical supply chain, especially from the perspective of a developing economy like Bangladesh. Sixteen CSFs were identified through a comprehensive literature review and expert validation. The finalized CSFs were grouped into three relevant groups and analyzed using a multi-criteria decision-making framework based on the BWM method. The study aimed to provide a model based on the identification and investigation of related criteria to evaluate supplier resilience and select the most resilient suppliers in the Iranian electronics industry, where the BWM and goal programming-GP methods have been applied in a fuzzy environment (Aghababayi & Nikabadi, 2021). The study by Ahmed et al., (2024) used BWM to explore the most critical Disruptive Technologies (DT) for the example of the Readymade Garment (RMG) industry in Bangladesh, where the results showed that the three most important DTs for Sustainable Supply Chain (SSC) are "Internet of things (IoT)", "Cloud manufacturing", and "Artificial in intelligence (AI)". The study ensures that selected suppliers comply with sustainability and resilience requirements while supporting the economic progress of the company through a novel approach that combines the BWM method with fuzzy technique order of preference by similarity to the ideal solution (Varchandi et al., 2024). The study by Salman et al., (2023) conducted as the trend of resource-saving and operational cost minimization has spurred a significant increase in the application of lean manufacturing in the context of circular economy across industries in recent years, where there is a significant gap in the research landscape, primarily related to the application of lean practices in the pharmaceutical industry to improve circular economy performance. The study Afrasiabi et al., (2022) proposed a hybrid multi-criteria decision making-MCDM method to solve sustainable-resilient supplier selection problems-SRSSP. The fuzzy BWM method is used to determine the importance weight of the selection criteria, where the technique for order of preference by similarity to ideal solution analysis is used further to evaluate suppliers in a fuzzy environment.

Previous studies on the application of the Lean, Agile, Resilient, and Green (LARG) approach have been widely conducted in various manufacturing sectors and global supply chains, such as the conventional automotive industry, agro-food, pharmaceutical, and energy, with a focus on the integration of the LARG paradigm to improve sustainability and competitiveness. These studies used methods such as the Best Worst Method (BWM), the Analytic Hierarchy Process (AHP), and system modeling to evaluate LARG indicators, with the dominant finding that lean-green synergy and resilience are key in facing disruption. However, most studies are still limited to the context of developed countries or large industries, do not touch on specific implementations in the electric vehicle industry in developing countries, and rarely integrate quantitative analysis based on real data. The current study fills this gap by evaluating LARG, specifically in the Indonesian electric motorcycle industry, using Bayesian BWM.

Materials & Methods

The methods or steps used in this research are: (i) The first step in this research is to identify all LARG sub-indicators that are most appropriate for the electric motor industry in Indonesia from various sources and references, both from various articles, direct observations and FGDs with experts and associations in the automotive industry, especially in the electric motor industry, (ii) Create a questionnaire about the most important LARG sub-indicators implemented in the electric motor industry in Indonesia. The questionnaire will be filled out by six respondents who are experienced in the automotive industry, especially electric motors (two peoples from the Indonesian Electric Motor Association, two peoples from the Indonesian electric motor industry, one academic who understands electric motors, one person from the ministry of industry who handles electric vehicles in Indonesia), (iii) Rank the sub-indicators of each LARG indicator. Then select sub-indicators 1-5 from each LARG indicator, (iv) Determine the weight of the indicator and the 5 sub-indicators of each LARG indicator using BWM. The selection of 5 sub-indicators per LARG indicator is a methodological strategy to ensure focused, relevant, and applicable results while accommodating resource limitations and analysis complexity in the context of the growing Indonesian electric motor industry. In addition, the Best Worst Method (BWM) requires pairwise comparisons between sub-indicators. Selecting 5 sub-indicators per category avoids excessive calculation complexity (combinatorial explosion) when determining weights, especially with a limited number of respondents (6–8 experts). (v) Identify the most appropriate alternatives that the Indonesian electric motor industry can implement to increase its competitiveness, (vi) Create a questionnaire on the relationship between alternatives and sub-indicators of each existing indicator. The questionnaire will be filled out by eight respondents who are experienced in the automotive industry, especially electric motors (2 people from the Indonesian Electric Motor Association, two people from the Indonesian electric motor industry, two academics who understand electric motors, two people from the ministry of industry who handle electric vehicles in Indonesia) (Figs. 1 and 2).

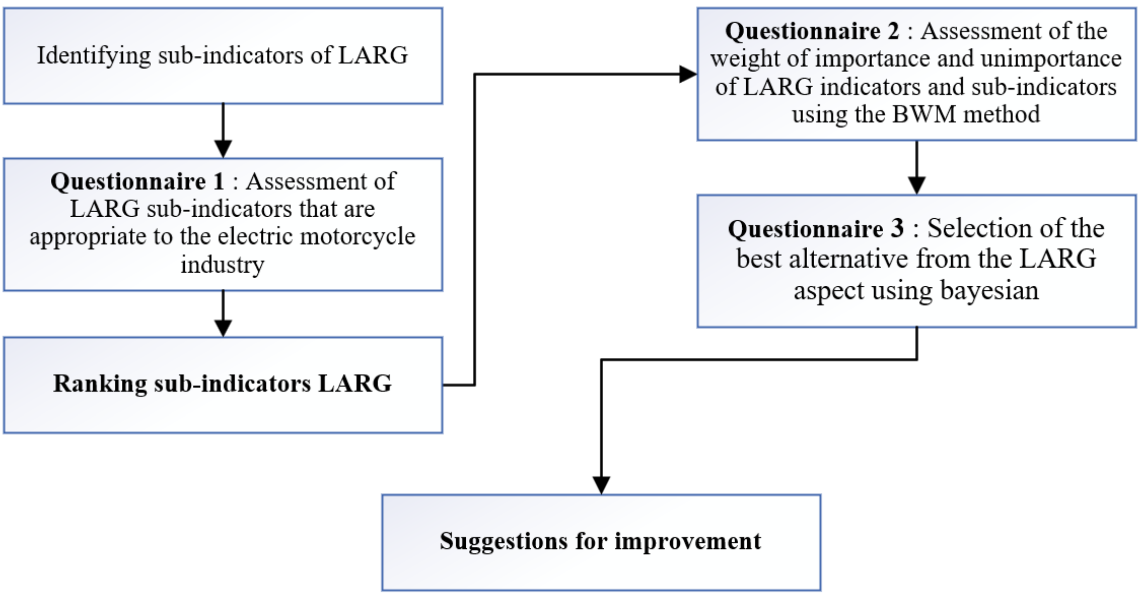

Fig. 1. Study framework

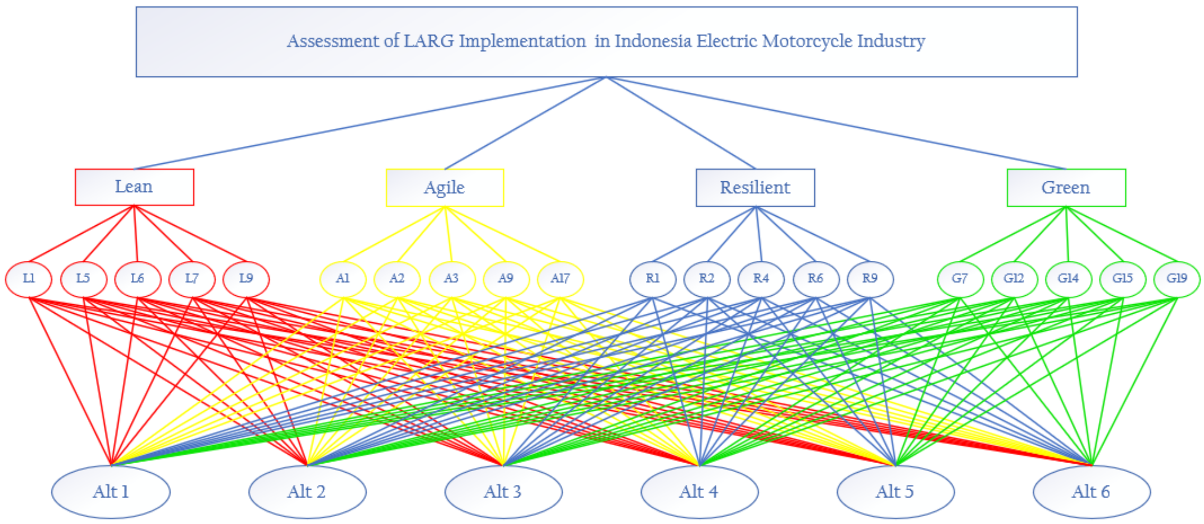

Fig. 2. A MCDM framework for assessment of LARG in Indonesia electric motocycle industry

L1: Ensure all components have been quality-tested

L5: Improve resource utilization

L6: Strive to shorten lead time, cycle time, and setup

L7: Quality assurance chain

L9: Multifunctional workforce

A1: Rapid ability to reconfigure planning and production processes

A2: Provide and facilitate continuous development of knowledge, skill, and work experience

A3: Flexible in collaboration with other brands (as development partners)

A9: Speed in improving customer service, delivery reliability, and response to market changes

A17: Ability to maintain and grow close relationships based on trust with customers and suppliers

Alt 1: Safety-based (including related to battery standards and specifications of electric motorcycle

Alt 2: Consistent Technology transfer policies from OEMs to SABHs

Alt 3: SNI that supports local industry growth

R1: Strategy to face the dynamics of government programs in the electrical motorcycle industry

R2: Ability to take corrective action when disruptions are identified quickly

R4: Availability of real-time information through improvements to management information sytems

R6: Utilization of flexible raw material sources

R9: Designing a production system that can accommodate multiple products and real-time changes

G7: Waste management according to regulations

G12: Evaluation and adjusment of component prices that accommodate the needs of green energy, which are usually more expensive

G14: Investment in more environmentally friendly design and technology

G15: Management that consuders environmental aspects

G19: Evaluation of existing business processes

Alt 4: Subsidy programs and financial system services

Alt 5: Provision of adequate infrastructure

Alt 6: Provision of regulations and battery recycling systems and waste management

Results and Discussion

The results of the first stage, namely searching for and identifying indicators and sub-indicators from various article references and discussions with electric motor experts, obtained 13 sub-indicators for lean, 17 sub-indicators for agile, 16 sub-indicators for resilience, and 19 sub-indicators for green. The identified sub-indicators have several differences from the LARG sub-indicators in the article on LARG implementation in the automotive industry in Indonesia (Aisyah et al., 2021). LARG analysis in several automotive industries in Europe has also been carried out by (Azevedo et al., 2013; Carvalho & Cruz-Machado, 2011; Carvalho et al., 2011). In this study, the implementation of LARG is specifically for electric motors, so several sub-indicators are indeed very much adjusted to the needs of the electric car industry. Then, a questionnaire was created and distributed to determine the level of importance of each sub-indicator. The results of the questionnaire from 6 respondents were processed using simple statistics. The results of the calculations and rank of each sub-indicator can be seen in Table 1.

Then, the first five rankings of each sub-indicator are selected to calculate the weight of their importance using BWM. The selected sub-indicators from each indicator are:

Table 1
The results of the calculations and rank of each LARG sub-indicator

Sub indicators	Symbol	Average	Rank
LEAN			
Minimize resource inventory (raw materials, work in process, finished goods, labor, machinery, and production tools)	L1	4.286	13
Ensure all components have been quality-tested	L2	5.000	1
Give workers confidence to continue to make continuous improvements so that their knowledge and skills develop.	L3	4.429	6
Minimize resource inventory and use	L4	4.286	12
Increase resource utilization	L5	4.714	5
Try to shorten the lead cycle time and set it up.	L6	5.000	2
Quality Assurance Chain	L7	4.714	3
Innovation in performance assessment	L8	4.286	11
Multifunctional workforce	L9	4.571	4
Prioritize customer satisfaction	L10	4.429	7
Just in Time	L11	4.429	8
Continuous improvement	L12	4.286	10
Produce according to customer need	L13	4.429	9
GREEN			
Designing products and processes using environmentally friendly materials	G1	4.571	6
Considering the energy consumption required by the product/process	G2	4.429	9
Ease of recycling the designed product	G3	4.286	18
Ease of reusing the materials used	G4	4.286	17
Ease of remanufacturing	G5	4,429	10
Using manufacturing facilities that cause the least pollution	G6	4.429	11
Waste management according to regulations	G7	5.000	2

Table 1 continued at the next column

Table 1 continued from the previous column

Sub indicators	Symbol	Average	Rank
GREEN			
Using production technology to minimize pollution	G8	4.429	12
Reducing the amount of waste	G9	4.571	7
Implementing energy-efficient manufacturing processes	G10	4.571	8
Water conservation in the manufacturing process	G11	4.286	16
Evaluating and adjusting the price of components that accommodate Green energy needs (usually more expensive)	G12	5.000	1
Adjusting products or services	G13	4.286	15
Investing in more environmentally friendly designs and technologies	G14	4.857	3
Management that considers environmental aspects	G15	4.714	5
Efforts to develop "green" technology	G16	4.143	19
Participation in socialization/training activities carried out by the government or related institutions	G17	4.286	14
Division of roles and responsibilities	G18	4.429	13
Evaluation of existing business processes	G19	4.857	4
Strategy for increasing market share	R16	4.571	7
AGILE			
Maximize employee skills, knowledge, judgment, experience, and intelligence.	A1	4.857	2
Provide and facilitate continuous development of employee knowledge, skills, and experience.	A2	4.571	4
Flexible in collaboration with other brands (as development partners)	A3	5.000	1
Multi-skilled and flexible employees	A4	4.429	6
Prioritize employee and consumer satisfaction.	A5	4.286	12

Table 1 continued at the next page

Table 1 continued from the previous page

Sub indicators	Symbol	Average	Rank
AGILE			
Speed in identifying and resolving problems	A6	4.286	13
Use IT to integrate/coordinate all production/manufacturing activities.	A7	4.429	7
Quick ability to reconfigure production planning and processes	A8	4.429	8
Speed in improving customer service, delivery reliability, and response to market changes	A9	4.714	3
Developing hard-to-copy business practices	A10	4.000	16
Awareness of technological developments and striving to be a leader in the use of the latest technology	A11	4.429	9
Designing and producing products that meet consumer needs and add significant value	A12	4.429	10
Using centralized planning and collaboration	A13	4.286	14
Speed in reducing development and production cycle times	A14	4.143	15
Increasing the frequency of new product introductions	A15	3.714	17
Responsive to changing market needs	A16	4.429	11
Ability to maintain and grow close relationships based on trust with consumers and suppliers	A17	4.571	5
RESILIENCE			
Strategy to face dynamics related to government programs in the electric motor industry	R1	4.857	2
Ability to take corrective action when disruptions are identified quickly	R2	5.000	1
Ability to continue to innovate to remain resilient to unavoidable disruptions.	R3	4.429	12

Table 1 continued at the next column

Table 1 continued from the previous column

Sub indicators	Symbol	Average	Rank
RESILIENCE			
Availability of real-time information Through improvements to the Management information system	R4	4.714	4
Using a raw material sourcing strategy for possible supplier changes	R5	4.143	15
Utilization of flexible raw material sources	R6	4.714	5
Creating inventory strategies for both raw materials and finished goods	R7	4.000	16
Commitment through contracts with suppliers	R8	4.429	11
Designing a production system that can accommodate multiple products and real-time changes	R9	4.857	3
Developing cooperation in all production activities to help reduce risk	R10	4.429	10
Implementing demand-based management	R11	4.286	13
Making improvements in maintenance, especially preventive maintenance	R12	4.571	6
Using a flexible transportation system	R13	4.429	9
Trying to reduce lead time and operational costs	R14	4.143	14
Using a multi-skilled workforce	R15	4.429	8
Strategy for increasing market share	R16	4.571	7

Lean: L2 (ensuring all components have been quality tested), L5 (increasing resource utilization), L6 (striving to shorten lead time, cycle time, and set up), L7 (quality assurance chain), and L9 (multifunctional workforce).

Agile: A1 (fast ability to reconfigure planning and production processes), A2 (providing and facilitating the development of knowledge, skills, and experience of workers on an ongoing basis), A3 (Flexible in cooperation with other brands (as development partners)), A9 (speed in improving customer service, delivery reliability and response to market changes), and A17 (ability to maintain and grow close relationships based on trust with consumers and suppliers).

Resilient: R1 (strategy to face dynamics related to government programs in the electric motor industry), R2 (ability to take corrective action when disruptions are identified quickly), R4 (availability of real-time information through improvements to management information systems, R6 (utilization of flexible raw material sources), and R9 (designing a production system that can accommodate multiple products and real-time changes).

Green: G7 (waste management according to regulations), G12 (evaluation and adjustment of component prices that accommodate the needs of "green energy", which is usually much more expensive), G14 (investment in more environmentally friendly design and technology), G15 (management that considers environmental aspects), and G19 (evaluation of existing business processes).

The results of the weight calculation using the BWM method are as follows: Figure 3 shows the weight of each indicator. The most important indicator is the Resilient indicator (0.46875), and the least important is the Lean indicator (0.09375). The consistency ratio level is 0.09524, which is still acceptable because it is still below 0.5.

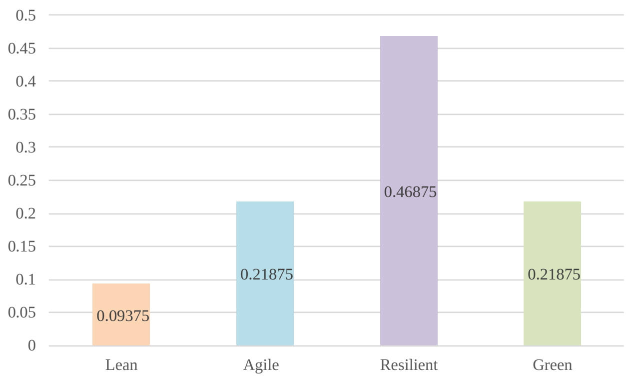

Fig. 3. The weight of each LARG indicator

In the sub-indicators:

Lean: The most important sub-indicator is L7 (0.400), and the least important is L5 (0.091). From the results of the BWM calculation, the consistency ratio level is 0.1667 and is still acceptable because it is still below 0.5. The weight of each lean sub-indicator can be seen in Figure 4.

Agile: The most important sub-indicator is A3 (0.414), and the least important is A17 (0.071). From the results of the BWM calculation, the consistency ratio level is 0.20 and is still acceptable because it is still below 0.5. The weight of each agile sub-indicator can be seen in Figure 5.

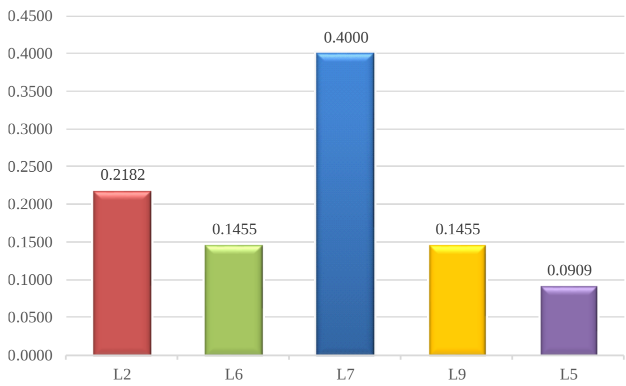

Fig. 4. The weight of Lean sub-indicator

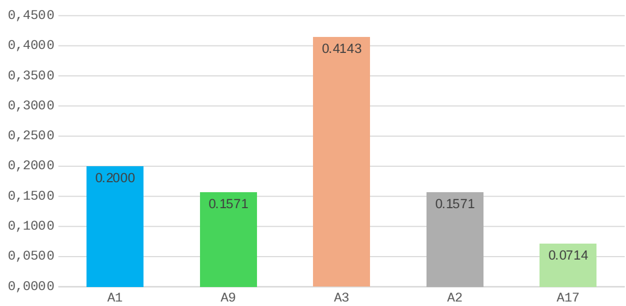

Fig. 5. The weight of Agile sub-indicator

Resilient: The most important sub-indicator is R2 (0.380), and the least important is R6 (0.080). The BWM calculation results show that the consistency ratio level is 0.05 and is still acceptable because it is below 0.5. The weight of each resilient sub-indicator can be seen in Figure 6.

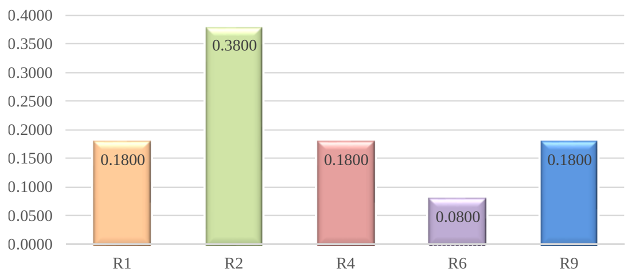

Fig. 6. The weight of Resilient sub-indicator

Green: The most important sub-indicator is G12 (0.433), and the least important is G15 (0.075). The BWM calculation results show that the consistency ratio level is 0.2 and is still acceptable because it is below 0.5. The weight of each green sub-indicator can be seen in Figure 7.

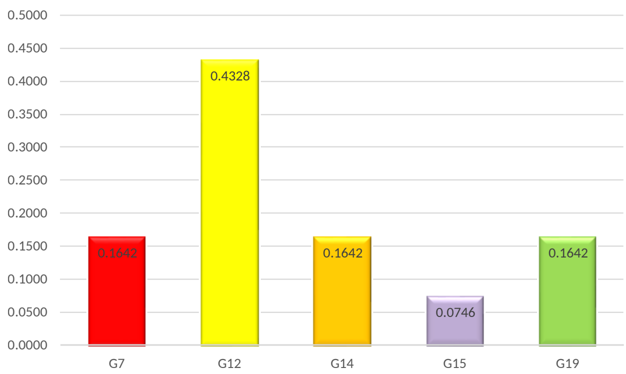

Fig. 7. The weight of Green sub-indicator

Priority of alternative selection stages

The priority calculations for the alternative selection stages are reported in Tables 2, 3, and 4. The global weights of the sub-indicators in Table 3 are calculated by multiplying the sub-indicator level weights by the respective indicator weights. To determine the priority score for each alternative stage, the normalized value for each sub-indicator is multiplied by the corresponding global weight, as shown in Table 3. For each alternative, the sum of the global weights for each sub-indicator indicates its priority. To calculate the priorities reported in Table 4, Alt 1 (Safety-based (including related to battery standards and specifications of electric motorcycle)) is the priority (0.779). Alt 2 (Consistent Technology transfer policies from OEMs to ATPMs) is in second place (0.773). Alt 5 (Provision of adequate infrastructure) is in third place (0.770), Alt 6 (Provision of regulations and battery recycling and waste management systems) (0.765), Alt 3 (SNI that supports local industry growth) (0.588), and Alt 4 (subsidy programs and financial system services) (0.521).

Table 2 summarizes raw data from the assessment of 10 respondents (industry experts, policymakers, etc.) on the relationship between strategic alternatives (Alt 1 to Alt 6) and sub-indicators in each LARG indicator. The score reflects the strength of each alternative's relationship to improving Lean, Agile, Resilient, and Green (LARG) practices in the Indonesian electric motorcycle industry. The scores ??range from 3 to 9 (higher scores = stronger relationships). Table 3 shows the process for creating normalized scores (raw data from Table 2). Normalization adjusts the scores so that they can be fairly compared across sub-indicators, which may have different scales or levels of importance. Table 4 integrates the weighting and normalization to produce strategy recommendations. In this table, the normalized scores (from the results of Table 3) are multiplied by the global weight of each sub-indicator (from BWM) to calculate the weighted score. Summing these weighted scores for each alternative produces the total priority score, thus obtaining a strategy recommendation. The interrelationship between Tables 2, 3, and 4 ensures a transparent, systematic, and evidence-based analysis.

Tables 2, 3, and 4 calculate the priority of alternative implementation strategies based on the relationship between LARG indicators and sub-indicators. The results of the analysis using the Bayesian Best Worst Method (BWM) show the following priorities and top strategy alternatives: Alt 1 (Safety-based strategy, including battery standards and electric motorcycle specifications) has the highest score (0.779), indicating the importance of safety standards to improve competitiveness and sustainability. Alt 2 (Consistency of technology transfer policies from OEMs to ATPMs) is in second place (0.773), underlining the importance of technology transfer in strengthening local capabilities. Other Alternative Rank: Alt 5 (Provision of adequate infrastructure) is in third place (0.770). Alt 6 (Provision of regulations, battery recycling systems, and waste management) is in fourth place (0.765). Alt 3 (Indonesian National Standard/SNI that supports local industry growth) and Alt 4 (Subsidy programs and

Table 2
Aggregate results from 10 respondents on the relationship between alternatives and sub-indicators

	Lean					Agile					Resilient					Green				
	L2	L5	L6	L7	L9	A1	A2	A3	A9	A17	R1	R2	R4	R6	R9	G7	G12	G14	G15	G19
Alt 1	9	3	3	9	3	3	3	9	3	3	5	9	5	5	7	5	9	7	5	3
Alt 2	5	5	7	7	7	5	7	5	5	5	3	7	7	7	9	5	7	5	3	5
Alt 3	7	3	3	5	3	5	5	7	5	3	5	3	5	3	5	5	7	5	3	3
Alt 4	3	3	3	7	3	3	3	5	3	3	7	3	3	3	5	3	5	5	3	7
Alt 5	7	5	5	9	5	5	7	9	7	5	9	5	5	5	5	5	7	5	5	5
Alt 6	3	3	5	7	5	7	5	7	5	7	9	5	5	5	3	9	9	9	7	5

Table 3
Normalized values

	Lean					Agile					Resilient					Green				
	0.094					0.219					0.469					0.219				
	L2	L5	L6	L7	L9	A1	A2	A3	A9	A17	R1	R2	R4	R6	R9	G7	G12	G14	G15	G19
Alt 1	1.00	0.60	0.43	1.00	0.43	0.43	0.43	1.00	0.43	0.43	0.56	1.00	0.71	0.71	0.78	0.56	1.00	0.78	0.71	0.43
Alt 2	0.56	1.00	1.00	0.80	1.00	0.71	1.00	0.56	0.71	0.71	0.33	0.78	1.00	1.00	1.00	0.56	0.78	0.56	0.43	0.71
Alt 3	0.78	0.60	0.43	0.60	0.43	0.71	0.71	0.78	0.71	0.43	0.56	0.33	0.71	0.43	0.56	0.56	0.78	0.56	0.43	0.43
Alt 4	0.33	0.60	0.43	0.80	0.43	0.43	0.43	0.56	0.43	0.43	0.78	0.33	0.43	0.43	0.56	0.33	0.56	0.56	0.43	1.00
Alt 5	0.78	1.00	0.71	1.00	0.71	0.71	1.00	1.00	1.00	0.71	1.00	0.56	0.71	0.71	0.56	0.56	0.78	0.56	0.71	0.71
Alt 6	0.33	0.60	0.71	0.80	0.71	1.00	0.71	0.78	0.71	1.00	1.00	0.56	0.71	0.71	0.33	1.00	1.00	1.00	1.00	0.71

Table 4
Priorities of alternatives

	Lean					Agile					Resilient					Green					Overall	Rank
	0.094					**0.219**					**0.469**					**0.219**						
	L2	L5	L6	L7	L9	A1	A2	A3	A9	A17	R1	R2	R4	R6	R9	G7	G12	G14	G15	G19		
Local	**0.218**	**0.091**	**0.415**	**0.4**	**0.145**	**0.2**	**0.157**	**0.414**	**0.157**	**0.071**	**0.18**	**0.38**	**0.18**	**0.08**	**0.18**	**0.164**	**0.433**	**0.164**	**0.075**	**0.164**		
Global	**0.020**	**0.009**	**0.039**	**0.038**	**0.014**	**0.044**	**0.034**	**0.091**	**0.034**	**0.016**	**0.084**	**0.178**	**0.084**	**0.038**	**0.084**	**0.036**	**0.095**	**0.036**	**0.016**	**0.036**		
Alt 1	0.020	0.005	0.017	0.038	0.006	0.019	0.015	0.091	0.015	0.007	0.047	0.178	0.060	0.027	0.066	0.020	0.095	0.028	0.012	0.015	0.779	1
Alt 2	0.011	0.009	0.039	0.029	0.014	0.031	0.034	0.050	0.025	0.011	0.028	0.139	0.084	0.038	0.084	0.020	0.074	0.020	0.007	0.026	0.773	2
Alt 3	0.016	0.005	0.017	0.021	0.006	0.031	0.025	0.071	0.025	0.007	0.047	0.059	0.060	0.016	0.047	0.020	0.074	0.020	0.007	0.015	0.588	5
Alt 4	0.007	0.005	0.017	0.029	0.006	0.019	0.015	0.050	0.015	0.007	0.066	0.059	0.036	0.016	0.047	0.012	0.053	0.020	0.007	0.036	0.521	6
Alt 5	0.016	0.009	0.028	0.038	0.010	0.031	0.034	0.091	0.034	0.011	0.084	0.099	0.060	0.027	0.047	0.020	0.074	0.020	0.012	0.026	0.770	3
Alt 6	0.007	0.005	0.028	0.029	0.010	0.044	0.025	0.071	0.025	0.016	0.084	0.099	0.060	0.027	0.028	0.036	0.095	0.036	0.016	0.026	0.765	4

financial system services) have lower scores, 0.588 and 0.521, respectively. Global Influence of LARG Indicators: Resilient has the highest weight (0.469), followed by Agile and Green with 0.219 each, while Lean has the lowest weight (0.094). This shows that Resilience is the most important aspect of the proposed strategy. Implications, safety-based strategies, and consistent technology transfer are the main focus of improving the competitiveness of the electric motorcycle industry. The provision of infrastructure and regulations that support battery recycling systems also plays an important role in driving sustainability.

Conclusions

This study successfully evaluated the implementation of the Lean, Agile, Resilient, and Green (LARG) approach in the electric motorcycle industry in Indonesia using the Bayesian Best Worst Method (BWM). The data processing results show that the Resilience aspect has the highest weight, reflecting the importance of the industry's ability to overcome disruptions, adapt to change, and improve system resilience. Conversely, the Lean aspect has the lowest weight, indicating the need for more attention to resource efficiency. The main sub-indicators identified include the ability to take corrective action when disruptions occur. Waste management by regulations. Flexibility of collaboration with industry partners. Comprehensive component quality testing. The proposed priority strategies include the development of safety standards, consistent technology transfer policies, and providing supporting infrastructure. This conclusion confirms that applying LARG indicators can provide strategic guidance to improve competitiveness and sustainability in facing challenges and opportunities in the Indonesian electric motorcycle industry.

The results of this study have answered the research objectives. However, this study still has several shortcomings that are opportunities for further research. Further research needs to focus on data expansion, method integration, and contextual analysis to produce more holistic and applicable recommendations. Thus, the implementation of LARG in the Indonesian electric motor industry can be optimized effectively.

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