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Aligning the Criteria of Green Economy (GE) and Sustainable Development Goals (SDGs) to Implement Sustainable Development

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Abstract: Global economic trends have shown the progression of social inequalities and environmental deterioration in the grey economy. New economic practices and policies need to be developed in order to achieve the sustainable development goals (SDGs). A green economy (GE) has a correlative role with the implementation of sustainable development (SD), which could revive the grey economy, human well-being, and social equity, as well as substantially decrease environmental risks and ecological scarcities. This study aims to develop a hybrid methodological and mathematical approach to prioritize the most effective variables from classified GE and SDGs criteria (23 criteria) to implement SD. This study has deliberated over the Decision making trial and evaluation laboratory (DEMATEL) technique for considering interconnections among numerous criteria to collect the most effective variables (12 criteria) based on three pillars (3Ps) of SD. Likewise, the analytic network process (ANP) technique ranked these effective variables by considering their network relations based on three indicators. Lastly, integration was used to finalize and prioritize the most effective variables based on their weight from the ANP technique. This study will highlight the green economy with exclusive environmental issues and sustainable growth as the greatest effective variables among GE and SDGs criteria for SD implementation.

Keywords: green economy (GE); sustainable development goals (SDGs); environmental issues; sustainable economic growth; overall social wellbeing; environmental quality

1. Introduction

Various indications have demonstrated that the current rate of global economic growth is not sustainable [1]. Although this economic growth has brought around one billion people out of extreme poverty during the last two decades, approximately another billion are still experiencing hardship. Around 1.1 billion of the population are deprived of electricity and 2.5 billion are without access to sanitation [2]. Failure to meet these basic human needs can also be a threat to the environment. For instance, the improper disposal and treatment of wastewater and domestic faecal sludge could also

affect water resources and ecosystems. In addition, the economic growth is affecting the environment because it is the main source of economy. This situation has led to environmental degradation and climate change, which are affecting everyone in the world [3]. Thus, it is vital to overcome these obstacles, a necessity that has led to the birth of the sustainable movement and inclusive economic growth.

Sustainable development (SD) provides the operational policy agenda and context for the economy, which can constructively accomplish concrete, measurable advancement at the interface between the economy and the environment [4,5]. The 2030 Agenda for SD is a plan of action for the people and the planet, which focuses on environmental issues and resource depletion through human activities [6]. All three pillars (3Ps) of SD (economic, environmental, and social pillars) are relevant entry points for identifying issues and developing green policies for the economy [7]. Incidentally, the green economy (GE) has been anticipated as the catalyzer to renew national policy growth and international support, which fundamentally supports SD as the strategic economy policy agenda. It is defined by United Nations Environment Programme (UNEP) as the economy that could enhance human well-being and social equity, while expressively mitigating environmental issues and ecological shortages [8,9].

The history of GE practice in policy began with the Rio Conference in 1992. Next, the GE was given a definition by the UNEP in 2011, in a paper entitled "Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication". Its history in the academic world began in 1989 in a paper by Pearce et al. entitled "Blueprint for a Green Economy" [10]. GE's practical operation is indubitably interrelated to the multiplicity of factors depending on the context, but there is no assorted and recognized categorization for GE conception [11]. This shortcoming includes insufficient global principles related to GE policies for economic growth and poverty eradication [12]. Additionally, the world is still concerned about global issues related to the environment, social inequality, and the economy that the SD initiative has failed to rectify [13,14]. Meanwhile, the GE has the ability to promote successful sustainable development goals (SDGs) and improve the conversion to low-carbon, resource-efficient, and comprehensive economies. This study was conducted with the aim of developing an operational and efficient approach for prioritizing the most significant criteria for GE and SDGs to ensure SD is achieved. The research objectives are as follows:

- To identify and classify the criteria and indicators for GE and SDGs, and expand their correlations for aligning GE criteria with SDGs based on the 3Ps of SD;
- To categorize and investigate the efficacy and interconnections of classified criteria through pairwise comparison in each 3Ps;
- To evaluate and quantify the relationships between the most effective criteria for SD implementation based on indicators;
- To analyze and prioritize the most effective criteria for GE and SDGs to support SD.

To achieve these objectives, the hybrid multi-criteria decision making (MCDM) technique was applied in this study to align GE and SDGs criteria for SD prevalence. This study has highlighted a new trend in research technique, with clear instructions on how to assemble these hybrid methods via the MATLAB software.

2. Literature Review

2.1. Sustainable Development Goals (SDGs)

Sustainable development consists of several goals that coalesce into 3Ps, namely environmental, economic, and social pillars. This unique development towards sustainability was introduced by Barbier (1987), which underlines the prospect of trade-offs among the countless economic, environmental, and social goals, with positive or negative preference [15]. The confluence and maximization of the 3Ps goals would lead to sustainable development and ease the implementation of sustainability [16].

The SDGs for 2015 to 2030 was adopted through "Transforming our world: the 2030 Agenda for Sustainable Development", with 193 United Nations (UN) member countries in September

2015 [17,18]. It represents the world's inclusive strategy for social inclusion, environmental sustainability, and economic development. To achieve all of the proposed SDGs, the assistance and teamwork among governmental and non-governmental organizations are needed around the world [19]. The participation of all countries in this new global consensus on sustainable development could tackle inequality and integrate environmental protection and poverty improvement in all policies and programmes.

In the United Nations, the voluntary national reviews (VNRs) track strategies are implemented by governmental institutions to gain multi-stakeholder support and partnerships for the implementation of SGDs [20]. They provide an online review platform that inscribe the division of involvements among the 172 countries in SDGs, including achievements, challenges, and knowledgeable instructions, with the intention of fast-tracking the execution of the 2030 Agenda. In addition, previous studies on SDGs have shown the inclusive domain paybacks of SDGs, which includes diverse categories based on 800 reviewed articles) in Web of Science, with Sustainable Development Goals in their titles, from 1989 until December 2018 (Figure 1).

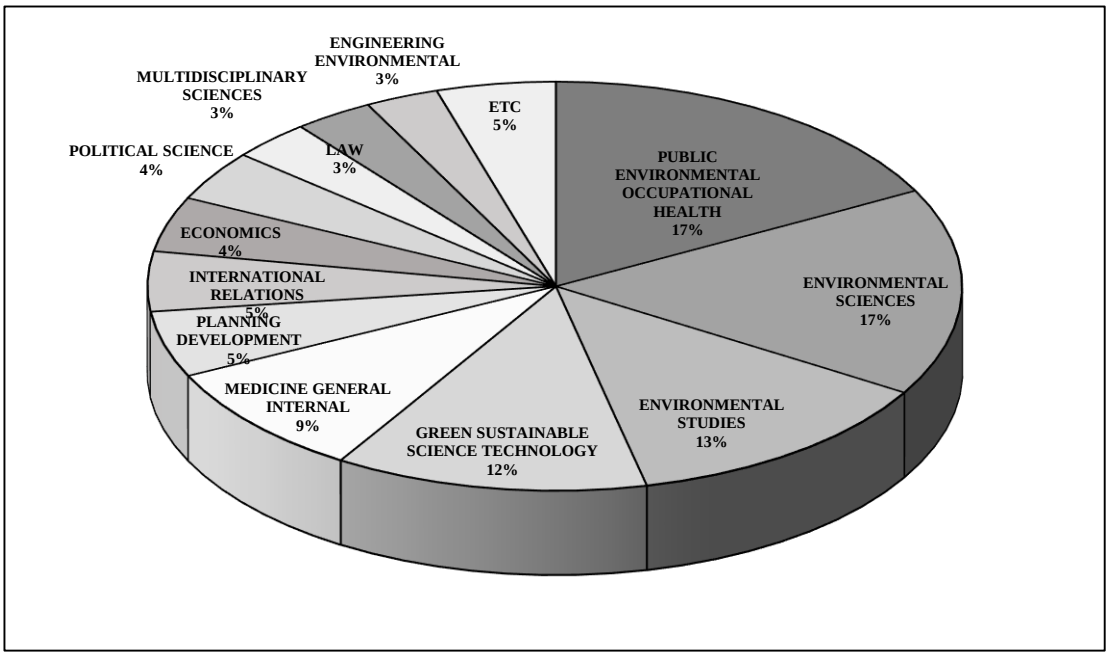

Figure 1. The diverse categories in Web of Science, with SDGs in the title from 1989 until December 2018.

Figure 1 shows that the main researches with SDGs in the title were the environmental and sustainable science at approximately 60% from a total of eight altered fields. Nonetheless, the economy, as one of the main pillars of SD, has four per cent coverage in previous SDGs research articles and publications. There is one article on SDGs and GE in relation to natural resources, which was published in December 2018 that implied to the uniqueness of this research gap [21]. This article revealed the connections between SDGs and natural resources though systematic analysis, while focusing on GE. Meanwhile, this current study will demonstrate the direct and indirect influences of GE indicators on the implementation of SDGs. This study is needed to exhibit the main goals of SD, which are included in the 2030 Agenda.

The main function of the SDGs is to maintain stability among the economic, social, and environmental aspects, which would promote universal changes towards a sustainable future [22,23]. There is an evolving global exercise and an upward directory of interrelated scientific publications to implement the SDGs framework [24–26]. The SDGs framework includes 17 goals, 169 targets, and 232 indicators that undoubtedly have unclear interconnections, contributory interactions, and reaction loops [27]. The alignment between indistinct functionalities from the SDGs framework and the previous weaknesses have confuted sustainability interventions by policy makers

when implementing the SDGs, simultaneously integrated in a consistent manner, as shown by evidence and scientific-based approaches [28–30].

The literature on SDG implementation has evidently disclosed general policy development, the implementation and practice of SDGs, and the measurement of ex-ante impact of their mandatory conditions [31,32]. These aspects need to be supplemented with methodical outlines, tools, and investigations that empower the interactions among SD goals through quantitative or coherent models. Science-based approaches have outlined the dynamic criticisms, interconnections, and incorporations of the 3Ps of sustainable development [33,34], such as the national study applying system dynamics modelling between energy, health, and education targets [24]. Other publications suggested using quantitative methods, such as the 'nexus' approach [19,24,33,35] or multi-criteria analysis [36–39] to support decision making for SDGs implementation. This current study has considered the multi-criteria decision-making method to align the GE criteria to SD goals through SD indicators.

Based on the Agenda 2030, there are 17 goals in the SDGs that all countries must act upon to promote prosperity, while protecting the earth (Table 1). It is important to achieve each goal by 2030 to end poverty with policies that shape economic growth and address an assortment of social requirements, as well as education, well-being, social safety, and career opportunities, while undertaking environmental protection [40]. Based on the definitions of SDGs listed in Table 1, the relative function of each goal is clear. It was difficult to classify all 17 goals consistent with the three dimensions of sustainability.

Table 1. The 17 sustainable development goals (SDGs) [41].

SDGs	Goals	Definition
SDG_1	No Poverty	Economic growth must be inclusive to provide sustainable jobs and promote equality.
SDG_2	Zero Hunger	The food and agriculture sector offers key solutions for development, and is central for hunger and poverty eradication.
SDG_3	Good Health & Well Being	Ensuring healthy lives and promoting the well-being for all at all ages is essential to sustainable development.
SDG_4	Quality Education	Obtaining a quality education is the foundation to improving people's lives and sustainable development.
SDG_5	Gender Equality	Gender equality is not only a fundamental human right, but a necessary foundation for a peaceful, prosperous and sustainable world.
SDG_6	Clean Water & Sanitation	Clean, accessible water for all is an essential part of the world we want to live in.
SDG_7	Affordable & Clean Energy	Energy is central to nearly every major challenge and opportunity.
SDG_8	Decent work & Economic Growth	Sustainable economic growth will require societies to create the conditions that allow people to have quality jobs.
SDG_9	Industry, Innovation & Infrastructure	Investments in infrastructure are crucial to achieving sustainable development.
SDG_{10}	Reduced Inequalities	To reduce inequalities, policies should be universal in principle, paying attention to the needs of disadvantaged and marginalized populations.
SDG_{11}	Sustainable Cities & Communities	There needs to be a future in which cities provide opportunities for all, with access to basic services, energy, housing, transportation and more.
SDG_{12}	Responsible Production & Consumption	Responsible Production and Consumption
SDG_{13}	Climate Action	Climate change is a global challenge that affects everyone, everywhere.
SDG_{14}	Life Below Water	Careful management of this essential global resource is a key feature of a sustainable future.
SDG_{15}	Life on Land	Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss
SDG_{16}	Peace, Justice & Strong Institutions	Access to justice for all, and building effective, accountable institutions at all levels.
SDG_{17}	Partnerships for the Goals	Revitalize the global partnership for sustainable development

However, the designation and classification of SDGs pursuant to the 3Ps have allowed researchers to investigate the UN SDGs using the arrangements method to sustainability. Previous researches and SDGs definitions [42] have categorized these goals based on the 3Ps of SD, which include:

- Economic: SDG_{Ec1} (No poverty), SDG_{Ec2} (Zero hunger), SDG_{Ec3} (Good health & well-being), SDG_{Ec4} (Clean water & sanitation), SDG_{Ec5} (Affordable & clean energy), SDG_{Ec6} (Good jobs & economic growth), and SDG_{Ec7} (Industry, Innovation, & Infrastructure)
- Social: SDG_{So1} (Quality Education), SDG_{So2} (Gender Equality), SDG_{So3} (Reduce Inequalities), SDG_{So4} (Peace, Justice, & strong institutions), and SDG_{So5} (Partnership for the goals)
- Environment: SDG_{En1} (Sustainable cities & communities), SDG_{En2} (Responsible consumption & production), SDG_{En3} (Climate Action), SDG_{En4} (Life below water), and SDG_{En5} (Life on land)

For example, SDG1 is marked as no poverty, which is defined as an economic growth that must be inclusive to provide sustainable jobs and promote equality. It has a direct bearing on the social aspect, while reflecting on the economic category of SD. Therefore, it is vital to consider the interconnections and influences among all SD goals in this study. The next part of this review is regarding the definition, function, and designation of the green economy.

2.2. Green Economy (GE)

The trends of the global economic models during the previous decades have shown growth in social inequalities, environmental deterioration, and aggravating societal tensions, which will pressure each country's prospective for upcoming development and growth [5]. Economic practices and policies need to be reframed and aligned with sustainability in order to achieve the sustainable development targets [43]. Policy makers around the world should transform their economies to exterminate poverty, grow careers and societal equity, strengthen incomes and environmental stewardship, and stand growing in line with the sustainable development goals.

GE and economic growth have correlative roles in implementing the SD goals. Economic growth is one of the important parameters of a booming economy. However, the paybacks of conventional economic growth are not consistently distributed, which can often lead to wealth inequality and social divisions [44]. This conventional strategy has undervalued ecological goods and services that outline the foundation of all economic movement. The GE is a prerequisite for economic growth based on the SD, which can result in a grey economy, human well-being and social equity, and substantially decreasing environmental risks and ecological scarcities [9]. It can be purely well-defined as being low-carbon, resource efficient, and socially inclusive [45].

The GE, as a widespread concept, is observed as a corridor to sustainability by international organizations [45,46]. The acceptance trend of top organizations regarding GE's policy started with the GE report by UNEP (2011) to green growth with the Organisation for Economic Co-operation and Development (OECD) (2011), and the comprehensive Green Growth with the World Bank (2012) [9,47,48]. GE policies are generating synergies across economic sectors and improving the overall well-being of the population. It operates like the umbrella concept to embrace diverse consequences, such as social equity and well-being, retrofitted economic growth, and mitigating environmental issues [3]. It is an essential division to achieve SD goals and the climate mitigation targets according to Paris meeting [9,49]. Nonetheless, the influences between GE and SDGs still need to be determined. Figure 2 shows a review of 600 academic publications, such as articles, reviews, books, and letters related to GE in the titles in a search of the Web of Science from 1993 until December 2018 (Figure 2).

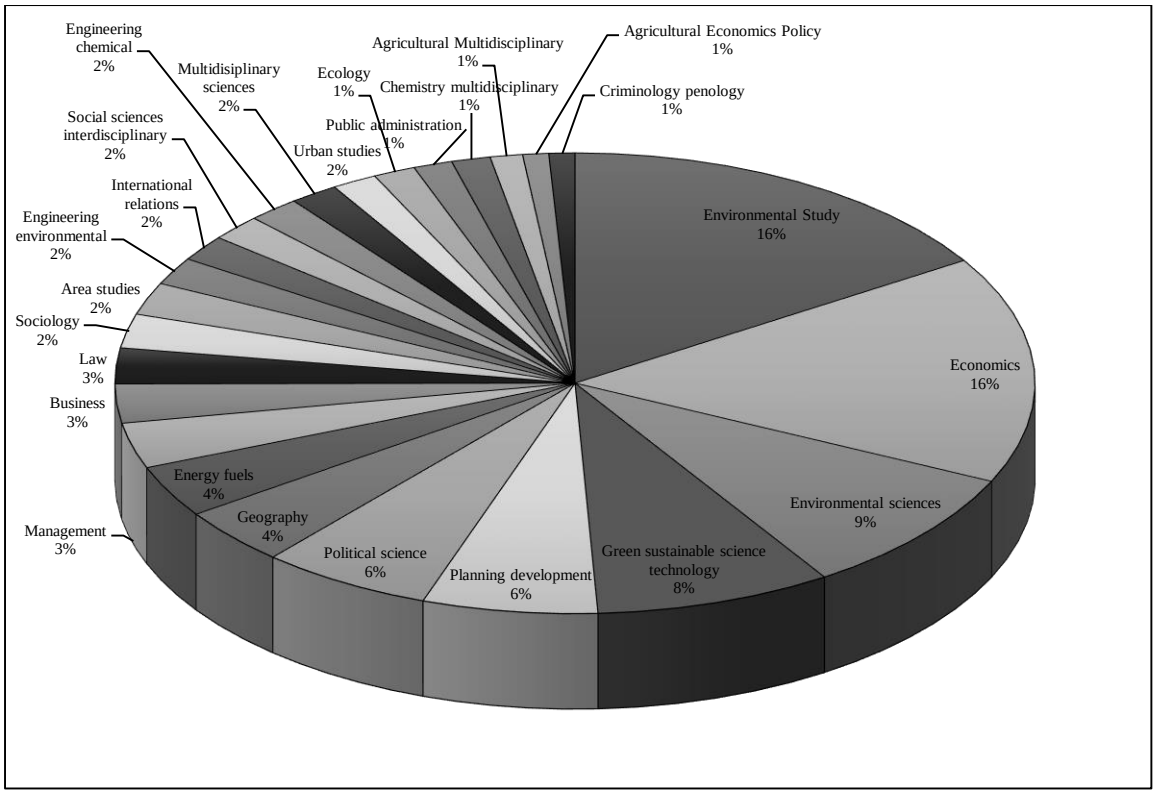

Figure 2. Publications record with GE in the title in the Web of Science from 1993 until December 2018.

Figure 2 shows that the main categories of academic studies are related to the environment at 30%, while 8% belongs to the green and sustainable science. These results imply at the critical influence of the GE concept in the environment category as one of the SD pillars. The second important category is the economic studies at 16%. In addition, GE studies, in terms of social studies, is only at 4%, which shows the absence of more research in this category. Table 2 shows the majority of recent articles with the title green economy in Web of Science that were published in the green sustainable and environment category.

Table 2. Recent articles, with green economy in their title, found in the Web of Science.

No	Focus Area	Contribution	Refs
1	Renewable energy investment and green economy development	Constructs a threshold effect model to investigate the non-linear relationship between renewable energy investment and the green economy development index	[50]
2	Impact of green economy measures on rural employment: green jobs	Attention on the labor use aspect of the circular economy and examine the potential for green economy measures to create green jobs in the agriculture sector	[51]
3	Investigating the oil curse in oil-exporting economies using green measures of income	Test the robustness of the curse theory in the predominantly used measures of national income, gross domestic product (GDP), by investigating the theme in genuine income measures of economic output as well	[52]
4	Articulating natural resources and sustainable development goals through green economy indicators	Provides insights to gain an improved understanding of the links between SDGs and natural resources and interpret their inherent complexity	[3]
5	Green economy and sustainable development: the economic impact of innovation on employment	The drivers of labor innovation effects are identified as a complex combination of job displacement and compensation forces of innovation.	[53]
6	Green supply chain management (GSCM) performance assessment based on circular economy	New holistic conceptual GSCM performance assessment framework to integrates environmental, economic, logistics, operational, organizational and marketing performance	[54]
7	Corporate social responsibility (CSR) and green economy	The relevance of companies' internal factors as determinants for accountability, also the significance of geographical factors in green companies' relationship with stakeholders	[55]

Table 2. *Cont.*

No	Focus Area	Contribution	Refs
8	The interrelationships between tourism and sustainability from a cross disciplinary perspective	Purpose a few implementation strategies on achieving sustainable tourism from the aspects of policy/regulation, institution, finance, technology and culture	[56]
9	Dynamics of supply environment and information system: integration, green economy and performance	Opportunistic behavior due to information asymmetry needs to be curtailed in supply chain to improve operational and environmental performance	[57]
10	"Breakthroughs" for a green economy? Financialization and clean energy transition	"Breakthrough" clean energy technologies are needed to produce an energy transition and to bolster U.S. Economic power into the 21st century.	[58]
11	The role of small and medium enterprices (SMEs)' green business models in the transition to a low-carbon economy	SMEs' value propositions give an intermediate valuation to both legally required and voluntary reduction of environmental impact, irrespective of SME size and the year analyzed.	[59]
12	Modelling of the "green" economy in an economic space	Construct a general extended map and a reduced-parametric cognitive map of the development of the "green" economy in the economic space of the region	[60]
13	Connections between financialisation in the green economy and the material commodification processes	Emphasize their status as durable processes of becoming or what could be called markets-in-the-making, by going beyond forms of market and economic reductionism.	[61]
14	Green total factor productivity growth and its determinants in china's industrial economy	Directional distance function (DDF) and the globalmalmquist-luenberger (GML) productivity index to measure the green total factor productivity (GTFP) growth of china	[62]
15	Investment for the transition to a low carbon economy through green economy	Finance ecosystem approach for low carbon investment are connected at local, national and international scales, alongside support to build entrepreneurial skills and investment readiness	[63]

The listed publications in Table 2 show the verities of recent researches in environmental areas, such as renewable energy, green supply chain management, and low carbon economy. These publications are needed to develop an outline that covers commonly appropriate green economy frameworks based on indicators as GE's metric or metric value. There are particular cases that considered the specific effective factors for GE. In 2013, The UNEP classified GE's effective factors into three different categories, namely environmental, policy, and well-being and equity [64,65].

Kasztelan A. (2017) deliberated that GE's effective factors include two different parts, namely, natural and built capital [66]. Canari (2017) considered five critical actions for GE implementation, which include valuing nature, eradicating inequality, greening economic sectors, reforming financial systems, and measuring and governing [67]. One of the greatest classifications was made by Loiseau et al. in 2016. They reviewed 877 documents with green economy in the title [68]. Their team found 157 keywords and finalized them based on the three pillars of sustainability. Based on the reviewed literature, the transition framework required for GE indicators to succeed must be focused on poverty eradication, ecological preservation, and economic prosperity (Figure 3). Figure 3 shows the Venn diagram of GE, with three specific indicators and three pillars (3Ps) as GE's benefits. Table 3 lists the three pillars (3Ps) as GE's benefits that have particular definitions and specifications.

Table 3. The three pillars (3Ps) of GE, with definition and abbreviation.

Sustainability 3Ps	Benefits
Economic	- Improvement economic growth, productivity and competitiveness - Accelerated innovation, through correction of market failures in knowledge
Environment	Climate change mitigate; Improvement of resource efficiency; Reduction in fossil fuel dependency; Reduction of air and water emission; Reduction in loss of biodiversity
Social	Reduction of health problems and risks; Increased resilience to natural disasters, commodity price volatility economic crises; Job creation and poverty reduction; Improved regional equality; Improved access to environmental services

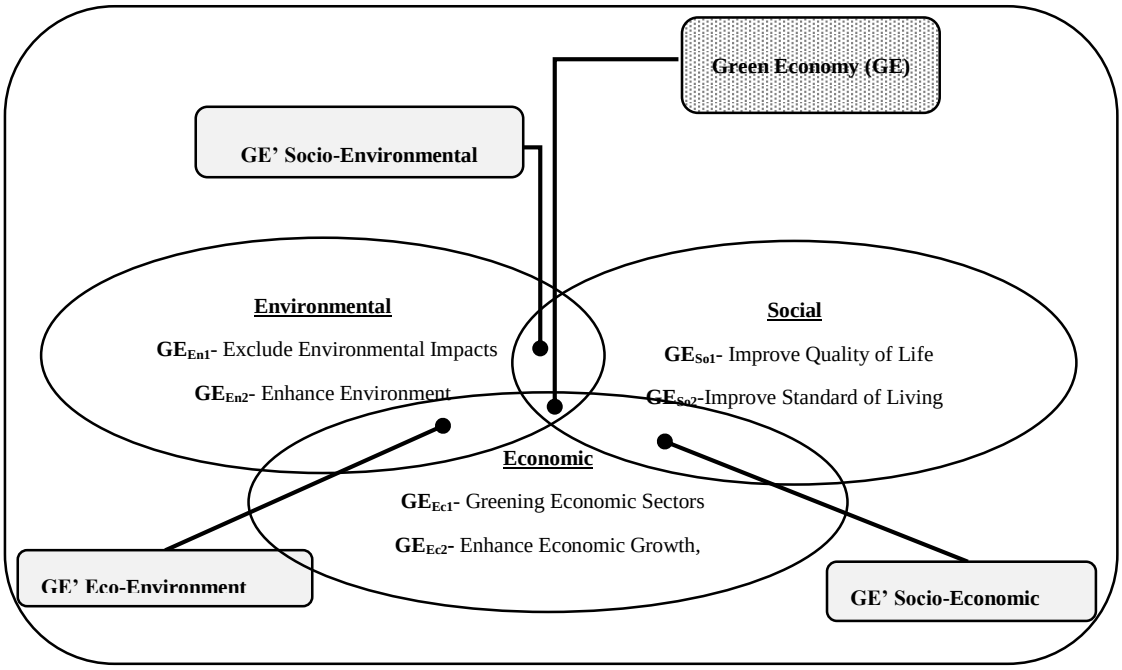

Figure 3. The final transition framework for the Green Economy.

The transition to green economy will transpire when the three distinctive pillars of GE are launched simultaneously. According to Figure 3, GE is executed by integrating the involvement of each pillar. Consequently, these interactions will create three shared boundaries, namely, eco-economic, socio-environment, and socio-economic. The reflection of GE, in the context of SD, would accurately deliver prospects for policymaking to achieve SD goals. GE conscript is as the catalyzer to reform the grey economy and activate SD goals in national and international policies. Based on Figure 3, the three precise GE indicators are as outlined below:

- Eco-Environment: the greater emphasis on the interaction between GE and the natural environment, with considerations for local and global environmental issues;
- Socio-Environment: the mutual function between environmental and social aspects, which are prepared through the GE activity; and
- Socio-Economic: the fairness of the GE movement and guidelines that provide at least the basic and equal minimum of income, goods, and services in society.

Based on the current research objective, the most significant criteria must be identified following the classification of GE and SDGs criteria to match the three pillars of SD. The DEMATEL is great mathematical technique to analyze the efficacy and interrelations among these classified criteria for accumulating the most significant criteria in three separated pillars. However, it is only capable of examining the cause-effect interactions among criteria, not prioritizing them. Hence, this technique was mixed with other approaches to prioritize these significant criteria and enroll three GE indicators for prevailing SD. These research techniques are summarized in Section 3, under four sub-sections

3. Research Method

This research method included five phases that were focused on evolving the methodological and systematic approach to categorize the criteria for green infrastructure for the implementation of green economy. These steps include:

- To classify and cluster criteria related to GE and SDGs based on the 3Ps through literature review;
- To evaluate the interrelations among these categorized criteria and determine the most significant factors using the DEMATEL technique, which was progressed through MATLAB software;

- To arrange and accurately rank the most significant criteria with their network relations based on three separated indicators through the ANP method (SuperDecisions software);
- To improve the integration technique for enrolling three indicators with the most significant-ranked criteria for prevailing SD.

Based on the literature review, 17 SDGs criteria and six GE criteria were classified, with specific abbreviations in three pillars (Figure 4), namely, social, economic, and environment. The next step extended this research methodology through the preparation of the research questionnaire.

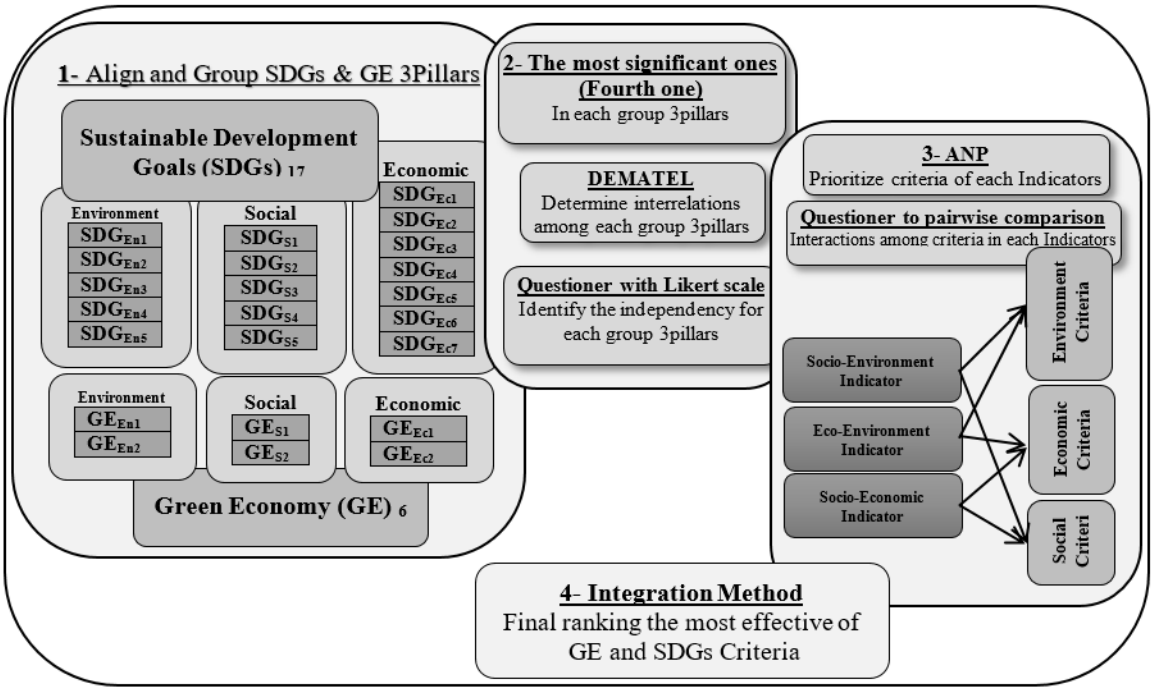

Figure 4. Research Framework.

3.1. Questioners and Sample Size

This phase of research methodology concentrated to scheme two separated questionnaires:

- Four-point Likert scale questions to categorize interrelations among group SDGs and GE criteria in separated three pillars through DEMATEL method that outcome the most significant criteria in 3Ps;
- Pair-wise comparison with scale of 1–9 to rank the most significant criteria based on their network relations in GE's three indicators through the ANP method

The random sample method considered for an equal geographic spreading amongst samples. The Equation (1) conducted to determine the sample size as signified the population of the questionnaire [69].

$$SS = \frac{a^2 P (1-P)}{c^2} \quad (1)$$

In Equation (1), SS is the considered sample size, a is the value of confidence level (e.g., 1.96 for 95% confidence level), P is proportion of the selection will be picked, stated as unit (0.5 for sample size), and c is the confidence interval. After calculation, SS is modified for fixing the population with Equation (2):

$$Corrected\ SS = \frac{SS}{1 + \left[\frac{SS-1}{Pop}\right]} \quad (2)$$

where *Pop* is inhabitants. The *Corrected SS* modified with Equation (3) through response rate (*rr*):

$$Corrected\ SS \text{ for } rr \ = \ rr \times \ Corrected\ ss \tag{3}$$

According to random sample method, around 100 questionnaires distributed to postgraduate students and researchers who have familiar with term of green economy and sustainable development goals.

3.2. DEMATEL Technique

Initially, the Science and Human Affairs Program of the Battelle Memorial Institute of Geneva established DEMATEL to decide the complex and intertwined problem group [70]. DEMATEL created based on graph philosophy to resolve problems visually which is comprehend causal relations to design the network interrelationship among classified variables [71]. DEMATEL technique explain shortly in next six steps:

3.2.1. Step 1

Initial average matrix: The pairwise judgements between any two variables are signified by x_{ij} and are given a number ranging from no impact (0); low impact (1); medium impact (2); high impact (3); and very high impact (4) respectively. The initial average matrix X is obtained based on the non-negative answer matrix A as follows:

$$X = \left[x_{ij}\right]_{n\times n} \ = \begin{array}{c} \\ C_1 \\ C_2 \\ \vdots \\ C_n \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} 0 & x_{12} & \cdots & x_{1n} \\ x_{21} & 0 & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & 0 \end{bmatrix} \end{array} \tag{4}$$

where n is the amount of criteria, C_i is a criterion, and x_{ij} is an average of the pairwise comparisons that is calculated in below:

$$x_{ij} = \ \frac{1}{p}\sum_{k=1}^{p}\left[a_{ij}^{k}\right]_{n\times n} \tag{5}$$

where, the scores by each professional will give us a $n \times n$ non-negative response matrix A = $[a_{ij}{}^{k}]_{n\times n}$. K is the amount of professionals (k = 1, 2, . . . , p), and $a_{ij}{}^{k}$ is a kth experts' scores.

3.2.2. Step 2

Normalized matrix: with the initial average matrix (X) that shows the dependences of each criteria, the normalized matrix (*Xnorm*) was consequent:

$$Xnorm = \propto \ *X \tag{6}$$

where α is $\propto = \ \frac{1}{max_{1\le i\le n}\sum_{j\ =\ 1}^{n} x_{ij}}$, $i, j \ = \ 1, 2, \ ..., \ n$

3.2.3. Step 3

The total-relation matrix (T) is obtained through normalized matrix as the follow equation:

$$T \ = \ Xnorm * (I - Xnorm)^{-1} \tag{7}$$

3.2.4. Step 4

Threshold value: This stage isolates the slight effects offered in T matrix and constructs a suitable cause-effect diagram. Judgement makers should fix a threshold value (h) for impact levels. In T, some features, that are upper than h, can convert into the cause-effect diagram. It's calculated through:

$$\text{Threshold value } (h) \;=\; \frac{1}{n^2}\sum_{i=1}^{n}\sum_{j=1}^{n} t_{ij} \tag{8}$$

3.2.5. Step 5

Cause–effect diagram: The sum of the rows and the columns represented as R vector and C vector in the next equations:

$$\begin{aligned} T^Z &= \left[t_{ij}\right]_{n\times n}, i, j = 1, 2, \ldots, n, t_{ij} \geq z \\ R &= [r_i]_{n\times 1} = \left[\textstyle\sum_{j=1}^{n} t_{ij}\right]_{n\times 1}, \\ C &= [c_i]_{1\times n} = \left[\textstyle\sum_{i=1}^{n} t_{ij}\right]_{1\times n}, \end{aligned} \tag{9}$$

This diagram, as a network relationship map (NRM), can be achieved by drawing the dataset of $(R + C, R - C)$. The horizontal axis $(R +)$, relation, interprets the component importance, while the vertical axis $(R -)$, Influence, separates components into cause and effect. When $(ri +)$ is positive, then the component i is disturbing further components and i fits to the cause group. If $(ri -)$ is negative, then the component i is being influenced by others components and i fits to the effect group.

3.2.6. Step 6

According to the value of h, it can filter the minor impacts in the components of matrix T. The new total-influence matrix T^h can acquire:

$$T^h \;=\; \left[t_{ij}^h\right]_{n*n},\; t_{ii}^h = \begin{cases} 0 & \text{if } t_{ij} < h \\ t_{ij} & \text{otherwise} \end{cases} \tag{10}$$

where the values of components in T are zero if their values less than h. That is, there are lower impacts with other criteria when their values are less than h.

3.3. ANP Technique

The ANP technique is the general model of relative dimension used to develop relation compound ratio scales from individual ratio scales representing the relation amounts of impact components interacting with a regulator criterion. It developed by Saaty in 1996 as a generalization of AHP [72] that captures dependence outcomes among the components clusters. This technique can briefed to:

3.3.1. Step 1

Create the network structure: the net has clusters of components, with the components in one cluster connected to components in another cluster (outer-dependence) or the same cluster (inner-dependence) (See in Appendix A Figure A1).

3.3.2. Step 2

Pairwise comparison matrices are created through questionnaires that show the importance and influence between criteria with considering the preferences of respondents. It is very important to test the inconsistency for the validity and reliability of respondent's questionnaires. The threshold as considered 0.1 to judge whether the comparison is consistent [73]. Therefore the study considered this for the comparison value as the consistency ratio.

3.3.3. Step 3

The super-matrix of a network characterizes the impact significance of a component on the left of the matrix on a component at the top of the matrix with respect to a specific control criterion. The priorities subsequent from pairwise comparison matrices are arrived as fragments of the columns of a super-matrix. The element C_1 in the super-matrix includes all the significance vectors consequent for nodes that are "parent" nodes in the C_1 cluster.

$$W = \begin{array}{c} \\ c_1 \\ c_2 \\ \vdots \\ c_n \end{array} \begin{array}{c} \begin{array}{cccc} c_1 & c_2 & \cdots & c_n \end{array} \\ \begin{bmatrix} W_{11} & W_{12} & \cdots & W_{1n} \\ W_{21} & W_{22} & \cdots & W_{2n} \\ \vdots & \vdots & \ddots & \\ W_{n1} & W_{n2} & \cdots & W_{nn} \end{bmatrix} \end{array} \tag{11}$$

3.3.4. Step 4

The limit super matrix of a network raises the super-matrix to limiting powers l (Equation (12)) until the super-matrix touched to get the global priority vectors or weights.

$$\lim_{l \to \infty} W^l \tag{12}$$

If the limiting super-matrix is not the only one, it would be considered to get the final weighted limiting super-matrix W_f (the average priority weights) as

$$\lim_{k \to \infty} \left(\frac{1}{n}\right) \sum_{j=1}^{N} W_j^k \tag{13}$$

where W_j denotes the jth limiting super-matrix.

The priorities of the alternatives achieved by normalizing the corresponding values in the suitable columns of the limit matrix.

3.4. Integration Method for GE Implementation

The final purpose of this research methodology is to rank the best of the most effective classified criteria. It acquired from combination of three separated indicator vectors from the results of ANP technique in Section 3.3. This research deliberated the integration method with consideration of the weighted average technique, which finalizes the new priorities of the most effective classified criteria based on the integration of the three indicators. Each indicator vector is sorted in descending order base on the weight of criteria. Three indicator vectors are shown as follow:

$$V^1 = \begin{array}{c} \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{array} \begin{bmatrix} x_1^1 \\ x_2^1 \\ x_3^1 \\ x_4^1 \\ x_5^1 \\ x_6^1 \\ x_7^1 \\ x_8^1 \end{bmatrix} V^2 = \begin{array}{c} \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{array} \begin{bmatrix} x_1^2 \\ x_2^2 \\ x_3^2 \\ x_4^2 \\ x_5^2 \\ x_6^2 \\ x_7^2 \\ x_8^2 \end{bmatrix} V^3 = \begin{array}{c} \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{array} \begin{bmatrix} x_1^3 \\ x_2^3 \\ x_3^3 \\ x_4^3 \\ x_5^3 \\ x_6^3 \\ x_7^3 \\ x_8^3 \end{bmatrix} \tag{14}$$

The process of obtaining the finalized priorities with integration of three vectors using weighted average is descripted as follow:

$$y_i = \frac{1}{2}\left(\frac{1}{m_{x_i^k}}x_i^k + \frac{1}{m_{x_i^l}}x_i^l\right),\ k,l = 1 \text{ or } 2 \text{ or } 3 \quad (15)$$

where y_i is the final value of ith criteria after integration method, ${x_i}^k$ is a value of ith criteria in the kth indicator vector before sorting, and the coefficient of ${x_i}^k$ in the above equation namely $\frac{1}{m_{x_i^k}}$ which in $m_{x_i^k}$ is the place of ith criteria in the kth sorted indicator vector.

4. Results

4.1. DEMATEL Results

According to the research methodology shown in Figure 4, the total relation matrix (T) from this part of the methodology was needed to collect the most effective criteria in the 3Ps. The MATLAB software was used to implement the DEMATEL method (as shown in Appendix A Figure A2). The average of the four-point Likert scale questions (questionnaire, part A) finalized the initial information (Table 4) in DEMATEL method to identify the interrelations among GI criteria.

Table 4. Initial DEMATEL info: Environment (4-a); Social (4-b); and Economic (4-c).

4-a-Environment Pillar							
	SDG_{En1}	**SDG_{En2}**	**SDG_{En3}**	**SDG_{En4}**	**SDG_{En5}**	**GE_{En1}**	**GE_{En2}**
SDG_{En1}	0	0.015	2.904	2.21	3.181	3.93	3.879
SDG_{En2}	1.879	0	2.809	1.005	2.005	3.05	3.109
SDG_{En3}	3.429	2.533	0	3.92	3.786	3.869	3.921
SDG_{En4}	2.266	1.975	1.875	0	0.02	3.021	2.17
SDG_{En5}	2.855	1.028	3.724	0.18	0	3.875	3.91
GE_{En1}	3.533	2.948	3.765	3.89	3.795	0	3.921
GE_{En2}	3.467	3.867	3.006	2.11	3.907	3.899	0
4-b-Social Pillar							
	SDG_{s1}	**SDG_{S2}**	**SDG_{S3}**	**SDG_{S4}**	**SDG_{S5}**	**GE_{S1}**	**GE_{S2}**
SDG_{S1}	0	0.905	1.903	3.23	2.891	3.901	1.809
SDG_{S2}	1.005	0	3.926	2.795	0.006	2.22	2.928
SDG_{S3}	2.895	1.95	0	3.33	0.019	3.619	3.015
SDG_{S4}	2.015	2.015	2.893	0	3.25	2.945	3.599
SDG_{S5}	3.007	2.879	3.145	3.109	0	3.005	2.859
GE_{S1}	3.906	2.912	3.674	2.809	3.905	0	3.905
GE_{S2}	3.875	1.907	3.108	3.91	3.802	3.785	0

4-c-Economic Pillar									
	SDG_{Ec1}	**SDG_{Ec2}**	**SDG_{Ec3}**	**SDG_{Ec4}**	**SDG_{Ec5}**	**SDG_{Ec6}**	**SDG_{Ec7}**	**GE_{Ec1}**	**GE_{Ec2}**
SDG_{Ec1}	0	3.467	2.085	1.805	1.21	2.045	1.062	0.0127	0.004
SDG_{Ec2}	3.067	0	1.925	1.021	0.052	0.005	0.025	0.005	0.01
SDG_{Ec3}	3.533	1.89	0	3.608	0.035	23.028	0.043	0.958	2.002
SDG_{Ec4}	2.05	1.533	3.276	0	0.221	0.004	0.85	0.0108	0.003
SDG_{Ec5}	2.21	0	2.038	1.085	0	2.918	2.98	3.821	2.884
SDG_{Ec6}	3.62	3.33	3.021	0	1.908	0	3.015	1.891	3.91
SDG_{Ec7}	3.85	2.875	2.867	2.892	3.052	3.928	0	3.892	3.905
GE_{Ec1}	1.17	1.253	0.879	2.02	2.054	1.891	2.905	0	3.025
GE_{Ec2}	3.07	2.167	0.904	1.008	2.85	3.855	3.867	2.908	0

Then, by using Equations (6) and (7), the normalized initial direct-relation matrix was calculated. Other parts of the DEMATEL had focused on calculating the total relation matrix (T), especially on the threshold value for impact level. The threshold value was at 0.6, which was calculated and inferred in each three pillars through Equation (8) and expert judgments. Through the sum of rows (D) and columns (R) of each criteria as the dataset, which was obtained from Step 6, the importance ($D + R$) and prominence ($D - R$), and finally, the rank of the criteria in the 3Ps were estimated. Table 5 shows the datasets for the network relation of criteria from DEMATEL technique in separate 3Ps.

Table 5. Final dataset and ranking of criteria from DEMATEL in separate pillars.

Group Environment Criteria of GE & SDGs					
Criteria	***D***	***R***	**Prominence = $D - R$**	**Importance = $D + R$**	**Rank**
SDG_{En1}	4.028238	4.235756	−0.20752	8.263994	**4**
SDG_{En2}	3.502275	3.121892	0.380383	6.624167	**7**
SDG_{En3}	4.976619	4.336573	0.640047	9.313192	**3**
SDG_{En4}	2.85362	3.365328	−0.51171	6.218948	**6**
SDG_{En5}	4.022084	4.175541	−0.15346	8.197625	**5**
GE_{En1}	5.04269	5.038759	0.003931	10.08145	**1**
GE_{En2}	4.764863	4.916541	−0.15168	9.681404	**2**
Group Social Criteria of GE & SDGs					
Criteria	***D***	***R***	**Prominence = $D - R$**	**Importance = $D + R$**	**Rank**
SDG_{S1}	3.826314	4.275136	−0.44882	8.10145	**5**
SDG_{S2}	3.308288	3.231866	0.076422	6.540155	**7**
SDG_{S3}	3.812675	4.575868	−0.76319	8.388543	**3**
SDG_{S4}	4.261014	4.737015	−0.476	8.998029	**2**
SDG_{S5}	4.461217	3.686371	0.774846	8.147587	**6**
GE_{S1}	5.153144	4.833992	0.319152	9.987135	**1**
GE_{S2}	5.044736	4.52714	0.517596	9.571876	**4**
Group Economic Criteria of GE & SDGs					
Criteria	***D***	***R***	**Prominence = $D - R$**	**Importance = $D + R$**	**Rank**
SDG_{Ec1}	0.5887	1.1767	−0.5880	1.7654	**5**
SDG_{Ec2}	0.3164	0.9132	−0.5969	1.2296	**8**
SDG_{Ec3}	1.7874	0.8973	0.8901	2.6847	**2**
SDG_{Ec4}	0.4482	0.6598	−0.2117	1.1080	**9**
SDG_{Ec5}	0.9733	0.6038	0.3695	1.5771	**6**
SDG_{Ec6}	1.0848	1.8605	−0.7757	2.9453	**1**
SDG_{Ec7}	1.3617	0.7766	0.5851	2.1383	**3**
GE_{Ec1}	0.7951	0.6815	0.1135	1.4766	**7**
GE_{Ec2}	1.0544	0.8405	0.2139	1.8949	**4**

Table 5 shows the final results of the ranking of criteria in each separate pillar. The ranking was according to the higher amount of importance ($R + C$) in each pillar. Table 6 shows the fourth most effective criteria in each separate pillar as the final output variables from the DEMATEL technique, which were used as the input for the ANP technique in the next part.

Table 6. Final output variables from DEMATEL—the fourth most effective criteria.

Rank	**Environment**	**Social**	**Economic**
1	GE_{En1}	GE_{S1}	SDG_{Ec6}
2	GE_{En2}	SDG_{S4}	SDG_{Ec1}
3	SDG_{En3}	SDG_{S3}	SDG_{Ec2}
4	SDG_{En1}	GE_{S2}	SDG_{Ec3}

These variables in Table 6 determined the rank of the most effective GE and SDGs criteria in 3Ps that should become the input in part 3 of Figure 4 to prioritise them based on their network relations in each indicator. The results of the ANP technique are explained in the following section.

4.2. ANP Results

Pairwise comparison was performed among the most effective criteria by considering their network relations in each indicator (Appendix A Figure A1). It derived the initial info from the average respondent answers in part B of the questionnaire. The reliability and validity of the respondents' answers were checked using the consistency ratio before calculating criteria priorities in each indicator. Figure 5 shows the averaging pairwise comparison matrices among the most effective criteria for the Eco-Environment indicator, with an acceptable inconsistency rate (0.08828, which is less than 0.1).

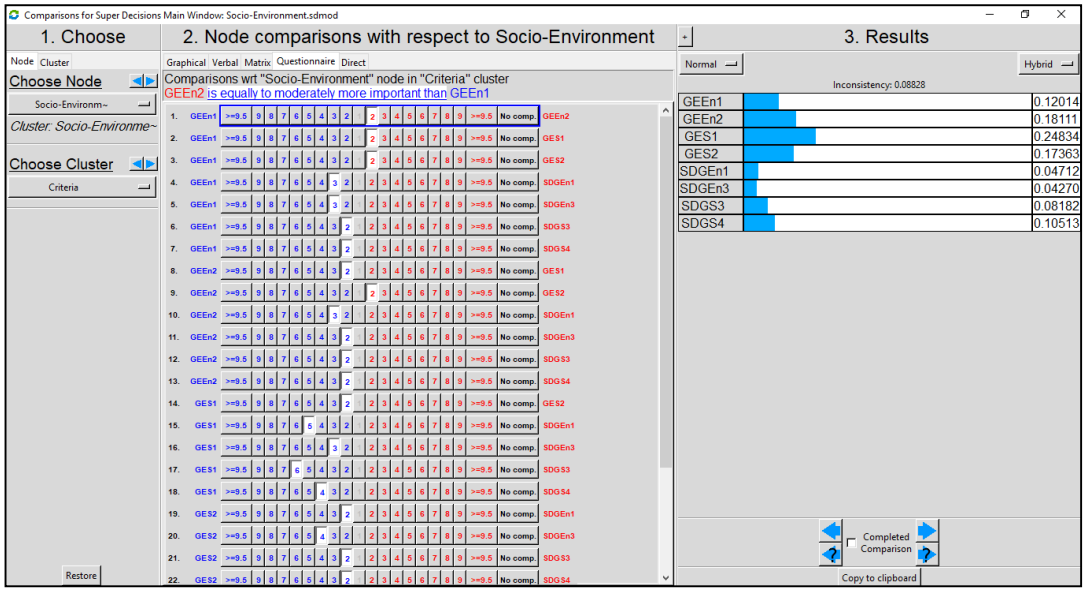

Figure 5. Pairwise comparison among the most effective criteria (Eco-Environment indicator).

The super decision software adapted the initial matrix to limit the matrix using Equations (12) and (13) by normalizing the corresponding values. Table 7 shows the rank and weight of the most effective criteria in each indicator.

Table 7. Final rank of the most effective criteria in each GE indicator.

Rank	Eco-Environment Indicator		Socio-Environment Indicator		Socio-Economic Indicator	
1	SDG_{Ec6}	0.34342	GE_{S1}	0.24834	SDG_{Ec6}	0.28229
2	GE_{En1}	0.21058	GE_{En2}	0.18111	SDG_{S4}	0.18090
3	GE_{En2}	0.14395	GE_{S2}	0.17363	SDG_{S3}	0.16049
4	SDG_{En3}	0.12090	GE_{En1}	0.12014	GE_{S2}	0.13361
5	SDG_{En1}	0.07522	SDG_{S4}	0.10513	SDG_{Ec3}	0.07918
6	SDG_{Ec1}	0.04695	SDG_{S3}	0.08182	SDG_{Ec1}	0.06676
7	SDG_{Ec3}	0.02950	SDG_{En1}	0.04712	GE_{S1}	0.06061
8	SDG_{Ec2}	0.02949	SDG_{En3}	0.04270	SDG_{Ec2}	0.03616

These final rankings were considered as the input data for the final step (4) of the research method, which was to finalise and rank the most effective GE and SDGs Criteria.

4.3. Integration Results

The integration method was the last part of this research method, leading to the finalised effective criteria. This mathematical method used the input data from Table 7 and converted them into the final data shown in Table 8 using Equations (14) and (15).

Table 8. Final rank of the most effective GE and SDGs criteria with normalised weight.

Final Rank	The Most Effective Criteria	Weight	Normalized
1	GE_{En1}	0.6766	0.490838
2	SDG_{Ec6}	0.3128	0.22692
3	GE_{S1}	0.12848	0.093206
4	GE_{En2}	0.06927	0.050252
5	SDG_{S4}	0.05574	0.040436
6	GE_{S2}	0.045633	0.033104
7	SDG_{S3}	0.035566	0.025801
8	SDG_{En3}	0.01794	0.013015
9	SDG_{En1}	0.012813	0.009295
10	SDG_{Ec3}	0.0100271	0.007274
11	SDG_{Ec1}	0.009483	0.006879
12	SDG_{Ec2}	0.0041063	0.002979

The final weight of criteria ranking was calculated from the integration of criteria weight in three separate indicators and normalised. These ranking criteria are needed to elucidate their definition and role in the implementation of sustainable development and the green economy.

5. Discussion

Institutionally, the GE was offered as a "vehicle" to distribute SD [64]. It was even supposed in some researches that the greater priority is needed for tackling poverty and inequality in GE procedures to influence SDGs. Clearly, the ignorance of social issues in green policymaking can result in significant costs for people living in poverty [74]. Based on the International Institute for Environment and Development (IIED) "for green growth to really fulfil its promise, it also needs to focus on people—to tackle the poverty, inequality, and exclusion that constrain both growth and environmental sustainability, to realize women and men's aspirations, and to gain broad societal support" [75]. This study aimed to align the criteria of the green economy and SD goals to promote sustainable development. There were three different techniques that were hybridised in this research methodology for SD implementation by aligning GE and SDGs criteria (23 criteria). These techniques were implemented to finalise and prioritise the most effective variables for achieving the research objective. DEMATEL was used to deliberate over four effective variables in each 3Ps of the classified GE and SDGs criteria by considering their interconnections. These results were applied as the input data for the ANP technique, which prioritised these variables into three different indicators by considering their network relations. These three indicators were consequently finalised through integration using a mathematical technique. These techniques produced different results, which needed more discussion according to their function. Aligning GE and SDGs criteria proceeded with the following three techniques:

- Obtain the most effective variable based on the 3Ps of SD:
  The results from first technique (DEMATEL) created the most effective criteria (12 criteria) from classified GE and SDGs criteria through pairwise comparison and considering their interrelations. These outputs (Table 4) demonstrated the rank of effective variables for GE and SDGs in each pillar of SD.
  In the environmental pillar of SD, the best rank belonged to GE_{En1} as the economy exclusive of environmental issues, such as global warming; and GE_{En2} as the economy with improving

environmental quality, such as resource efficiency. In this pillar, the effective variables were followed by SDG_{En3}, focusing on climate actions that could affect everyone and everyplace, and SDG_{En1} as sustainable cities and communities.

In the social pillar, GE_{S1} was placed as an effective variable among other classified criteria that are defined as improving quality of life. This was followed by SDG_{S4} as peace, justice, and strong institutions, while SDG_{S3} as reduced inequalities. These two items are focused on political actions and administrating social equality. GE_{S2} was the final most important variable of the social pillar for SD implementation, which was defined as improving the standards of living, such as education, job security, income, and inflation rate.

In the economic pillar, the most effective variables belonged to SDGs, which include SDG_{Ec6} as productive decent work and sustainable economic growth; SDG_{Ec1} as eliminating poverty, the supreme challenges facing humanity; SDG_{Ec2} as endorsing sustainable agriculture and food security to end hunger; and SDG_{Ec3} as promoting well-being and healthy lifestyle.

- Rank of the most effective variables based on three indicators:

  The most effective variables and criteria were the output of DEMATEL, which were used as input in the second technique, ANP. They were classified based on the 3Ps of SD, and their network relations were analysed through ANP technique in the next step. Three different indicators were determined for variables network relations, and pairwise comparison among them were considered for data collection and software modelling. The output data from the ANP technique, as shown in Table 7, were prioritised variables based on their network relations in three different indicators. Each indicator has eight weighted variables that determined their priorities for SD implementation, which need more discussion. Nonetheless, the initial discussion was focused on analysing the majority weighted variables (first half), where their weight formed more than 70% of each indicator (Table 7).

  The Eco-Environment indicator is emphasised for lining up the green economy with environmental issues. The major weight of the most effective variables in this indicator was at 82%, which consisted of sustainable growth (SDG_{Ec6}), excludes environmental issues (GE_{En1}), improvements of environmental quality (GE_{En2}), and the promotion of well-being (SDG_{En3}).

  The Socio-Environment indicator implied that a collaboration between society and environment should be organised to achieve green economy. The majority of the weighted variables originated from the green economy at 72% based on the following priorities: increase quality of life (GE_{S1}), develop environmental quality (GE_{En2}), recover standard of living (GE_{S2}), and eliminate environmental concerns (GE_{En1}).

  The Socio-Economic, as the final indicator, determined the green economy as an effort to promote equality and social welfare. The major weight of the most effective variables in this indicator was at 76% that promote sustainable economy (SDG_{Ec6}), peace and justice ($SDG_{S4)}$, equalities (SDG_{S3}), and standard of living (GE_{S2}).

- Achieve final rank of the most effective variables for SD implementation:

  The final technique was integration, which prioritised the most effective criteria in three indicators (output from ANP) to achieve the final rank for SD implementation. The final data in Table 8 is epitomized (in Appendix A Figure A3), which shows the proportions of the most effective GE and SDGs criteria for SD implementation. The first four variables present the major weight of the most effective criteria, which was 86%.

  The most effective variable among the ranked GE and SDGs criteria was GE_{En1} at 50% value towards SD implementation. It was defined as excludes environmental issues from economy, which is an important factor for aligning green economy and SD goals. Environmental issues are destructive features of human movements and actions that lead to different effects, such as climate change and pollution on the biophysical environment. The second effective variable (with 23% effectiveness) for aligning GE and SDGs was sustainable economic growth (SDG_{Ec6}) that was focused on reaching higher stages of efficiency through technical innovation. Mandated actions,

such as endorsing improved government policies, are required to nurture sustainable business practices, and to produce prospects for noble and decent works.

GE_{S1} was estimated to be 9% effectiveness as the third variable from the most effective GE and SDGs criteria for SD implementation. Quality of life refers to the general well-being in the society that could shape adverse and progressive features of life, such as health, safety, education, wealth, and profession. The fourth most effective variable was GE_{En2} at 5% efficacy for SD implementation. It was defined as improving environmental quality, which was focused on several actions, such as improving resource efficiency and condensing fossil fuel consumption to mitigate environmental degradation. The rest of the analysed variables made up to 14% of effectiveness that their roles were undeniable for aligning GE and SDGs to SD implementation.

6. Conclusions

As the main resource of economy, unsustainable economic growth has become one of the causes of the costly degradation of the environment. The green regulation of economic policy has explicitly reduced environmental issues and degradation, while enhancing social welfare, justice, and economic prosperity. Furthermore, sustainable development could afford a comprehensive strategy of performance, and measurable improvement for social inclusion, environmental sustainability, and economic development.

The current research determined the most effective variables among green economy and SDG criteria to endorse sustainable development. There is variation among these most effective variables based on each indicator. In the Eco-Environment indicator, the major weight of the variables was at 82%, which was characterised through the GE with sustainable economic growth. The weight of the variables for Socio-Environment indicator was at 72%, which was designated for intensifying the quality of life, environmental quality, and standard of living, while eradicating environmental concerns. As a final point, the weight of the most effective variables in the Socio-Economic indicator was 76%, which was categorised as green economy efforts to endorse SD; peace and justice, equalities, and standard of living.

The most effective variables that reached the research objective were the first four variables with 86% of total effectiveness that prioritized: GE_{En1} (50% of effectiveness) as the economy that excludes environmental issues; SDG_{Ec6}, defined as sustainable economic growth (23% of weight); GE_{S1}, as the overall welfare in society (9% of effectiveness), and GE_{En2}, as improving environmental quality (5% of efficacy).

This study concluded that the most effective variable among GE and SDGs criteria for SD implementation is the GE with exclusive environmental issues and sustainable growth, and the next highlighted variable is focused on the overall social well-being. This can be considered as a guideline if precisely addressed in future studies on greening the economy. The authors suggest the premises of the systematic outline, which could be advantageous for improving understanding of the SDGs implementation, and it's application for future research on complex and confusing concepts.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

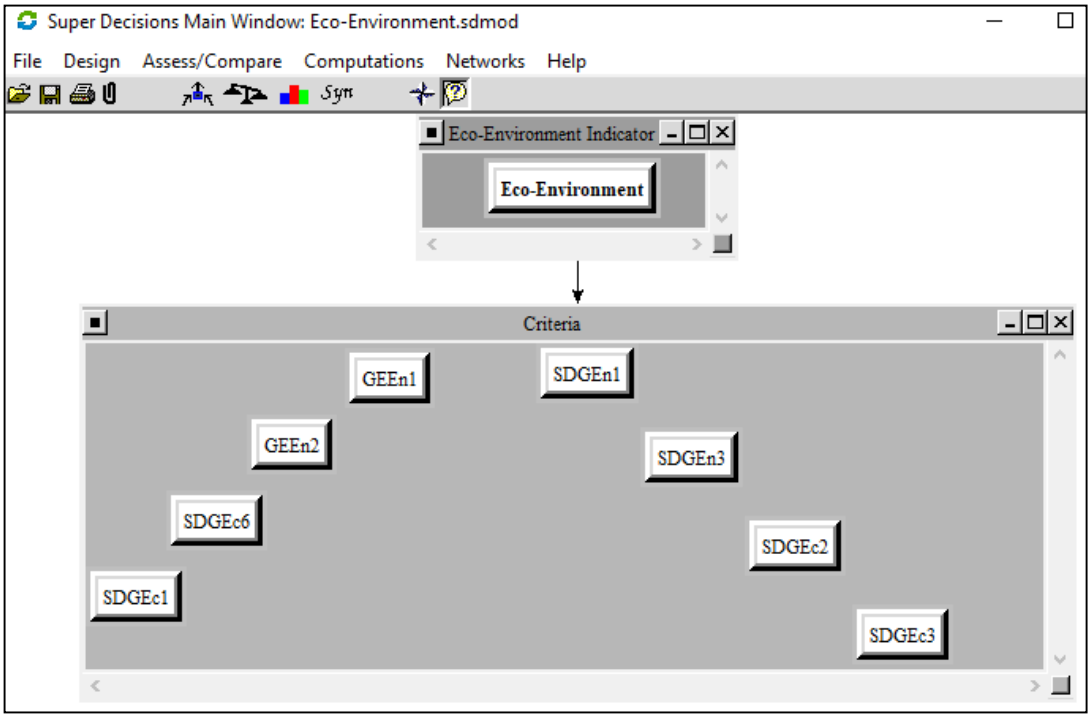

Figure A1. Network structure among the most effective GE and SDGs criteria based on Eco-Environment indicator.

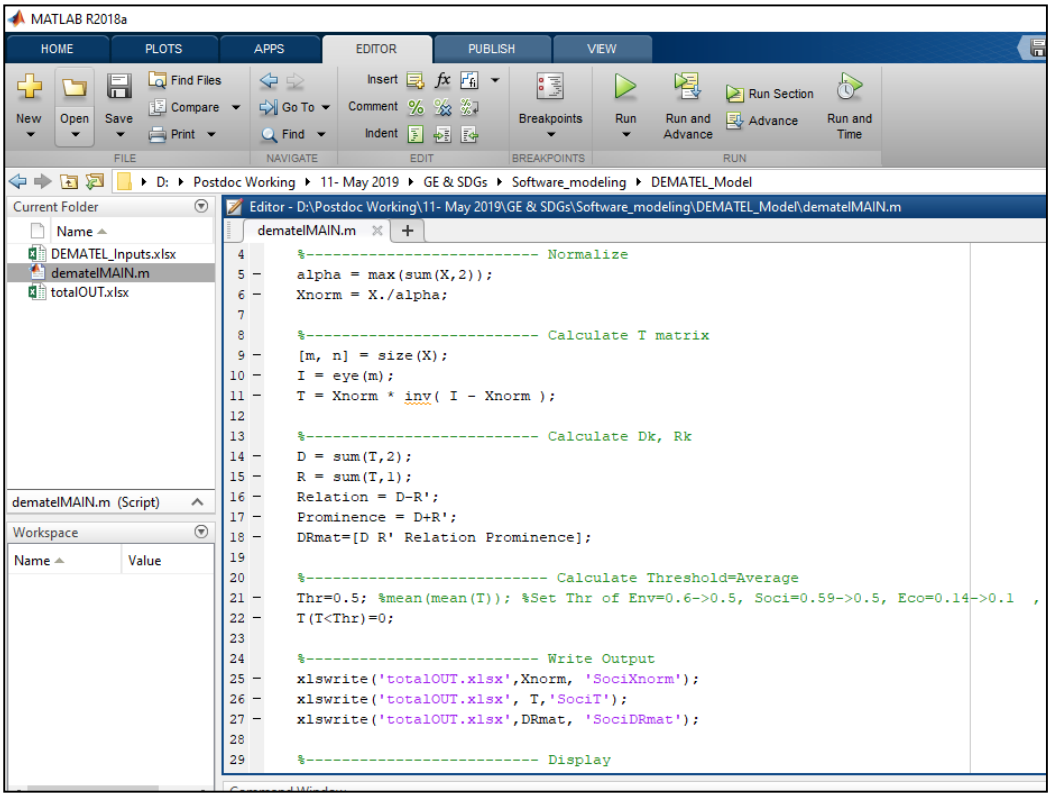

Figure A2. DEMATEL framework implementation in MATLAB software.

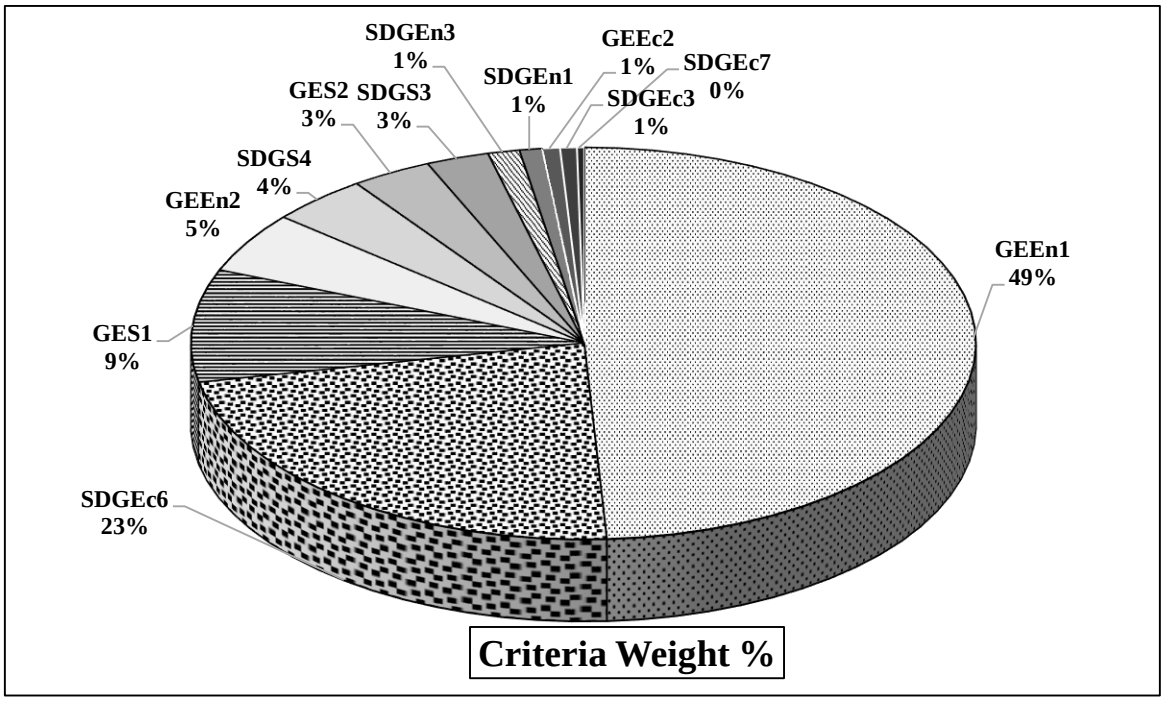

Figure A3. Proportion of the most effective GE and SDGs criteria for SD implementation.

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