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## **MALAYSIA GREEN HIGHWAY INDEX: THE ESG QUADRUPLE HELIX JOURNEY**

**Rozana Zakaria<sup>1</sup>, Eeydzah Aminudin<sup>2</sup>, Jeffryl Azniel Adzar<sup>3</sup>, M. Hafizzudin  
Syafiq<sup>4</sup>, Ferry Firmawan<sup>5</sup>**

*<sup>1</sup>Faculty of Artificial Intelligence,  
UNIVERSITI TEKNOLOGI MALAYSIA*

*<sup>2</sup>Faculty of Civil Engineering,  
UNIVERSITI TEKNOLOGI MARA*

*<sup>3</sup>Road Division, Department of Public Works Malaysia,  
JKR MALAYSIA*

*<sup>4</sup>Faculty of Civil Engineering,  
UNIVERSITI TEKNOLOGI MALAYSIA*

*<sup>5</sup>Faculty of Engineering,  
UNIVERSITAS SEMARANG INDONESIA*

### **Abstract**

This paper highlights the Malaysia Green Highway Index (MyGHI) as a national index that evaluates the Highway Infrastructure responsible for green initiatives. The index offers a measurable system for assessing the highway operation and services that reflect on Environmental, Social, and Governance (ESG) factors. To evaluate and promote the sustainability of the life cycle of highway projects, the MyGHI assessment focused on the sustainable practice from design, construction, operation & maintenance of highways in Malaysia, which entails reducing carbon footprint, conserving resources, and environmental conservation. The study explores how a green policy is connected to green rating tools developed to meet governmental priorities for enhanced national sustainable development. The MyGHI ESG journey is a step-by-step process of government agencies and universities collaborating on the Quadruple-Helix Methodology. MyGHI elevates social factors concerned with sustainability, which creates rest and service areas and safety for the community, engaging the community in meaningful ways and achieving equitable allocation of comfort and safety benefits. As a result, this paper expounded on MyGHI ESG's road map from the cradle to the present.

**Keywords:** Environmental Social Governance, Green Highway Index, Sustainable Leadership, Quadruple Helix

<sup>1</sup> Corresponding author. Email: rozana@utm.my

## **INTRODUCTION**

What is the Green Highway Index? The Malaysia Green Highway Index (MyGHI) is a green rating tool for sustainable practice measurement that reflects the presence of green infrastructure in any highway. The MyGHI measures sustainable highway infrastructures and analyses the highway projects based on environmental impact, society, and governance factors. The index aims to make highway design, construction, operation, or maintenance compliant with Malaysia's or even international sustainable development objectives, where ESG factors are involved.

The road map began in late 2011 when Lembaga Lebuhraya Malaysia (MHA) invited Universiti Teknologi Malaysia (UTM) for a research and consultation courtesy visit to prepare for this research. The first briefing of the project to the MHA Department of Planning and the Department of Expert Services & Technical Collaboration (KPKT) received a positive reception. Both entities showed keen interest in possible cooperation in the Quadruple-Helix activities concerning several avenues for cooperation towards the development and innovation of the highway sector. Therefore, this paper is inquisitive about how green policies and green rating tools, such as MyGHI, were developed to match government attention to elevating the sustainable development of the country.

From the potential of collaboration, the Quadruple-Helix concept became a pivotal model to address the multifaceted and interconnected processes of academics and highway authorities involved in innovation, knowledge formation, and sustainable development. Specifically, the model's focus on the co-evolving and co-generative nature of knowledge, technology, and social change is well aligned with the multifaceted systems thinking because the sustainability transformation in the construction industry demands, by nature, a 'wicked', integrated approach. The driving of the Quadruple-Helix model concerning sustainable development and innovation was discussed in this paper, which presented the perspectives of green highway practices.

## **PROBLEM BACKGROUND**

### **Malaysia Green Highway/Road Research**

Malaysia has been at the forefront of encouraging sustainable development, primarily through the implementation of the MyGHI. The MyGHI is a tool to facilitate the adoption of green protocols in the planning, design, construction, management, and maintenance of highways in Malaysia. The index was commissioned by the Malaysian Highway Authority (LLM) to achieve green roads and provide more sustainable highways in terms of carbon footprint and transport infrastructure. The MyGHI also checks and ensures the environmental sustainability of highway projects to meet the country's sustainability goals on ESG factors. In short, it is a framework that aims to determine the sustainability

of highway infrastructure within the country. The MyGHI established stakeholder values and the principles and/or objectives deemed necessary by the MHA, and further discussed sustainability and the issues encountered by the construction industry in Malaysia in the broader context. Several researchers have explored the comparison of green highway criteria. For example, a comprehensive survey of green highway assessment frameworks appeared in Husin et al.'s (2024) work. Their assessment checked the requirements within five vital components to develop green highways, which include sustainable design and construction operations, energy efficiency, environmental and water stewardship, materials technology, and social security measures.

**Table 1:** Green Highway Road/Research Project of Quadruple Helix Collaboration from 2011-2025

| <b>Year of Project Granted</b> | <b>Title of Research Project</b>                                                               | <b>Collaboration Team</b> |
|--------------------------------|------------------------------------------------------------------------------------------------|---------------------------|
| 2011                           | Malaysia Green Highway Index (MyGHI)                                                           | MHA-UTM                   |
| 2017                           | Carbon Calculator of Malaysia Green Highway Index (MyGHI) Web-based                            | MHA-UTM                   |
| 2018                           | Cost-Benefit Analysis of Malaysia Green Highway Index (MyGHI)                                  | MHA-UTM                   |
| 2019                           | The development of Malaysia Green Rural Road (MyRRI) for neighbourhood socio-economic benefits | JKR- UTM - UITM - UPNM    |
| 2024                           | MHA Green Policy                                                                               | MHA-UKM                   |
| 2024-2025                      | UTM- Universitas Semarang Green Highway Joint Research                                         | UTM-USM-LLM               |

Transitioning effectively towards the environmental, social, and governance aspects of green highways/roads from a concept to reality has been a complex process that requires the adoption of the Quadruple-Helix approach. To include civil society in the model, which focuses on the participatory engagement of stakeholders and democratic views for the actualisation of innovation, the existence of civil society as a stakeholder was recognised. Furthermore, the Quadruple-Helix model has been considered one of the strategies for attaining the Sustainable Development Goals (SDGs). In light of Table 1 above, it is necessary to describe the journey of MyGHI and MyRRI research implementations.

Adopting the whole-of-nation approach is crucial for SDG implementation in accordance with the "leaving no one behind" principle. The MHA adopted SDG principles and responded as the catalytic policy enablers. With the inspiration of enhancing connectivity and transport infrastructure focused on being responsible for SDG Principle 9: Industry, Innovation, and

Infrastructure, combined with SDG Principle 11: Sustainable Cities and Communities, MHA embarked on its journey of responsive, sustainable efforts and green technology. The first output was a book entitled “*Preliminary Guide to Nurture Green Highway in Malaysia*.” This book aided the planning and execution of environmentally friendly road projects in Malaysia. The handbook provided a fundamental resource for engineers, developers, contractors, and other stakeholders engaged in Malaysia's design, building, and upkeep of highways. In line with international and national sustainability goals, it aimed to encourage the highway industry to embrace green practices.

Research and efforts to identify the relevant green highway elements and the possibility of applying the green concept in highway development have been undertaken to achieve a green highway with proper assessment. The creation of the MyGHI green rating tool in 2014 was a good fit for Malaysian highways since it addressed the shortcomings of existing worldwide highway green technologies. The MHA of Malaysia initiated several projects to use MyGHI to ensure more sustainable highways and marked a notable advancement in green technology (Gara et al., 2021). When built to the standards of the concept, a green highway produces invaluable environmental benefits. A green highway needs more consideration from all parties concerned. As a policymaker, the government provides the rules and regulations to be practised by the concession companies and highway users (Uchehara et al., 2022). Awareness among the highway users and stakeholders is essential to ensure that the equilibrium between development and sustainability is maintained.

As the Ministry of Works (MoW) and MHA successfully integrated sustainable practices into their core activities, they actively collaborated with a wide range of government, academic, civil society, and business actors to achieve meaningful and sustainable progress to safeguard the sustainability of their ESG efforts (Institute for Capital Market Research Malaysia, 2023). The ‘Quadruple-Helix’ model has helped MyGHI understand how best to implement the ESG model. Having other participating organisations from the government agencies, academic institutions, and other industry peers allowed them to gain full access to knowledge and resources. It shared best practices that made the ESG highly resilient. This was in line with findings from current studies that argued that companies that integrate ESG factors into their management and operation frameworks are likely to realise numerous opportunities and efficiencies (Wang et al., 2025).

## **LITERATURE REVIEW**

### **Environmental Social Governance (ESG)**

ESG is the abbreviation for Environmental, Social, and Governance. Over the last few years, ESG factors have become crucial for investors and firms. In general, ESG factors potentially affect the company’s reputation, business processes, and

financial results (Che et al., 2024). While using ESG criteria, investors seek better returns on investment since they know that organisations with good ESG performance indicators have higher chances of outcompeting their counterparts in the long run.

The organisation of a company needs to incorporate sustainability strategies into their current operations since the complexity of the environment demands improvements in environmental laws, consumer requirements, and community standards. ESG data disclosure can also assist firms in improving their prospects in terms of brand image, financing, and financing cost, which is a positive contribution to their valuation. In the past decades, managers adopted radical changes in their goals, where they used to work more in the quest for making higher profits in the short run, as demanded by shareholders and investors. However, given the increasing awareness of corporate responsibility toward the environment and civil society, promoted by diverse actors, including the government, they were forced to shift their paradigms (Sideri, 2021). Consequently, ESG disclosures were made to align corporate social responsibilities and corporate governance to facilitate the presentation of companies' claims that their business operations were environmentally friendly and had no negative impact on civil society; The board of directors was more involved in active discussions with civil society (Dwekat et al., 2020; Ebaid, 2022).

ESG-focused sustainability leadership with a profound commitment to actualisation is significant in guiding organisations and communities toward embracing and imbuing sustainable business management and development principles and practices in their business. This type of leadership sustains a focus on generating sustainable business value over the long term regarding ecological sustainability, social responsibility, and the principles of good corporate governance (Brühl, 2023). Regarding the advancement of sustainable development, the Malaysia SDG Council is a key institutional structure set to lead, monitor and facilitate the UN-SDGs across the nation (Pawar et al., 2020). This council has an important role in coordinating the alignment of Malaysia's national development priorities with the international SDG framework to improve progress towards achieving the goals set for 2030, as indicated in Figure 1 below. The formation of the SDG Council in Malaysia is an aspect of the focus towards the realisation of the SDGs as championed in the United Nations 2030 Sustainable Development Agenda. The 17 SDGs outlined several environmental, social and economic goals for countries of different stages of development, stating that every country should do its part in their implementation. As a member of the United Nations, Malaysia has made a global commitment to the SDGs, and the SDG Council serves as the primary mechanism for coordinating and overseeing the country's efforts to fulfil this commitment.

From the SDG council, it sparked the continuity of the sustainability mission and was being taken by the ministerial and private sectors, including the construction industry sector.

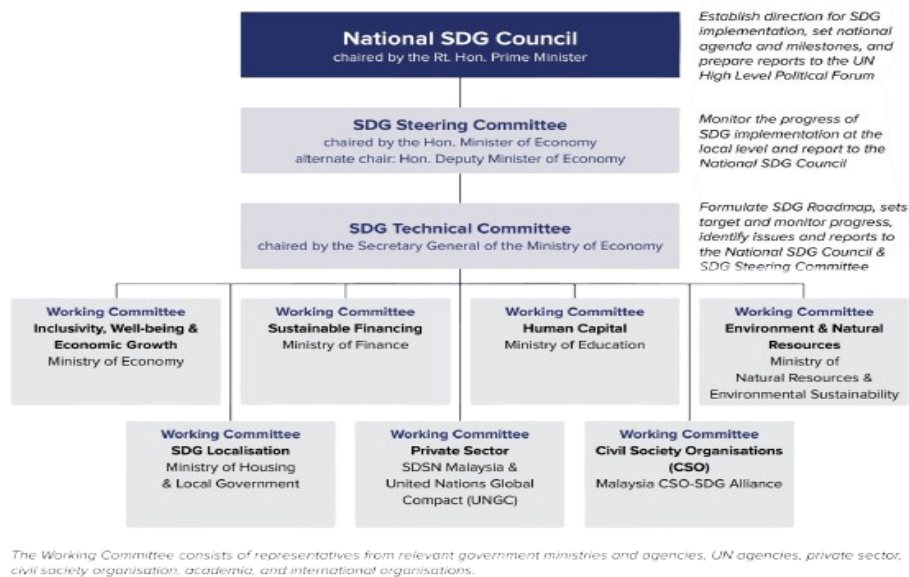


**Figure 1.** The National SDG Governance Structure of Malaysia  
(Source: Economic Planning Unit, 2018)

From the SDG council, it sparked the continuity of the sustainability mission and was being taken by the ministerial and private sectors, including the construction industry sector. Thus, the National Construction Policy was established with six core areas (i) Quality and safety project performance, (ii) Embrace Sustainable Built Environment, (iii) Improve construction productivity, (iv) Strengthen infrastructure maintenance, (v) International competitiveness, and (vi) Strengthen good governance and adoption of best practices (Ministry of Works Malaysia, 2021).

The MoW, whereby it took further strategies and actions, the Highways Planning Division published an apparent reference to the Highway Network Development Plan (HNDP). The HNDP is a national master plan of road infrastructure developed by the MoW. Its aim is to create a national highway network that complements the national economic development plan and considers several factors, including the volume of traffic, land use, socioeconomics, and financial and environmental factors. The earlier HNDP was HNDP 2010: duration from 2010 to 2025. The efforts will continue to evolve with HNDP 2030: duration from 2020 to 2030, consisting of Part 1: Peninsular

Malaysia and Part 2: Klang Valley & its conurbation, as shown in Figure 2. The MoW is studying the HNBP 2040 (HNBP 2040).

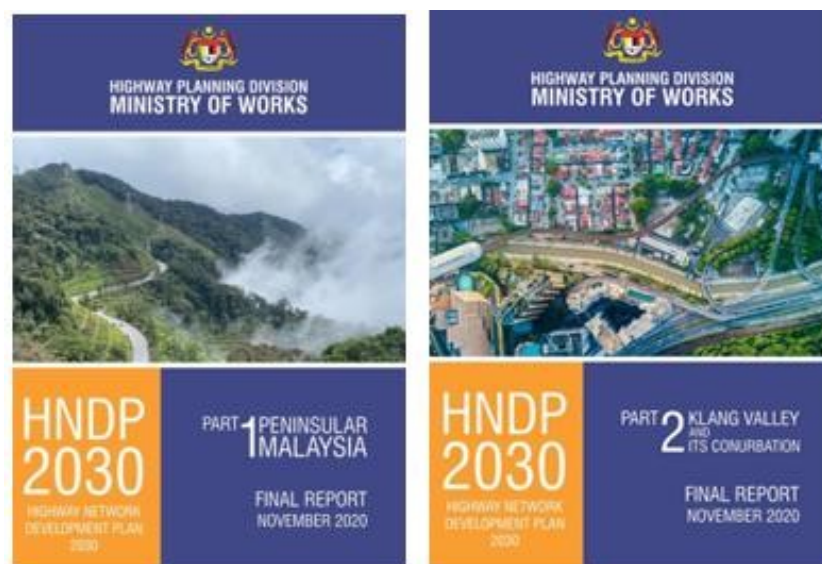


**Figure 2:** Highway Network Development Plan (HNBP 2030) Part 1 & Part 2  
 (Source: Ministry of Works Malaysia, 2020)

### Malaysia SDG Council and the Key Roles and Responsibilities

The Malaysia SDG Council has a crucial role in advancing the country towards the challenging goalpost outlined in the United Nations SDGs (Sahimi et al., 2018). Being an institutional arrangement that is responsible for the coordination of the processes of implementation of the SDGs, the council is responsible for the integration of the strategies for the development of the country with the global idea of sustainable development (Johan et al., 2017; Sahimi et al., 2018). To do this, Malaysia needs to determine which particular objectives and goals need more input from the country. Consequently, plans must be developed and executed to achieve the aforementioned goals more effectively. Many other countries are also taking the same strategic approach, such as St. Lucia, which has established the National Coordinating Mechanism to oversee the implementation of the 2030 Agenda and the 17 SDGs (United Nations Office for Barbados and the Eastern Caribbean, 2023). Another example is Jamaica, whose national coordination mechanism for the 2030 Agenda includes the National 2030 Agenda Oversight Committee (NAOC) (Planning Institute of Jamaica, 2019). The roles and responsibilities of the five roles are explained below:

***Role 1 - Strategic Coordination and Oversight***

The role of the Malaysia SDG council is to devise and develop the national framework for implementing the SDGs, which is ensured to be integrated into Malaysia's coherent development framework and agendas. The council also supervises and disseminates data concerning the implementation of the SDGs in Malaysia and shares this information with local and international parties.

***Role 2- Policy Guidance and Integration***

Guaranteeing consistency of these policies with the national strategies of Malaysia and the commitments at the global level, the council provides consultation on establishing the policies that contribute to the SDG achievement. To this end, the council collaborates with various ministries, agencies, and government sectors to develop cooperation in establishing the integration of all SDG goals in the country's overall development framework.

***Role 3- Stakeholder Engagement***

The council is mandated to promote sustainable development across all societal strata and ensure that the understanding of the SDGs increases. The SDG council can engage with various stakeholders from the government, commercial, academic, civil society, and foreign sectors. This ensures that there will be a favourable approach in achieving the set common development goals and objectives.

***Role 4- Resource Mobilisation and Capacity Building***

The council mobilises funds and other resources from the corporate sector and international organisations for funding SDG endeavours. In the same regard, capacity building is stressed across various sectors to ensure that other players equally have the necessary capacity in terms of knowledge, technologies, and financial enablers required to support the achievement of the SDGs. For example, a study by Mohamed Anuar and Abdullah (2021) investigated methods of transforming underused areas beneath urban highways into sustainable functional space using green infrastructure approaches. This article showed the economic and urban lifestyle enhancements that resulted from implementing such programs.

***Role 5- International Collaboration and Reporting***

The Malaysian SDG council is responsible for ensuring that Malaysia fulfils its international reporting obligations for the SDGs by providing Voluntary National Reviews (VNRs) to the UN. To share and acquire knowledge of experiences of other countries and organisations in implementing the SDGs, the council supports cooperation with other countries and international and global educational networks.

An organisation implementing sustainability at the centre of its business strategies will likely handle different risks effectively. In this sense, the integration of sustainability practices within the organisational structure and supply chain, as written in the conceptual framework, implied that such companies could improve their capability to address current and future environmental, social, and economic issues (Schulte & Hallstedt, 2018). Sustainable risk mitigation requires a holistic approach that considers risks within and outside the organisation, affecting all supply chain partners and stakeholder groups. Adopting a multi-dimensional framework for sustainability risk management can enable firms to systematically identify, assess, and address various risks, from technical and operational to regulatory and reputational.

## **RESEARCH METHODOLOGY**

There were several steps of methodology to generate much interest in the possible partnership on the Quadruple-Helix agenda, especially regarding innovation and sustainable development in the green Highway initiative. The MyGHI ESG journey was a step-by-step process of the above collaboration on the Quadruple-Helix Methodology. The following are the steps that were taken:

**Step 1:** It started with the inauguration of a shared vision and mutual benefit aligned with all parties' objectives. This stage was to make academia understand SDG's vision and mission, which were governed by the SDG Council and translated via the MoW through the Malaysian Highway Authority. UTM and other universities were invited and welcomed to share their research idea and innovations in improving highway operation and services.

**Step 2:** There were consultative meetings with all parties to discuss the Quadruple-Helix agenda. It started with a meeting to nurture the SDG agenda in highway development, and several more presentations to pitch the research idea, as well as a Focus Group Discussion (FGD) with the road and highway industry experts. Workshops and seminars were also organised with industry experts, researchers, and policymakers to discuss and exchange ideas on key topics, such as sustainable materials, green construction practices, and technological advancements. UTM, as the academic counterpart, played a significant role in giving the training and upskilling assessment for the MyGHI Auditor.

**Step 3:** Roles and responsibilities were clearly defined to ensure everyone was aware of how their efforts would advance the project's objectives and how to utilise their own abilities optimally. MHA sought to upskill the staff and the highway concessionaires' sustainability officer so that they could understand the implementation of MyGHI, how it was assessed in terms of audits, and define how vital data is as evidence of sustainability. MHA established a cooperative

framework that described the processes for making decisions, allocating resources, and monitoring progress with the use of the MyGHI tool.

**Step 4:** In demonstrating the early wins, 10 sectional highways were selected as the pilot project. The initiation of pilot projects was the showcase of the Quadruple-Helix collaboration. The 10 sectional highways received awards for initiating green highway achievement as the early success story.

**Step 5:** MHA made an effort in a public relations campaign to inform people about the Quadruple-Helix partnership. The initiative's significance and each stakeholder's part in promoting sustainable growth in the highway industry were emphasised through social media, the media, and public events. An example was MHA Green Day, which encouraged highway concessionaires to make continuous improvement efforts to demonstrate their resilience in SDG responsibility.

**Step 6:** The MHA expanded the research funding based on the outcome of MyGHI for the Carbon Calculator of the MyGHI Web-based system. This suggested that Malaysia's green highway is not about the score but responsive to its responsibility for carbon reduction, and the assessment is computerised and achievable via a web-based system.

**Step 7:** The journey continued with a MOU signing and one research project to another with a memorandum of agreement to create a system for ongoing improvement, whereby all parties involved evaluated the relationship's progress regularly, exchanged insights, and modified plans of action in response to new problems that arose.

## **ANALYSIS AND DISCUSSION**

Developing sustainable and resilient infrastructure requires a collaborative approach that aligns the goals and objectives of diverse stakeholders, including government agencies, academia, industry, and civil society (A. Bhattacharya et al., 2019; Acuña-Coll & Sánchez-Silva, 2023). This journey established a shared vision aligned with all parties' objectives, including government organisations, educational institutions, businesses, and civil society. It emphasised how the partnership can support the accomplishment of shared goals, like promoting innovation, enhancing infrastructure resilience, and increasing sustainability. For example, the first collaboration between MHA and UTM was presented as the project background in Table 2.

**Table 2:** 1<sup>st</sup> Collaboration Research Project for Green Highway Assessment

| <b>A Collaboration Project between Malaysia Highway Authority (MHA) and Universiti Teknologi Malaysia (UTM)</b> |                                                                                                                                                                                 |
|-----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RESEARCH TITLE                                                                                                  | The Development of An Assessment Framework for Green Highways in Malaysia                                                                                                       |
| RESEARCH DURATION                                                                                               | 2 Years                                                                                                                                                                         |
| START- END DATE                                                                                                 | 25 November 2011 - 25 November 2013                                                                                                                                             |
| GRANT DETAILS                                                                                                   | The Research Project is divided into two Project Leaders and produces 2 capacity buildings. (Refer to MOA: 1 Postgraduate Student from LLM and 1 postgraduate student from FKA) |

Collaboration among stakeholders could lead to significant benefits for all parties involved. Collaborative partnerships positively impacted individual organisations and the broader value chain, enabling system-wide changes and addressing complex social and environmental challenges (Green & Johnson, 2015). The benefits that each stakeholder would gain from the collaboration were clearly outlined. For instance, government agencies could gain better governance support, the highway concessionaires could find new markets, academic institutions could promote research and innovation, and civil society could receive better public services.

### ***The Grant Details***

Cooperation was fortified via official contracts, including partnership agreements or Memoranda of Understanding (MoUs). These agreements spelt out long-term obligations and guaranteed that everyone was on the same page regarding the objectives and results. Securing financing for research and development initiatives associated with the Quadruple-Helix agenda could foster innovation. This could entail providing funding to academic institutions and research centres so they could work on initiatives that further the collaboration's objectives, as shown in Table 3.

**Table 3:** Grant Funding and Division of Research Projects

| Grant     | Project Title                                                | Project Leader (Research Supervisor) | Capacity Building (Students) |
|-----------|--------------------------------------------------------------|--------------------------------------|------------------------------|
| 1 (4B055) | The Development of a Framework for Green Highway in Malaysia | Prof. XXX                            | Student PG 1 (LLM)           |
| 2 (4B056) | Weightage Factors for Malaysian Green Highway Assessment     | Assoc. Prof. YYY                     | Student PG 2 (UTM)           |

### ***The Research Flow***

This journey clearly explained each stakeholder's obligations within the Quadruple-Helix framework. The framework flowed from Phase 1: Confirmatory of green highway assessment elements; Phase 2: Determination of criteria and sub-criteria of green highway assessment; Phase 3: Data collection and data analysis; Phase 5: Presentation and data validation; Phase 6: Green highway manual and publications. It was also crucial for everyone to understand how each contribution would help achieve overall goals and how one might leverage one's talents to further the cause of the initiative. Developed a system that provided structure to the cooperation between groups and explained how material resources, power delegation, and information would be divided, and how any achievements would be measured. This promoted trust and facilitated productive cooperation.

### ***The Project Progress and Monitoring***

Consultative meetings offered a forum for setting this shared strategic direction and ensuring that organisational goals were in harmony with those of stakeholders. Frequent conference sessions were set up with all stakeholders, especially regarding the green highway Quadruple-Helix actors. Such an integrated approach, involving the governmental and non-governmental actors, required solid knowledge of the best teamwork practices and the willingness to share information (Green & Johnson, 2015). It was advised to take advantage of such meetings to gather feedback, address and solve problems, and ensure all participants were part of the decision-making on how the collaboration would be conducted.

In addition, workshops and seminars were working meetings that allowed for the presentation of key trends, discussion of best practices and outcomes, and development of recommendations for further industry development. Besides, they attracted the attention of experts, researchers, and policymakers to sustainable materials, green construction practices, and innovative technologies. As such, these meetings could be used to create impactful activities and to show that collaboration is relevant and beneficial.

### ***The Quadruple Helix Research Outcome:***

Demonstration projects were launched to highlight the Quadruple-Helix collaboration's potential. These include modest-scale but significant highway projects that highlighted the advantages of creative problem-solving and sustainable methods. Success stories of such partnerships in other areas or industries were also presented. Emphasising successful results increased confidence and excitement about the possibilities of this partnership. A system for ongoing enhancement was also provided, whereby involved parties regularly evaluated the collaboration's progress, exchanged insights, and modified tactics

to remain adaptable and sensitive to new problems. The outcome of 13 years (from 2011 to 2024) of trust in the Quadruple-Helix collaborative journey of Malaysia's green highway/road is portrayed in Table 4.

**Table 4:** Quadruple Helix Research Outcome (2011-2024)

| Year of Project Granted | Title of Research Project                                                                      | Capacity Buildings  | Publications (Journals/Manuals/ Guideline)               |
|-------------------------|------------------------------------------------------------------------------------------------|---------------------|----------------------------------------------------------|
| 2011                    | Malaysia Green Highway Index (MyGHI)                                                           | 4-PhD<br>5-Masters  | 9-Journals<br>1-Preliminary Guidelines<br>1- MyGHI Index |
| 2017                    | Carbon Calculator of Malaysia Green Highway Index (MyGHI) Web-based                            | 1-PhD<br>4-Masters  | 10-Journals<br>1-Guidelines                              |
| 2018                    | Cost-Benefit Analysis of Malaysia Green Highway Index (MyGHI)                                  | 1- PhD<br>2-Masters | 1- Manual                                                |
| 2019                    | The development of Malaysia Green Rural Road (MyRRI) for neighbourhood socio-economic benefits | 3- PhD<br>6-Masters | 7-Journals<br>2-Guidelines<br>2- Manual<br>1-MyRRI Index |

## CONCLUSION

Assuring that Malaysia makes significant progress towards accomplishing the SDG Agenda by 2030, the SDG Council plays a key role in ensuring that Malaysia's national development strategies align with the global SDG agenda. Transparency in sustainability reporting has become increasingly important as organisations seek to demonstrate their commitment to environmental and social responsibility. Transparency helps to build trust with stakeholders, such as investors, customers, and the general public, by providing reliable and verifiable information about an organisation's sustainability performance (Auger, 2014).

The Quadruple-Helix framework is a booster for an ESG comprehensive approach to innovation and problem-solving that involves the collaborative efforts of four key stakeholders: academia, industry, government, and civil society. Each stakeholder played a crucial role in driving the initiative forward and leveraging their unique strengths to contribute to the overall goals.

(i) **Academia** - The academic sector, comprising universities and research institutions, served as the knowledge hub within the Quadruple-Helix framework. Their primary duties were to produce quality research, generate new ideas, and offer conclusions based on scientific facts to encourage people to make informed decisions. Academia also played a huge role in training the workforce for the

community's future needs to ensure that knowledgeable human resources fit for the initiative are available.

(ii) **Industry** - The stakeholders of private firms, start-ups, and multinational industries contributed to the practical experience, market intelligence, and capacity for commercialisation in the Quadruple-Helix framework. Their responsibility was to transform the science created in universities into solutions that can be successfully adopted in the market, including offerings and business models.

(iii) **Government** -The local, regional, and national government stakeholders were expected to provide the necessary environment to develop the Quadruple-Helix initiative. This involved creating guidelines, rules, and resources that nurture innovation and entrepreneurship and stakeholder cooperation. To this end, the government played a significant role in ensuring that the initiative addressed overall social, economic, and environmental objectives.

(iv) **Civil society** -The community, through people in the civil society, such as groups and individuals, acts as the middle link between the initiative's implementation and the beneficiaries or the users. Their responsibility was to represent the needs and demands of the initiative, to assess and provide feedback on the effects of change or innovation, and finally to apply the innovation through the implementation of change in solving societal issues.

These ESG journey examples provided a comprehensive set of processes and steps spanning environmental, social, and economic dimensions, which can be customised to align with an organisation's unique sustainability objectives.

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