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Impact-Relation Map of Innovative Service Development Regarding the Sustainable Growth for Emerging Markets

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Abstract

This paper introduces a tool for new service development in the context of emerging economies. For this aim, two-stage decision making model is applied for measuring the new service development-enhanced sustainable growth of emerging economies. At the first stage, bipolar q-ROF M-SWARA with golden cut is used for weighting the new service development process. At the second stage, bipolar q-ROF ELECTRE with golden cut is employed for illustrating the impact-relation map of sustainable growth determinants with respect to the new service development process for emerging economies. The novelties of this study are to construct a novel decision-making approach by using the bipolar q-ROFSs and golden cut and to figure out the influencing degrees and directions of sustainable growth determinants for emerging economies. It is also determined that testing has the highest significance while creating a new service for sustainable growth. Ranking results also demonstrate that qualified organizational teams and equipment is the most critical factor regarding innovative service process-based sustainable growth. It is necessary to adapt current technological developments to new products to be developed for sustainable growth. In this context, technological advances for these products should be followed carefully. In this process, it would be appropriate for companies to reach this goal by employing qualified personnel.

Keywords Innovative services · Sustainable growth · Emerging markets · Decision support systems

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Introduction

Sustainable growth means that the economy is both high-rate and long-term. For economic growth to be healthy, it must be sustainable. To achieve this goal, it is important to meet certain conditions. First, it is necessary to establish a healthy and competitive economic structure by ensuring macroeconomic stability in the country. Moreover, in parallel with the increasing demand for products, the supply of resources must also be sustainable (Mughal et al., 2022). In this way, it is possible to obtain higher added value. Furthermore, studies should be carried out to increase the scarce production factors in the country. In addition, productivity should be increased by using the factors of production more effectively. To achieve sustainable growth targets, it is necessary to develop new products with high productivity. In this process, it is necessary to ensure the effective use of natural resources and to attach importance to environmental quality (Girdzijauskas et al., 2022).

For sustainable growth, when developing new products, first, the products produced should be suitable for customer needs. In this context, it is necessary to clearly define the demands of the customers. This is essential for the products to be developed within the scope of sustainable growth to be demanded by the customers (Hosan et al., 2022). Otherwise, although these products will support sustainable development, they will not be in demand and will not be able to contribute to this goal. For new products developed for sustainable development to be efficient, companies should pay attention to technological developments. Technological innovations will help companies produce more efficient products (Chien et al., 2022). In this way, it will be much easier for the products to find a place in the market for a long time.

To develop new products that will contribute to the sustainable development goals of the countries, companies must employ qualified personnel. To increase the effectiveness of environmentally friendly new products, technological developments should be adapted to the product development process. In this context, people working in companies should also have a good command of this process (Siddikee et al., 2022). For this reason, qualified personnel should be needed, who are familiar with the processes of these complex products and can solve possible problems in a short time. Therefore, it is important for companies to prioritize this issue when selecting personnel. On the other hand, the development of the market for the green economy concept will also contribute to this process (Umurzakov et al., 2022). In this context, developing more products for green products will make the sustainable development of countries easier.

Sustainable growth is especially important for emerging countries. One of the most basic goals of these countries is to be included in the category of developed countries in a short time. Therefore, they can take aggressive actions to grow their economies in a short time. This situation increases the fragility of economies. Fragile economies are also an important obstacle to sustainable development (Vovchenko et al., 2022). In this context, emerging countries should also give priority to products that will contribute to sustainable development. In this

way, it will be possible for economies to grow more stably (Noeh et al., 2022). By minimizing the risks in this process, emerging countries will also be able to reach their sustainable development goals and be included in the classification of developed countries.

In the literature, there are lots of studies that focused on the new service development process and sustainable economic growth. However, the combination of these two subjects were considered rarely in the literature. There can be different determinants of the sustainable growth especially for emerging markets. Additionally, it is also important to identify which stages of new service development play more critical role to achieve this objective. In other words, there is a need for a prioritization analysis to understand more effective strategies to increase sustainable economic development. This analysis can be very helpful to use the budget of the countries and companies more efficiently and effectively. Accordingly, in this study, a tool for new service development in the context of emerging economies is introduced. In this context, two-stage decision-making model is applied. At the first stage, bipolar q-ROF M-SWARA with golden cut is used for weighting the new service development process. At the second stage, bipolar q-ROF ELECTRE with golden cut is employed for illustrating the impact-relation map of sustainable growth determinants with respect to the new service development process for emerging economies.

The novelties of this study are to construct a novel decision-making approach by using the bipolar q-ROFSs and golden cut and to figure out the influencing degrees and directions of sustainable growth determinants for emerging economies. The proposed model has also some essential benefits. Firstly, some improvements have been made to SWARA methodology. With the help of these improvements, causal relationship among the factors can be identified. Additionally, the degrees in q-ROFSs are calculated with golden cut that has a powerful contribution to the originality of the proposed model. Considering bipolar fuzzy sets also provide some advantages to the proposed model, such as using both positive and negative sets together (Gong & Hua, 2022). Therefore, a comprehensive information set can be defined (Zararsız & Riaz, 2022). Furthermore, ELECTRE method avoids compensation among the factors and normalization process (Figueira et al., 2022; Menekse & Camgoz-Akdag, 2022). Moreover, the calculations are made with both q-ROFSs, IFSs, and PFSs so that the validity of the analysis results can be checked.

Literature evaluation is conducted in the following part. Part three gives information about the methodology. Analysis details are shown in the fourth part. The final part focuses on the discussions and conclusions.

Literature

It is necessary to develop effective new products to achieve sustainable growth. In this process, it is very important for companies to have technological developments. Technological developments contribute to the more effective development of new products (Heidenreich et al., 2022). Thanks to technological developments, it will be possible to lower the costs of new products. In this context, companies should design a structure that can follow the advances in technology (Ding & Ding, 2022).

In this way, rapid developments in technology will be understood in a timely manner and adapted to the product development process immediately (Yoon & Kwon, 2022; Zeng, 2022). Thanks to this situation, it will be possible to develop products that will contribute to sustainable growth (Lee et al., 2022). Wan et al., (2022) assessed the process of new product generation for the industrial decarbonization. They highlighted the importance of the technological improvements for the sustainable economies. Lyu et al. (2022) evaluated new product outcomes and concluded that companies should give priorities to the technological development for the success of this process.

Qualified personnel are needed for the new products developed to contribute to sustainable growth. To increase the sustainability in economic growth, the products to be developed must be environmentally friendly (Ullah & Arslan, 2022). To develop these products, it is necessary both to have up-to-date technology and to use this technology effectively (Ahmad & Zheng, 2022; Shi et al., 2022). Qualified personnel are needed to use this technology correctly and efficiently (Venesz et al., 2022). The problems that may occur during the product development process will be solved much faster thanks to these personnel (AlMazrouei et al., 2022). Therefore, companies should give priority to these issues when employing personnel. Huang and Chen (2022) focused on the new product generation process in Taiwan's high-tech industries. They reached a conclusion that companies need qualified personnel to create products that contribute the sustainable economic growth. Jiang and Sun (2022) also evaluated Chinese manufacturing firms and identified that the quality of the personnel plays a crucial role for creating new products for the sustainability of the economic development.

For new products that will help sustainable growth to be successful, customer expectations must be met. In this context, first, it is necessary to understand what the expectations of the customers are (Shou et al., 2022). To achieve this goal, a comprehensive analysis is required to determine the demands of different customer groups (Mousavi et al., 2022). In this way, it will be possible for the new products to be developed to be preferred by the customers (Campo & Trio, 2021; Firu et al., 2022). As this will increase customer satisfaction, the success of the products will increase (Miranda et al., 2022). This will help countries achieve their sustainable development goals. Altunel and Say (2022) studied significant indicators that have a positive impact on the effectiveness of the software product system. They determined that the demands of different customer groups should be evaluated effectively for this situation. Pegan et al. (2022) evaluated importers' innovativeness in new product trials and defined that customer satisfaction should be provided in this respect.

The development of the market for the green economy is also of great importance in this process. To develop environmentally friendly products, this perception must rise in the market. In this context, it is necessary to increase the level of awareness on the subject (Xie et al., 2021). In this process, states have very important duties. States can make the green economy attractive by developing some practices (Li et al., 2021). For example, data advantage can be provided to products that reduce carbon emissions, such as electric cars (Andrade et al., 2022; Yousef et al., 2021). In addition, investors' interest in these projects can be increased with some incentives for renewable energy investments (Mahmoudi

et al., 2021). Adedoyin et al. (2021) studied renewable energy generation system in Sub-Saharan Africa. They underlined that green economy market should be improved for the sustainable economic growth. Zhou et al. (2021) also studied the important items of renewable energy investments. They reached a conclusion that risks in the green energy market should be handled effectively to provide sustainability in economic development.

Some studies also pointed out the importance of different determinants for the sustainable growth of the emerging markets. For economic growth to be sustainable, the equipment used must be qualified (Jang & Oh, 2022). In this context, current technological developments should be followed carefully by countries (Disli et al., 2022). On the other hand, new technological applications must be adapted quickly. If technological equipment is not used, it will not be possible for economic growth to be sustainable (Allal-Chérif et al., 2022). On the other hand, developing countries should consider the expectations of both internal and external customers when determining their growth targets (Luo et al., 2022). Otherwise, the products will not be preferred especially by foreign customers (Malik et al., 2022). Corporate social responsibility activities also play an important role in helping emerging countries achieve their sustainable development goals (Anwar et al., 2022). This will improve the images of both companies and countries in a positive way. Finally, markets need to be formed in countries with a green economy (Dana et al., 2022). This will contribute to the increase in the use of green products and services.

Some of the studies emphasized the details of new product and service processes. In order to achieve sustainable economic growth in emerging countries, first of all, environmentally friendly products must be designed (Blommerde-Winters, 2022). After that, a comprehensive analysis is required for effective development of this product (Salman et al., 2022). In this process, it is necessary to conduct necessary research on the details of the product (Pérez-Moreno et al., 2022). On the other hand, after the development of the product, necessary quality control tests must be carried out (Khan et al., 2022). These tests will give information about whether there are any glitches in the process. If there is a defect in the process, the product is returned to the analysis phase (Kivimaa & Rogge, 2022). After passing the test step completely, the product is commercialized and sold on the market (Wan et al., 2022).

Sustainability of economic growth is very important for countries' economies to have stability. In this context, it is vital to develop new products that will contribute to sustainable economic growth. To develop products in this way, companies need to pay attention to many different issues. However, it is very difficult for companies to achieve full-scale progress on all factors. Since such improvements create new costs, there is a risk that the profitability of the companies will decrease. In this framework, companies need to prioritize certain issues while developing new products for sustainable economic growth. Therefore, it is important to identify the factors that are more important for companies. A new decision-making model is applied in this study for measuring the new service development-enhanced sustainable growth of emerging economies.

Methodology

Bipolar q-ROFSs, M-SWARA, and ELECTRE are explained in the following sub-sections.

Bipolar q-ROFSs with Golden Cut

Atanassov (1999) introduced IFSs with membership and non-membership (MPR and NGR) degrees (μ_I, n_I) in Eq. (1).

$$I = \left\{\langle \vartheta, \mu_I(\vartheta), n_I(\vartheta)\rangle / \vartheta \epsilon U\right\} \tag{1}$$

Equation (2) represents the condition.

$$0 \le \mu_I(\vartheta) + n_I(\vartheta) \le 1 \tag{2}$$

Yager (2013) generated PFSs by novel degrees (μ_p, n_p) in Eq. (3).

$$P = \left\{\langle \vartheta, \mu_P(\vartheta), n_P(\vartheta)\rangle / \vartheta \epsilon U\right\} \tag{3}$$

The condition is given in Eq. (4).

$$0 \le \left(\mu_P(\vartheta)\right)^2 + \left(n_P(\vartheta)\right)^2 \le 1 \tag{4}$$

Yager (2016) developed q-ROFSs with improving IFSs and PFSs in Eq. (5).

$$Q = \left\{\langle \vartheta, \mu_Q(\vartheta), n_Q(\vartheta)\rangle / \vartheta \epsilon U\right\} \tag{5}$$

Equation (6) states the condition.

$$0 \le \left(\mu_Q(\vartheta)\right)^q + \left(n_Q(\vartheta)\right)^q \le 1, q \ge 1 \tag{6}$$

Zhang (1994) generated bipolar fuzzy sets with the aim of minimizing uncertainties in this process. They are detailed in Eq. (7) where $\mu_B{}^+$ refers to the satisfaction degree of an element while satisfaction of the same element is given by $\mu_B{}^-$.

$$B = \left\{\langle \vartheta, \mu_B{}^+(\vartheta), \mu_B{}^-(\vartheta)\rangle / \vartheta \epsilon U\right\} \tag{7}$$

Bipolar IFSs, PFSs, and q-ROFSs are given in Eqs. (8)–(13).

$$B_I = \left\{\langle \vartheta, \mu_{B_I}{}^+(\vartheta), n_{B_I}{}^+(\vartheta), \mu_{B_I}{}^-(\vartheta), n_{B_I}{}^-(\vartheta)\rangle / \vartheta \epsilon U\right\} \tag{8}$$

$$B_P = \left\{\langle \vartheta, \mu_{B_P}{}^+(\vartheta), n_{B_P}{}^+(\vartheta), \mu_{B_P}{}^-(\vartheta), n_{B_P}{}^-(\vartheta)\rangle / \vartheta \epsilon U\right\} \tag{9}$$

$$B_Q = \left\{\langle \vartheta, \mu_{B_Q}{}^+(\vartheta), n_{B_Q}{}^+(\vartheta), \mu_{B_Q}{}^-(\vartheta), n_{B_Q}{}^-(\vartheta)\rangle / \vartheta \epsilon U\right\} \tag{10}$$

$$0 \le \left(\mu_{B_I}{}^{+}(\vartheta)\right) + \left(n_{B_I}{}^{+}(\vartheta)\right) \le 1, -1 \le \left(\mu_{B_I}{}^{-}(\vartheta)\right) + \left(n_{B_I}{}^{-}(\vartheta)\right) \le 0 \tag{11}$$

$$0 \le \left(\mu_{B_P}{}^{+}(\vartheta)\right)^2 + \left(n_{B_P}{}^{+}(\vartheta)\right)^2 \le 1, 0 \le \left(\mu_{B_P}{}^{-}(\vartheta)\right)^2 + \left(n_{B_P}{}^{-}(\vartheta)\right)^2 \le 1 \tag{12}$$

$$0 \le \left(\mu_{B_Q}{}^{+}(\vartheta)\right)^q + \left(n_{B_Q}{}^{+}(\vartheta)\right)^q \le 1, -1 \le \left(\mu_{B_Q}{}^{-}(\vartheta)\right)^q + \left(n_{B_Q}{}^{-}(\vartheta)\right)^q \le 0 \tag{13}$$

Figure 1 indicates this situation.
Calculation process is stated in Eqs. (14)–(17).

$$\begin{aligned} B_{Q1} &= \left\{ \langle \vartheta, \mu_{B_{Q1}}{}^{+}(\vartheta), n_{B_{Q1}}{}^{+}(\vartheta), \mu_{B_{Q1}}{}^{-}(\vartheta), n_{B_{Q1}}{}^{-}(\vartheta) \rangle / \vartheta \epsilon U \right\} \text{ and} \\ B_{Q2} &= \left\{ \langle \vartheta, \mu_{B_{Q2}}{}^{+}(\vartheta), n_{B_{Q2}}{}^{+}(\vartheta), \mu_{B_{Q2}}{}^{-}(\vartheta), n_{B_{Q2}}{}^{-}(\vartheta) \rangle / \vartheta \epsilon U \right\} \\ B_{Q1} \oplus B_{Q2} &= \Bigg(\left(\left(\mu_{B_{Q1}}{}^{+}\right)^q + \left(\mu_{B_{Q2}}{}^{+}\right)^q - \left(\mu_{B_{Q1}}{}^{+}\right)^q . \left(\mu_{B_{Q2}}{}^{+}\right)^q \right)^{\frac{1}{q}}, \\ &\quad \left(n_{B_{Q1}}{}^{+} . n_{B_{Q2}}{}^{+}\right), -\left(\mu_{B_{Q1}}{}^{-} . \mu_{B_{Q2}}{}^{-}\right), -\left(\left(n_{B_{Q1}}{}^{-}\right)^q + \right. \\ &\quad \left. \left(n_{B_{Q2}}{}^{-}\right)^q - \left(n_{B_{Q1}}{}^{-}\right)^q . \left(n_{B_{Q2}}{}^{-}\right)^q \right)^{\frac{1}{q}} \Bigg) \end{aligned} \tag{14}$$

$$\begin{aligned} B_{Q1} \otimes B_{Q2} = \Bigg(& \left(\mu_{B_{Q1}}{}^{+} . \mu_{B_{Q2}}{}^{+}\right), \left(\left(n_{B_{Q1}}{}^{+}\right)^q + \left(n_{B_{Q2}}{}^{+}\right)^q - \left(n_{B_{Q1}}{}^{+}\right)^q . \left(n_{B_{Q2}}{}^{+}\right)^q \right)^{\frac{1}{q}}, \\ & - \left(\left(\mu_{B_{Q1}}{}^{-}\right)^q + \left(\mu_{B_{Q2}}{}^{-}\right)^q - \left(\mu_{B_{Q1}}{}^{-}\right)^q . \left(\mu_{B_{Q2}}{}^{-}\right)^q \right)^{\frac{1}{q}}, -\left(n_{B_{Q1}}{}^{-} . n_{B_{Q2}}{}^{-}\right) \Bigg) \end{aligned} \tag{15}$$

$$\begin{aligned} \lambda B_{Q1} = \Bigg(& \left(1 - \left(1 - \left(\mu_{B_{Q1}}{}^{+}\right)^q \right)^{\lambda} \right)^{1/q}, \left(n_{B_{Q1}}{}^{+}\right)^{\lambda}, \\ & - \left(-\mu_{B_{Q1}}{}^{-}\right)^{\lambda}, -\left(1 - \left(1 - \left(-n_{B_{Q1}}{}^{-}\right)^q \right)^{\lambda} \right)^{1/q} \Bigg), \lambda > 0 \end{aligned} \tag{16}$$

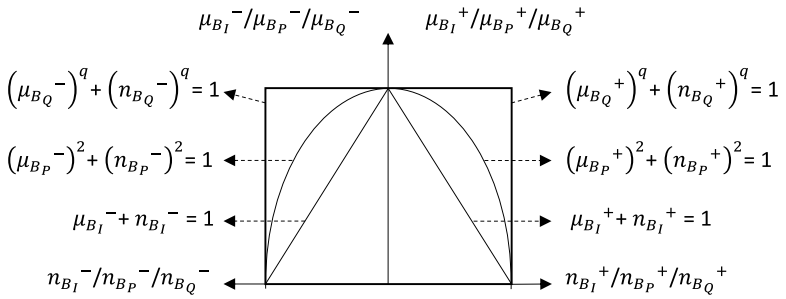


Fig. 1 Degrees of bipolar fuzzy sets

$$B_{Q1}{}^{\lambda} = \left(\left(\mu_{B_{Q1}}{}^{+}\right)^{\lambda}, \left(1-\left(1-\left(n_{B_{Q1}}{}^{+}\right)^{q}\right)^{\lambda}\right)^{1/q}, \right.$$
$$\left. -\left(1-\left(1-\left(-\mu_{B_{Q1}}{}^{-}\right)^{q}\right)^{\lambda}\right)^{\frac{1}{q}}, -\left(-n_{B_{Q1}}{}^{-}\right)^{\lambda}\right), \lambda > 0 \tag{17}$$

Score functions are shown in Eqs. (18)–(20).

$$S(\vartheta)_{B_I} = \left(\left(\mu_{B_I}{}^{+}(\vartheta)\right) - \left(n_{B_I}{}^{+}(\vartheta)\right)\right) - \left(\left(\mu_{B_I}{}^{-}(\vartheta)\right) - \left(n_{B_I}{}^{-}(\vartheta)\right)\right) \tag{18}$$

$$S(\vartheta)_{B_P} = \left(\left(\mu_{B_P}{}^{+}(\vartheta)\right)^2 - \left(n_{B_P}{}^{+}(\vartheta)\right)^2\right) + \left(\left(\mu_{B_P}{}^{-}(\vartheta)\right)^2 - \left(n_{B_P}{}^{-}(\vartheta)\right)^2\right) \tag{19}$$

$$S(\vartheta)_{B_Q} = \left(\left(\mu_{B_Q}{}^{+}(\vartheta)\right)^q - \left(n_{B_Q}{}^{+}(\vartheta)\right)^q\right) - \left(\left(\mu_{B_Q}{}^{-}(\vartheta)\right)^q - \left(n_{B_Q}{}^{-}(\vartheta)\right)^q\right) \tag{20}$$

In this model, degrees are computed by golden cut (φ). In this process, large and small quantities are given with a and b. Equations (21)–(23) indicate the details.

$$\varphi = \frac{a}{b} \tag{21}$$

$$\varphi = \frac{1+\sqrt{5}}{2} = 1.618\ldots \tag{22}$$

$$\varphi = \frac{\mu_{G_{B_Q}}}{n_{G_{B_Q}}} \tag{23}$$

Equations (24)–(26) give information about the adaptation of the golden cut with bipolar fuzzy sets.

$$G_{B_Q} = \left\{\langle \vartheta, \mu_{G_{B_Q}}{}^{+}(\vartheta), n_{G_{B_Q}}{}^{+}(\vartheta), \mu_{G_{B_Q}}{}^{-}(\vartheta), n_{G_{B_Q}}{}^{-}(\vartheta)\rangle / \vartheta \epsilon U\right\} \tag{24}$$

$$0 \le \left(\mu_{G_{B_Q}}{}^{+}(\vartheta)\right)^q + \left(n_{G_{B_Q}}{}^{+}(\vartheta)\right)^q \le 1, -1 \le \left(\mu_{G_{B_Q}}{}^{-}(\vartheta)\right)^q + \left(n_{G_{B_Q}}{}^{-}(\vartheta)\right)^q \le 0 \tag{25}$$

$$0 \le \left(\mu_{G_{B_Q}}{}^{+}(\vartheta)\right)^{2q} + \left(n_{G_{B_Q}}{}^{+}(\vartheta)\right)^{2q} \le 1, 0 \le \left(\mu_{G_{B_Q}}{}^{-}(\vartheta)\right)^{2q} + \left(n_{G_{B_Q}}{}^{-}(\vartheta)\right)^{2q} \le 1 \quad q \ge 1 \tag{26}$$

M-SWARA Method with Bipolar q-ROFSs

Keršuliene et al. (2010) developed SWARA for weighting the factors with hierarchical priorities. Relation matrix is constructed in Eq. (27) by using the evaluations of the experts.

$$Q_k = \begin{bmatrix} 0 & Q_{12} & \cdots & \cdots & Q_{1n} \\ Q_{21} & 0 & \cdots & \cdots & Q_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ Q_{n1} & Q_{n2} & \cdots & \cdots & 0 \end{bmatrix} \tag{27}$$

Bipolar q-ROFSs are created, and the score functions are calculated. Next, critical values are identified in Eqs. (28)–(30). In this scope, k_j explains the coefficient value, q_j identifies the recalculated weight, s_j represents the comparative importance rate and w_j indicates the weights of the criteria.

$$k_j = \begin{cases} 1 & j = 1 \\ s_j + 1 & j > 1 \end{cases} \tag{28}$$

$$q_j = \begin{cases} 1 & j = 1 \\ \frac{q_{j-1}}{k_j} & j > 1 \end{cases} \tag{29}$$

If $s_{j-1} = s_j,\ q_{j-1} = q_j$; *If* $s_j = 0,\ k_{j-1} = k_j$

$$w_j = \frac{q_j}{\sum_{k=1}^{n} q_k} \tag{30}$$

Finally, by transposing and limiting the matrix to the power of $2t+1$, stable matrix is generated to rank the items.

ELECTRE with Bipolar q-ROFSs

Benayoun et al. (1966) developed ELECTRE to rank alternatives. Equation (31) shows the decision matrix created with the evaluations.

$$X_k = \begin{bmatrix} 0 & X_{12} & \cdots & \cdots & X_{1m} \\ X_{21} & 0 & \cdots & \cdots & X_{2m} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ X_{n1} & X_{n2} & \cdots & \cdots & 0 \end{bmatrix} \tag{31}$$

With Eq. (32), the values are normalized.

$$r_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{m} X_{ij}^2}}. \tag{32}$$

The values are weighted by Eq. (33).

$$v_{ij} = w_{ij} \times r_{ij} \tag{33}$$

Equations (34)–(39) are used for concordance and discordance interval matrixes.

$$C = \begin{bmatrix} - & c_{12} & \cdots & \cdots & c_{1n} \\ c_{21} & - & \cdots & \cdots & c_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ c_{n1} & c_{n2} & \cdots & \cdots & - \end{bmatrix} \tag{34}$$

$$D = \begin{bmatrix} - & d_{12} & \cdots & \cdots & d_{1n} \\ d_{21} & - & \cdots & \cdots & d_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ d_{n1} & d_{n2} & \cdots & \cdots & - \end{bmatrix} \tag{35}$$

$$c_{ab} = \left\{ j | v_{aj} \geq v_{bj} \right\} \tag{36}$$

$$d_{ab} = \left\{ j | v_{aj} < v_{bj} \right\} \tag{37}$$

$$c_{ab} = \sum_{j \in c_{ab}} w_j \tag{38}$$

$$d_{ab} = \frac{max_{j \in d_{ab}} \left| v_{aj} - v_{bj} \right|}{max_j \left| v_{mj} - v_{nj} \right|} \tag{39}$$

Equations (40)–(47) denote the calculations of the concordance E, discordance F, and aggregated G index matrixes.

$$E = \begin{bmatrix} - & e_{12} & \cdots & \cdots & e_{1n} \\ e_{21} & - & \cdots & \cdots & e_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ e_{n1} & e_{n2} & \cdots & \cdots & - \end{bmatrix} \tag{40}$$

$$F = \begin{bmatrix} - & f_{12} & \cdots & \cdots & f_{1n} \\ f_{21} & - & \cdots & \cdots & f_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ f_{n1} & f_{n2} & \cdots & \cdots & - \end{bmatrix} \tag{41}$$

$$G = \begin{bmatrix} - & g_{12} & \cdots & \cdots & g_{1n} \\ g_{21} & - & \cdots & \cdots & g_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ g_{n1} & g_{n2} & \cdots & \cdots & - \end{bmatrix} \tag{42}$$

$$\begin{cases} e_{ab} = 1 \ \ if \ \ c_{ab} \geq \overline{c} \\ e_{ab} = 0 \ \ if \ \ c_{ab} > \overline{c} \end{cases} \tag{43}$$

$$\overline{c} = \sum_{a=1}^{n} \sum_{b}^{n} c_{ab} / n(n-1) \tag{44}$$

$$\begin{cases} f_{ab} = 1 \ \ if \ \ d_{ab} \leq \overline{d} \\ f_{ab} = 0 \ \ if \ \ d_{ab} > \overline{d} \end{cases} \tag{45}$$

$$\overline{d} = \sum_{a=1}^{n} \sum_{b}^{n} d_{ab} / n(n-1) \tag{46}$$

$$g_{ab} = e_{ab} \times f_{ab} \tag{47}$$

Additionally, e_{ab}, f_{ab}, and g_{ab} represent the sets of concordance, discordance, and aggregated index matrixes. Also, $\overline{c}$ and $\overline{d}$ indicate the critical values. Next, the net superior c_a, inferior d_a, and overall o_a values are computed in Eqs. (48)–(50).

$$c_a = \sum_{b=1}^{n} c_{ab} - \sum_{b=1}^{n} c_{ba} \tag{48}$$

$$d_a = \sum_{b=1}^{n} d_{ab} - \sum_{b=1}^{n} d_{ba} \tag{49}$$

$$o_a = c_a - d_a \tag{50}$$

Proposed Model

By considering the methods discussed in this section, a new decision-making model is applied for measuring the new service development-enhanced sustainable growth of emerging economies as in Fig. 2.

Figure 2 demonstrates that there are two different stages in this proposed model. At the first stage, bipolar q-ROF M-SWARA with golden cut is used for weighting the new service development process. In this framework, firstly, the processes of the new service development are defined. After that, linguistic evaluations are collected from the expert team. With the help of bipolar q-ROF M-SWARA methodology, the weights of the factors are identified. On the other side, in the second stage of the proposed model, bipolar q-ROF ELECTRE with golden cut is employed for illustrating the impact-relation map of sustainable growth determinants with respect to the new service development process for emerging economies. Within this context, linguistic evaluations of the decision makers are collected for the determinants of the sustainable growth. By implementing the steps of the bipolar q-ROF ELECTRE technique, the alternatives are ranked.

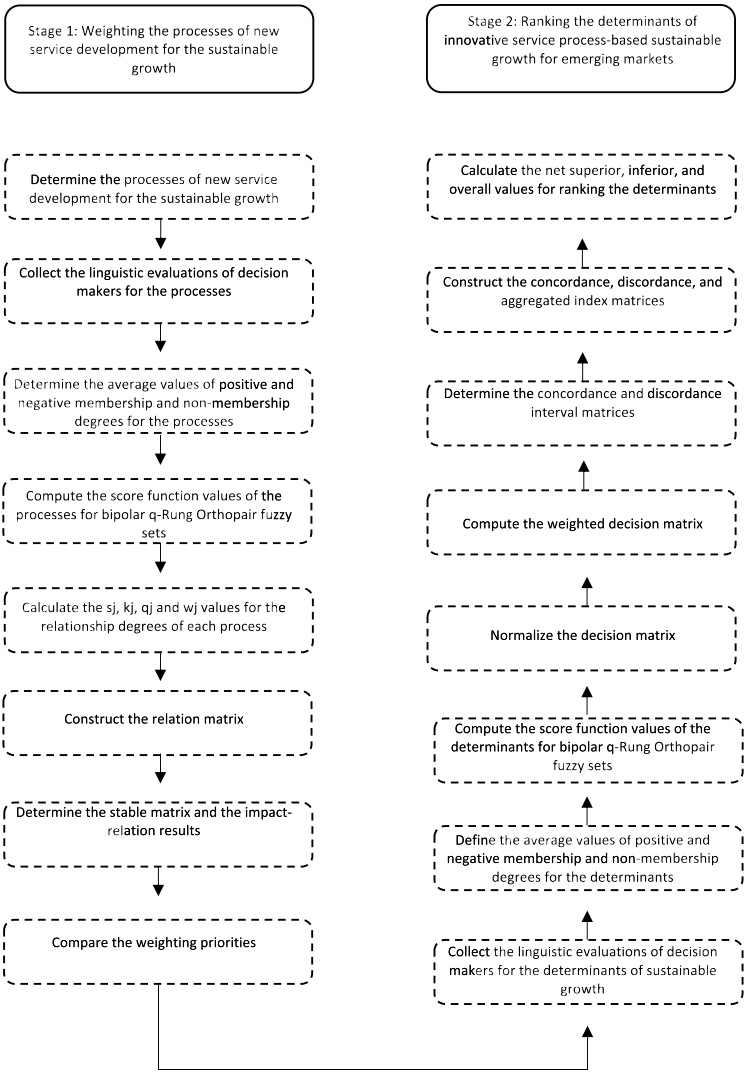


Fig. 2 Proposed model

Analysis

The process of new service development for the sustainable growth is detailed in Table 1.

The design is the first process while creating a new product. After that, the details of this products should be analyzed. The third step includes the testing of

Table 1 Selected processes of new service development for the sustainable growth

Processes	References
Design (DGN)	Zhou et al. (2021)
Analyzing (ANG)	Firu et al. (2022)
Testing (TNG)	Miranda et al. (2022)
Commercialization (CZT)	Shi et al. (2022)

the information. Commercialization is occurred in the final stage of this issue. Degrees and scales used in the examination are indicated in Table 2.

Table 3 includes the evaluations for the processes. In this framework, an expert team is created with three different decision makers. These people have at least 24-year experience about the new service development process. Questions are created by comparing the criteria given in Table 1 and they are asked to the decision makers. These people evaluated the questions by using the scales given in Table 2.

Table 4 includes average values.

Score functions are indicated in Table 5. Equations (18)–(20) are taken into consideration for the aim of calculating the score functions.

Additionally, sj, kj, qj, and wj values are computed in Table 6. Equations (28)–(30) are considered to calculate these values.

Relation matrix is generated in Table 7. In this framework, Eq. (27) is taken into consideration.

Table 8 explains the stable matrix. This matrix is created by transposing and limiting the matrix to the power of $2t+1$.

By considering these values, causal relationship among the processes is shown in Fig. 3.

Commercialization has an impact on design and analyzing. Furthermore, testing is influenced by analyzing and design. Comparative evaluation results are demonstrated in Table 9.

It is determined that testing has the highest significance while creating a new service for sustainable growth. Analyzing plays also an important role for this condition. The second part of the proposed model is related to ranking the determinants of innovative service process-based sustainable growth for emerging

Table 2 Degrees and scales

Scales		PVS		NVS	
For processes	For determinants	MPR	NPR	MPR	NPR
None (n)	Weakest (w)	.40	.25	−.60	−.37
Some (s)	Poor (p)	.45	.28	−.55	−.34
Medium (m)	Fair (f)	.50	.31	−.50	−.31
High (h)	Good (g)	.55	.34	−.45	−.28
Very high (vh)	Best (b)	.60	.37	−.40	−.25

Table 3 Evaluations of processes

Decision Maker 1								
	DGN		**AGN**		**TNG**		**CZT**	
	PVS	**NVS**	**PVS**	**NVS**	**PVS**	**NVS**	**PVS**	**NVS**
DGN			H	VH	S	N	S	H
AGN	H	M			VH	H	M	H
TNG	S	N	H	M			S	M
CZT	VH	VH	VH	H	VH	H		
Decision Maker 2								
	DGN		**AGN**		**TNG**		**CZT**	
	PVS	**NVS**	**PVS**	**NVS**	**PVS**	**NVS**	**PVS**	**NVS**
DGN			H	VH	H	N	H	M
AGN	H	H			VH	M	H	H
TNG	N	S	H	M			S	S
CZT	H	H	VH	H	VH	H		
Decision Maker 3								
	DGN		**AGN**		**TNG**		**CZT**	
	PVS	**NVS**	**PVS**	**NVS**	**PVS**	**NVS**	**PVS**	**NVS**
DGN			VH	VH	M	VH	M	H
AGN	VH	M			VH	H	M	M
TNG	M	M	H	M			S	M
CZT	VH	VH	VH	VH	M	VH		

markets. Table 10 demonstrates the determinants of sustainable growth. Many different studies in the literature reached similar conclusions. For example, Firu et al. (2022) aimed to define important indicators of effective new service development. They determined that necessary quality control tests must be carried out to have effective new service development process. Design and commercialization have the lowest weights according to the analysis results. However, Shi et al. (2022) defined that commercialization plays a very important role for the effectiveness of the new service development process.

Companies should employ qualified people regarding the sustainable growth. Additionally, the products should be designed based on the expectations of the customers. Corporate social responsibility activities also play a critical role for this purpose. Moreover, market should also be adopted to the green economy concept. The evaluations for the determinants are indicated in Table 11.

Table 12 includes average values.

Score function values of the determinants are calculated in Table 13.

Table 4 Average values for the processes

	DGN				AGN				TNG				CZT			
	PVS		NVS		PVS		NVS		PVS		NVS		PVS		NVS	
	μ	*n*	*μ*	*n*	*M*	*n*	*μ*	*n*	*μ*	*n*	*μ*	*n*	*μ*	*n*	*μ*	*n*
DGN					.57	.35	−.40	−.25	.50	.31	−.53	−.33	.50	.31	−.47	−.29
AGN	.57	.35	−.48	−.30					.60	.37	−.47	−.29	.52	.32	−.47	−.29
TNG	.45	.28	−.55	−.34	.55	.34	−.50	−.31					.45	.28	−.52	−.32
CZT	.58	.36	−.42	−.26	.60	.37	−.43	−.27	.57	.35	−.43	−.27				

Table 5 Score function values of the processes

	DGN	AGN	TNG	CZT
DGN	.000	.188	.211	.173
AGN	.225	.000	.243	.183
TNG	.197	.223	.000	.175
CZT	.207	.227	.201	.000

This matrix is normalized in Table 14. In this normalization process, Eq. (32) is taken into consideration.

This matrix is weighted in Table 15. Equation (33) is considered in this process.

Interval matrixes are constructed in Table 16. Equations (34)–(39) are used for concordance and discordance interval matrixes.

Index matrixes are demonstrated in Table 17. Equations (40)–(47) are used for the calculations of the concordance E, discordance F, and aggregated G index matrixes.

Net superior, inferior, and overall values for ranking the determinants are computed in Table 18. Equations (48)–(50) are considered in this process.

Ranking of the determinants are shown in Table 19.

It is identified that qualified organizational teams and equipment is the most critical factor regarding innovative service process-based sustainable growth. Market adaptation to green economy is found as another important issue for this condition. Customer-oriented service and products and corporate social responsibilities are on the last ranks. These results are quite similar to some previous studies. For instance, Venesz et al. (2022) focused on the significant determinants of the sustainable growth for emerging markets. They identified that for this purpose, it is quite necessary to have qualified organizational teams and equipment. However, some researchers also underlined the importance of different factors for this situation, such as customer-oriented service and products (Lyu et al., 2022) and market adaptation to green economy (Shi et al., 2022).

Table 6 Sj, kj, qj, and wj values

DGN	Sj	kj	qj	wj	AGN	Sj	kj	Qj	Wj
TNG	.211	1.000	1.000	.391	TNG	.243	1.000	1.000	.399
AGN	.188	1.188	.842	.329	DGN	.225	1.225	.816	.326
CZT	.173	1.173	.718	.280	CZT	.183	1.183	.690	.275
TNG	**Sj**	**kj**	**qj**	**wj**	**CZT**	**Sj**	**kj**	**Qj**	**Wj**
AGN	.223	1.000	1.000	.393	AGN	.227	1.000	1.000	.353
DGN	.197	1.197	.836	.328	DGN	.207	1.000	1.000	.353
CZT	.175	1.175	.711	.279	TNG	.201	1.201	.833	.294

Table 7 Relation matrix

	DGN	AGN	TNG	CZT
DGN		.329	.391	.280
AGN	.326		.399	.275
TNG	.328	.393		.279
CZT	.353	.353	.294	

Table 8 Stable matrix

	DGN	AGN	TNG	CZT
DGN	.251	.251	.251	.251
AGN	.264	.264	.264	.264
TNG	.267	.267	.267	.267
CZT	.218	.218	.218	.218

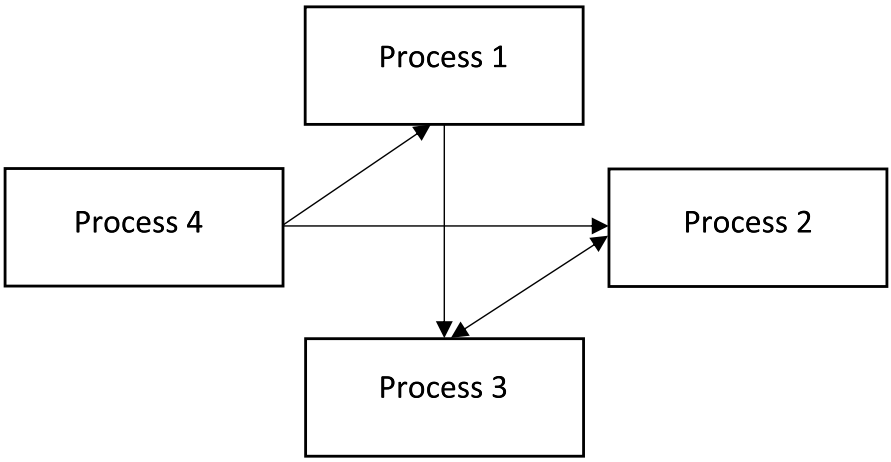


Fig. 3 Causal relationship for the processes

Table 9 Comparative evaluation results for the processes

	Bipolar IFSs	Bipolar PFSs	Bipolar q-ROFSs
DGN	3	3	3
AGN	2	2	2
TNG	1	1	1
CZT	4	4	4

Table 10 Selected determinants of the sustainable growth for emerging markets

Determinants	References
Qualified organizational teams and equipment (QTE)	Venesz et al. (2022)
Customer-oriented service and products (CSP)	Lyu et al. (2022)
Corporate social responsibilities (CEL)	Girdzijauskas et al. (2022)
Market adaptation to green economy (MGE)	Shi et al. (2022)

Table 11 Evaluations of determinants

Decision Maker 1

	DGN		AGN		TNG		CZT	
	PVS	NVS	PVS	NVS	PVS	NVS	PVS	NVS
QTE	B	W	B	W	B	F	B	G
CSP	P	F	F	F	G	W	G	G
CEL	F	F	G	W	G	F	G	W
MGE	B	W	B	P	P	G	G	B

Decision Maker 2

	DGN		AGN		TNG		CZT	
	PVS	NVS	PVS	NVS	PVS	NVS	PVS	NVS
QTE	B	F	B	W	B	F	B	G
CSP	P	W	F	G	G	W	G	G
CEL	F	F	G	G	G	F	G	W
MGE	B	W	B	F	P	G	G	B

Decision Maker 3

	DGN		AGN		TNG		CZT	
	PVS	NVS	PVS	NVS	PVS	NVS	PVS	NVS
QTE	B	F	B	B	B	B	B	G
CSP	P	F	F	F	G	B	G	G
CEL	F	W	G	F	G	F	G	B
MGE	B	W	B	W	P	F	G	B

Table 12 Average values for the determinants

	DGN				AGN				TNG				CZT			
	PVS		NVS		PVS		NVS		PVS		NVS		PVS		NVS	
	μ	n	μ	n	μ	n	μ	n	μ	n	μ	n	μ	n	μ	n
QTE	.60	.37	−.53	−.33	.60	.37	−.53	−.33	.60	.37	−.47	−.29	.60	.37	−.45	−.28
CSP	.45	.28	−.53	−.33	.50	.31	−.48	−.30	.55	.34	−.53	−.33	.55	.34	−.45	−.28
CEL	.50	.31	−.53	−.33	.55	.34	−.52	−.32	.55	.34	−.50	−.31	.55	.34	−.53	−.33
MGE	.60	.37	−.60	−.37	.60	.37	−.55	−.34	.45	.28	−.47	−.29	.55	.34	−.40	−.25

Table 13 Score function values of the determinants

	DGN	AGN	TNG	CZT
QTE	.281	.281	.243	.235
CSP	.186	.182	.243	.197
CEL	.211	.232	.223	.243
MGE	.330	.292	.147	.176

Table 14 Normalized matrix

	DGN	AGN	TNG	CZT
QTE	.544	.560	.558	.547
CSP	.359	.363	.559	.459
CEL	.409	.464	.512	.567
MGE	.639	.583	.339	.411

Table 15 Weighted matrix

	DGN	AGN	TNG	CZT
QTE	.136	.148	.149	.119
CSP	.090	.096	.149	.100
CEL	.103	.123	.137	.123
MGE	.160	.154	.090	.089

Table 16 Concordance (CNC) and discordance (DCN) interval matrixes

Determinants	CNC				DCN			
	QTE	CSP	CEL	MGE	QTE	CSP	CEL	MGE
QTE	.000	.733	.782	.485	.000	.004	.126	.407
CSP	.267	.000	.267	.485	1.000	.000	1.000	1.000
CEL	.218	.733	.000	.485	1.000	.469	.000	1.000
MGE	.515	.515	.515	.000	1.000	.839	.804	.000

Table 17 Index matrices

Determinants	CNC				DCN				Aggregated matrix			
	QTE	CSP	CEL	MGE	QTE	CSP	CEL	MGE	QTE	CSP	CEL	MGE
QTE	0	1	1	0	1	1	1	1	0	1	1	0
CSP	0	0	0	0	0	1	0	0	0	0	0	0
CEL	0	1	0	0	0	1	1	0	0	1	0	0
MGE	1	1	1	0	0	0	0	1	0	0	0	0

Table 18 Net superior, inferior, and overall values of the determinants

Determinants	Net superior values	Net Inferior values	Overall values
QTE	1.000	−2.463	3.463
CSP	−.961	1.688	−2.649
CEL	−.129	.538	−.668
MGE	.090	.237	−.147

Table 19 Ranking results for innovative service process-based sustainable growth

Determinants	Bipolar q-ROF Multi SWARA-ELECTRE	Bipolar PF Multi SWARA-ELECTRE	Bipolar IF Multi SWARA-ELECTRE
QTE	1	1	1
CSP	4	4	4
CEL	3	3	2
MGE	2	2	3

Discussions

The new product and service development process is vital for the performance of companies. If this process cannot be designed effectively, the continuity of the companies is in danger. In order for this process not to lead to high costs, companies need to focus on key stages. According to the results obtained from this study, the testing process is the stage that companies should pay the most attention to. In this context, companies should carry out final controls very effectively for new products and services developed. In this way, the disruptions in the product development process will be minimized. This will allow companies to improve their performance. In the event that companies with efficient investments increase, it will be easier for countries to reach their sustainable development goals.

Developing new products is vital for developing countries to achieve their sustainable growth targets. It is necessary to adapt current technological developments to new products to be developed for sustainable growth. In this context, technological advances for these products should be followed carefully. In this process, it would be appropriate for companies to reach this goal by employing qualified personnel. Complex processes can be found in new products developed for sustainable development. Products containing specific details such as engineering processes can be developed by competent personnel. Therefore, companies should give priority to this issue in the selection of personnel. Kumar et al. (2020), Pugna et al. (2020), Odei et al. (2021), and Agrawal et al. (2020) also focused on the ways to increase the performance of the new products. They defined that the employee quality is essential to increase the performance of this process.

Conclusion

A new decision-making model is applied for measuring the new service development-enhanced sustainable growth of emerging economies. First, bipolar q-ROF M-SWARA with golden cut is used for weighting the new service development process. Secondly, bipolar q-ROF ELECTRE with golden cut is employed for illustrating the impact-relation map of sustainable growth determinants with respect to the new service development process for emerging economies. It is found that commercialization has an impact on design and analyzing. Furthermore, testing is influenced by analyzing and design. It is also determined that testing has the highest significance while creating a new service for sustainable growth. Analyzing plays also an important role for this condition. Ranking results also demonstrate that qualified organizational teams and equipment is the most critical factor regarding innovative service process-based sustainable growth. Market adaptation to green economy is found as another important issue for this condition. Customer-oriented service and products and corporate social responsibilities are on the last ranks.

The novelties of this study are to construct a novel decision-making approach by using the bipolar q-ROFSs and golden cut and to figure out the influencing degrees and directions of sustainable growth determinants for emerging economies. The results will be generated for the further studies at the country and industry level. The limitation of this study is to focus on a general view regarding the sustainable growth. A specific industry can be evaluated in the following studies, such as green energy market. Additionally, the model can also be improved in the future research. In this context, AHP can be preferred instead of M-SWARA for the purpose of weighting items. Moreover, technique for order of preference by similarity to ideal solution (TOPSIS) can be considered to rank determinants by aim of making comparative analysis with the results of ELECTRE.

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