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Abstract

The COVID-19 crisis has immensely impacted the implementation of the 2030 Agenda for Sustainable Development worldwide. This research aims at providing a policy response to support achieving the Sustainable Development Goals (SDGs) taking the COVID-19 long-term implications into account. To do so, a qualitative analytical method was employed in the following

four steps. First, a fuzzy cognitive map was developed to specify causal-effect links of the interdependent SDGs in Iran as a developing country in the Middle East. Second, potential effects of the pandemic on the SDGs achievement were analyzed. Third, five strategies were formulated, including *green management*, *sustainable food systems*, *energizing the labor market*, *inclusive education*, and *supporting research and technology initiatives in the energy sector*. And finally, different scenarios corresponding to the five proposed strategies were tested based on the identified interconnections among the SDGs. The analysis showed that applying each of the five considered strategies or their combination would mitigate the effect of COVID-19 on the SDGs only in case of a medium pandemic activation level. Moreover, implementing a single strategy with a high activation level leads to better outcomes on the SDGs rather than applying a combination of strategies in low or medium activation levels during the pandemic situation. The provided insights support stakeholders and policy-makers involved in the post-COVID-19 recovery action plan towards implementing the 2030 Agenda for Sustainable Development.

Keywords: Pandemic, Sustainability, Fuzzy cognitive map, Scenario analysis, Policy recommendation.

1. Introduction

The 2030 Agenda for Sustainable Development was adopted by the United Nations (UN) General Assembly in 2015 as a shared plan of action including 17 Sustainable Development Goals (SDGs) for peace and prosperity (General Assemly, 2015), which works for both people and the planet. The 17 SDGs consist of 169 specific targets that can be clustered in three main pillars of sustainability including economic (SDGs 1-3 and SDGs 8-9), social (SDGs 4-5, SDGs 10-11, and SDGs 16-17), and environmental (SDGs 6-7 and SDGs 12-15) pillars (Kostoska and Kocarev,

2019). Due to the wide range of SDGs from basic needs and economic growth to innovation and modern infrastructures, and the interdependent nature of the 17 SDGs (Ranjbari et al., 2019), the accomplishment of the 2030 Agenda for Sustainable Development needs a full integration and active collaboration of different sectors and disciplines within a society (Shulla et al., 2020). In order to support the achievement of the SDGs, the interactions among SDGs that make it a complex system have been studied in several research (Singh et al., 2018; van Soest et al., 2019; Weitz et al., 2018).

The COVID-19 pandemic implications for the governments, industries, and all business activities across the world have seriously challenged the SDGs' achievement and have added to the complexity of the interacting SDGs. Not only health but almost all sectors of the global community have been significantly affected by the current pandemic crisis. In this vein, the economic activities (Rahman et al., 2020; Sahoo and Ashwani, 2020), education (Iivari et al., 2020), tourism (Sigala, 2020), the energy sector (Fell et al., 2020; Rajput et al., 2021), manufacturing activities (Shokrani et al., 2020), transportation (Mogaji, 2020; Ravina et al., 2021), food (Aldaco et al., 2020), healthcare waste management (Ranjbari et al., 2022), air quality (Ambade et al., 2021; Chelani and Gautam, 2021; Gautam et al., 2021), and agricultural sector (Aldaco et al., 2020) are only some examples addressed by the scientific community. Therefore, the long-term effects of the pandemic should be analyzed and managed properly at an appropriate time to ensure successful progress towards sustainable development (Ranjbari et al., 2021c). Consequently, the role of decision- and policy-makers in different sectors of the society for implementing the 2030 Agenda has become much critical due to the panic situation that emerged from this crisis.

Although several studies have been conducted to investigate the effects of COVID-19 on the sustainability domain such as sustainability transition (Kanda and Kivimaa, 2020), sustainable supply chain (Majumdar et al., 2020), and ecological sustainability (Zabaniotou, 2020), limited research has been carried out on the sustainable development agenda and especially its SDGs. The research conducted by Alibegovic et al. (2020) in Italy showed that SDG 1, SDG 4, and SDG 8 are the most affected SDGs by COVID-19. Barbier and Burgess (2020) proposed subsidy swap and also tropical carbon tax on fossil fuel after COVID-19 as a progress policy for SDGs with a special focus on the energy sector in developing countries. The impact of COVID-19 on SDGs in India was analyzed by Bherwani et al. (2021) with a focus on air quality. Besides, Suriyankietkaew and Nimsai (2021) investigated the challenges and opportunities post COVID-19 for possible sustainable recovery solutions considering SDGs. In the study conducted by Alam et al. (2021), 15 challenges were identified for the COVID-19 vaccine supply chain and their implications for SDGs were presented. The importance of government's support and optimal portfolio allocation for SDGs achievement post pandemic was mentioned by Yoshino et al. (2020) in a theoretical analysis. Finally, considering Iran that is also the case of the current research, Ranjbari et al. (2021b) focused on the analysis of SDGs targets at the country level post COVID-19 and concluded that SDG 1.2, SDG 8.3, SDG 3.3, SDG 11.5, and SDG 9.3 are the highest priorities for action in Iran for the post-pandemic recovery agenda.

The present research considers all the 17 UN's SDGs and aims at presenting a new insight for the 2030 Agenda for Sustainable Development and achieving the SDGs post COVID-19 in Iran, as a developing country. Iran has been infected dramatically by the pandemic with 4,960,744 positive cases, 107,151 death records, and the rank of 9 among all countries in terms of cumulative total death per 100,000 populations by August 31, 2021 (WHO, 2021). Total economic loss resulting

from the pandemic restrictions in Iran is estimated to be 47.23 billion dollars (Hemant Bherwani et al., 2021), which can affect the achievement of the UN's SDGs in this country. In this regard, the main questions of the research are formulated as follows. (1) How do SDGs affect each other? (2) How much has COVID-19 affected each one of the SDGs? and (3) What are the proper strategies to approach the 2030 Agenda for Sustainable Development post COVID-19?

In order to answer the research questions, Fuzzy Cognitive Map (FCM) modeling is utilized to conceptualize the mental model of a panel of experts. FCM is a method based on the experts' opinion, which have been widely applied in many research within different areas of sustainability context before the pandemic, such as sustainable environment (Kokkinos et al., 2020), sustainable consumption (Morone et al., 2019), and energy sustainability (Pereira et al., 2020). Due to the lack of adequate and reliable data concerning COVID-19, the application of participatory methods informed by a panel of experts and decision-makers has become much highlighted by researchers (Sarzi-Puttini et al., 2020; Sawhney et al., 2020) to overcome this deficit. In this vein, FCM has also been applied in a few studies for predicting the severity level of COVID-19 (Abbaspour Onari et al., 2021), medical diagnosis of COVID-19 (Groumpos, 2021, 2020), and healthcare service quality during the current pandemic (Babroudi et al., 2021). Also for Iran, as a reach country in terms of renewable energies (Fadai et al., 2011), a study was conducted by Ghaboulian Zare et al. (2022), which concluded that the continuation of the pandemic situation can result in the shrink of government budget and abstain private companies from renewable energy projects. However, the literature lacks a study that has applied FCM to analyze strategies regarding the UN's SDGs in the post-COVID-19 era. To the best of the authors' knowledge, this research is the first attempt to employ FCM to identify the causality strength of the links among the SDGs and analyze recovery scenarios considering the COVID-19 pandemic in Iran.

The rest of the paper is structured as follows. Section 2 explains the research design and the methodology framework applied in this study. Section 3 provides an overview of the panel experts who participated in this research and presents the main steps to build the FCM model. Strategy formulation and scenario testing, accompanied with the analysis of the test results are provided and discussed in section 4. And finally, section 5 concludes the research and provides future research recommendations for further studies.

2. Research design and methodology

Applying a mixed-method approach, two main steps were taken in this research as shown in Fig. 1. Considering the complex interconnections between SDGs, FCM was applied to draw the causality among the SDGs in the concept mapping stage. Then, recommended strategies by experts were tested in the model and analyzed in the scenario analysis stage.

A set of variables and their relevant interconnections, which are derived from the knowledge and experience of experts and key stakeholders, are the two main pillars of a FCM model. On this basis, the main four steps of FCM modeling, adopted from (Kontogianni et al., 2012; Wang et al., 2019) and elaborated for our research, are as follows:

Step 1. Concept (node) selection: In this step, the 17 SDGs and COVID-19 were considered as nodes in the FCM model, presented by $C = \{c_1, c_2, \dots, c_n\}$.

Step 2. Fuzzy FCM questionnaire: A questionnaire was designed to capture the experts' viewpoint regarding the existence and the weight of causal relationships between the nodes. A seven-point scale was considered for weights, including "high", "medium" and "low" in either positive or negative directions, as well as "no effect" to show that c_i does not affect c_j.

Step 3. Building the diagraph and the adjacency matrix: The linguistic terms in the questionnaire were translated into triangular fuzzy numbers (TFNs) based on the experts' opinion reflected in Table 1, transformed into crisp values and then, used to build the adjacency matrix. Besides the weight of the arcs between the identified SDGs, the weights for the COVID-19 level of effect on the SDGs were used to weight the arcs linking COVID-19 to the other nodes.

Step 4. Specifying the activation level of the driver nodes (COVID-19 and five proposed strategies) and simulating the scenarios: An initial activation vector was applied as an input for the driver components in the model and the values of the ordinary components were simulated. For each component, the activation level was also illustrated by the seven-point scale $\{H^+, M^+, L^+, N, L^-, M^-, H^-\}$, ranging from fully active with a positive relative change to fully active with a negative relative change. The simulation process was conducted repeatedly for each scenario by changing the activation level of the nodes. Finally, based on the simulation of the scenarios, relevant recommendations for the adoption of the proposed strategies by decision-makers and authorities were provided.

3. FCM model building

According to the wide range of the SDGs within the 2030 Agenda for Sustainable Development, 22 potential experts from different fields of activity were invited to the research. Finally, 9 experts participated in our research. The responses were gathered from the expert panel through questionnaires to build the FCM model from May 5, 2021, to June 28, 2021. However, formulating the scenarios and identifying their effect on each SDG was conducted based on an interview with 3 experts. Table 2 reports the characteristics of the expert panel in our research.

The FCM diagraph was constructed based on the SDGs and their existing relationships specified by the experts. Each SDG was added to the model as a component. Then the weights of the arcs, stated by the experts, were used to construct the FCM adjacency matrix. COVID-19 was also added to the model as a driver component affecting the SDGs, and the weights of their linking arcs were used to complete the adjacency matrix. Then, five strategies proposed by the experts were added to the model as five driver nodes. The weights of the arcs from these strategies to the SDGs affected by them were also specified and added to the model.

Fig. 2 illustrates the FCM diagraph constructed in the Mental Modeler software. The blue arcs with '+' signs demonstrate a positive magnitude in the causal relationship between the nodes (an increase of concept C_j when C_i increases), while the red arcs with '-' signs indicate a negative one (a decrease of concept C_j when C_i increases). Moreover, the thicker the arc, the higher the relationship weight. The developed diagraph contains 23 components and 205 connections, leading to 8.9 connections per component. The number of existing connections compared to the number of all possible connections is 0.4, which shows the density of the model. Table 3 presents the metrics for the model components, including indegree index (the sum of the weights of the component's entering arcs), the outdegree index (the sum of the weights of the component's leaving arcs), and the centrality index (the sum of incoming and outgoing connections) (Santoro et al., 2019). To validate the model, sensitivity analysis was conducted by considering different activation levels for the nodes, and the output was presented to and confirmed by a group of 3 experts.

4. Strategy formulation and scenario analysis

The strategies considered in the model are introduced in section 4.1 and the potential scenarios regarding different activation levels of these strategies are tested and analyzed in section 4.2.

4.1. Strategy formulation

Given the experts' opinion, five strategies, including *green management*, *sustainable food systems*, *energizing the labor market*, *inclusive education*, and *supporting research and technology initiatives in the energy sector* were selected to be considered in the model. These strategies are described in the following.

Strategy A: Green management

Green management is a comprehensive strategy referring to the utilization of water, energy, and other resources and their effects on the environment. In addition to the changes in the resource consumption behavior of households and organizations (Abulibdeh, 2021; Baker et al., 2020; Liu et al., 2020; Ranjbari et al., 2021a), the pandemic can be an opportunity to encourage people and organizations to try and continue working from home during and after the pandemic, which may result in lower time and energy consumption (Kylili et al., 2020). During the pandemic, the Iranian government should try to build the essential infrastructures for digital government services and other similar facilities to reduce the need for the presence of workers at their workplace, and at the same time, try to promote sustainable consumption of resources. Therefore, this strategy entails a variety of activities to be conducted by the government and authorities to make the transition towards comprehensive green management possible. These activities may include but are not limited to the following: (1) providing the require infrastructure for information and

communication technologies, and support high-speed internet all over the country, especially in outlying and rural areas, (2) building and supporting sharing platforms for information technology equipment, such as laptops and tablets, to enable poor and vulnerable people to follow the changes happening in the lifestyle and workstyle post pandemic, (3) making public services online and reducing in-person services as much as possible, (4) reducing the use of papers in public and private organizations by improving online systems and integrating and linking data bases, (5) implementing systems to increase efficiency in water consumption, reduce waste of water in governmental organizations, and encourage private sectors and households to save water, (6) improving energy efficiency and utilizing clean and renewable energy resources, (7) facilitating teleworking and providing regulations for both public and private organizations in this regard, and (8) implementing systems to improve waste sorting and recycling in public and private sectors as well as households.

Strategy B: Sustainable food systems

Research shows that the COVID-19 pandemic has affected food security in Iran (Rad et al., 2021) and worldwide (Niles et al., 2021; Sereenonchai and Arunrat, 2021). Strategy B (*Sustainable food systems*) concentrates on providing a sufficient food supply for the whole population in Iran, aiming at providing access for all people to healthy food and nutrients, which can be achieved by providing the required financial support and subsidies as well as strengthening the food supply chain in this country. The main suggested activities required to fulfill the implementation of this strategy are as follows: (1) providing comprehensive databases on all food supply chain sectors and stakeholders, (2) establishing a strong and transparent communication network among food supply chain stakeholders to balance supply and demand, and to prevent disorders caused by

profiteers, (3) improving food supply chain management to increase efficiency and reduce the cost of food production and distribution, (4) using methods, tools, and information to improve efficiency and reduce food losses and waste, and (5) providing sufficient financial and non-financial support to farmers to reduce the effect of the pandemic on their activities, and to consumers in vulnerable situations to help them access their required food and nutrition in the wake of the pandemic.

Strategy C: Energizing the labor market

The pandemic has affected the labor market in developing countries both in terms of income and job loss (Bottan et al., 2020) and mental health (Radulescu et al., 2021). To support the labor market in Iran, which is highly affected by the pandemic, *energizing the labor market* was suggested as a strategy to focus on the financial and non-financial support for the creation of new jobs and attempts to maintain current jobs by supporting their relevant activities. Critical components of this strategy include: (1) financial and non-financial support to workers and the self-employed to overcome the economic pressure resulting from their lower income during the pandemic, (2) providing more support for social security and unemployment insurance of workers, (3) facilitating work from home where possible, (4) recovery plans for small and medium enterprises and supporting them to adopt digital technologies, and (5) extending tax payments by institutions and small and medium enterprises.

Strategy D: Inclusive education

Iran is facing various challenges regarding distance learning during the pandemic due to the lack of network infrastructure, access of all students to the required digital devices, and internet access,

like other developing countries (Tadesse and Muluye, 2020). The strategy *Inclusive education* was proposed aiming at the development and enhancing of the required platforms to provide fair education to all children, and to improve work conditions and opportunities in poor regions by providing sufficient facilities for parents in order to allow their children to study. The main elements of this strategy are as follows: (1) providing access to electricity, internet, computers, and other digital communication tools for education and training of children and also university students especially in faraway and poor regions, (2) trying to minimize child labor despite the economic pressure of the pandemic situation on poor people and providing the opportunity for all children to study school lessons, (3) providing the students in poor regions with food and nutrients at schools, and (4) providing basic sanitation facilities at schools and educate children, especially girls, in terms of hygiene and sanitation.

Strategy E: Supporting research and technology initiatives in the energy sector

Although Iran is a rich country in terms of both renewable and non-renewable energy sources (Fadai et al., 2011), renewable sources of energy do not play a significant role in the energy supply in this country (Solaymani, 2021). Research shows that Iran is facing several challenges for knowledge creation and diffusion of renewable energy technologies (Fartash et al., 2021), and the post-pandemic era is worse than the pre-pandemic regarding the development of renewable energies in this country (Ghaboulian Zare et al., 2022). Strategy E targets *research and technology initiatives in the energy sector* and concentrates on financial support for research on renewable energies. The main components of this strategy are as follow: (1) removing subsidies from fossil fuels and instead, providing subsidies for renewable energy resources consumption by public and private sectors, (2) devoting financial support and funds to support the development of renewable

energy infrastructures and to foster technological innovation through research collaborations, (3) supporting start-ups and venture capital financing in the field of renewable energies, and (4) promoting innovation through competition among research institutions and also research and development departments of public and private companies.

4.2. Scenario analysis and discussion

Before analyzing the implementation of the proposed scenarios, the effect of the COVID-19 pandemic on the achievement of SDGs is simulated in this section. Two different activation levels of $L^0_{\mathrm{COVID-19}} = M^+$ and $L^0_{\mathrm{COVID-19}} = H^+$ are considered for COVID-19 node in the built FCM model, representing middle and high relative change in the current situation of the pandemic, respectively. These activation levels, which refer to the worsening of the pandemic situation, have been considered based on the opinion of experts believing that with respect to vaccination rate and new virus variants, the pandemic or its consequences will last long in Iran. As can be seen in Fig. 3, by changing the activation level of COVID-19 from medium to high, (i) more SDGs would be affected, and (ii) the negative impact on different SDGs would increase. SDGs 1, 5, 6, 8, 9, 10, 12, 14, 15, and 17 would be affected negatively even with a medium level of worsening the pandemic situation. The most drastic impact is on SDG 17 (Partnerships for the goals), followed by SDG 9 (Industry, innovation, and infrastructure). As the governments around the world are struggling with the COVID-19 pandemic, it is trivial to allocate most of their resources to overcome the pandemic and its effects, and helping other countries or considering environmental and social programs are a lower priority. Besides, some SDGs are difficult to be achieved in Iran even in the absence of the pandemic, and there is not a properly defined program for them. Therefore, the

pandemic would not significantly affect these SDGs and even by deactivating the COVID-19 node, the achievement of these SDGs would not improve.

In order to analyze the effects of the proposed strategies on the UN's SDGs achievement in the post-COVID-19 era, potential scenarios based on different activation levels of the mentioned strategies are tested. Besides, the implementation of a combination of two and three proposed strategies is also tested and analyzed in this section. The results of these tests are discussed in the following sections.

4.2.1. Activation of Strategy A: Green management

Activation of Strategy A in the designed model considering $L^0_{\mathrm{COVID-19}} = M^+$ leads to the changes shown in Fig. 4. Three different activation levels are considered for Strategy A in this figure. Fig. 4 (a) refers to the low activation level of Strategy A ($L^0_{\mathrm{A}} = L^+$) and shows the negative impact on eight SDGs. By changing the activation level of Strategy A to medium level ($L^0_{\mathrm{A}} = M^+$) in Fig. 4 (c), the number of SDGs with negative relative change reduces to six, and finally, with a high activation level of Strategy A ($L^0_{\mathrm{A}} = H^+$) as illustrated in Fig. 4 (e), the number of SDGs with negative relative change remain unchanged but their relative change declines. In addition, by implementing this strategy, eight SDGs would have a relative positive change. As can be seen, SDG 17 (Partnerships for the other SDGs) experiences the highest relative change in the negative direction by implementing Strategy A.

While considering a high activation level for COVID-19 ($L^0_{\mathrm{COVID-19}} = H^+$), activation of Strategy A at low, medium, and high levels are illustrated in Fig. 4 (b), (d), and (f), respectively. As expected, the number of the SDGs with a negative relative change would increase if the pandemic situation

worsens. Again, SDG 17 shows the highest negative relative change in terms of all the considered activation levels of Strategy A.

Activating Strategy A has an upper-medium relative impact on SDGs 7 (affordable and clean energy), 11 (sustainable cities and communities), and 13, a lower medium relative impact on SDGs 3 (good health and well-being), 6 (clean water and sanitation), 10 (reduced inequalities), and 12 (responsible consumption & production), and a low relative impact on SDGs 14 and 16. Therefore, the achievement of these SDGs improves by activating Strategy A. A notable result is that although SDGs 6 (referring to clean water and sanitation) and 14 (referring to life below water) are slightly affected by this strategy, they have a high positive relative change in practice. In addition, SDGs 6, 7, and 13 with the highest positive relative change remain constant even with the high activation level of the COVID-19 pandemic. The following reasons can describe the obtained results: (i) SDGs 6 (Clean water and sanitation), 7 (Affordable and clean energy), and 13 (Climate action), are mostly affected by government policies rather than COVID-19. Therefore, increasing the activation level of COVID-19 may not change these SDGs significantly; and (ii) both SDG 6 and 14, which are less affected by Strategy A, are about water resources. Although the direct effects of other SDGs on SDGs 6 and 14 are low, their cumulative low indirect effects lead to a significant positive change in these two SDGs.

4.2.2. Activation of Strategy B: *Sustainable food systems*

Implementing Strategy B at a low level ($L_{\mathrm{B}}^{0} = L^{+}$) while assuming that the pandemic situation improves at a medium level ($L_{\mathrm{COVID-19}}^{0} = M^{+}$), leads to relative changes in the SDGs as illustrated in Fig. 5 (a). In this case, eight SDGs would experience a negative relative change among which SDG 17 would face the highest level of change. Applying Strategy B at the medium level reduces

the number of SDGs with negative change and only by considering a high level of activation, six SDGs would experience positive relative changes. Moreover, applying this strategy in the high and medium levels of pandemic and in case of worsening the situation, as illustrated in sections (b), (d), and (f) of Fig. 5, respectively, would affect almost all SDGs negatively.

This strategy has an upper-medium relative impact on SDG 2 (Zero hunger) (upper medium relative impact), a medium relative impact on SDGs 3, a lower medium relative impact on SDGs 10, 12, 13, 14, and 15, and a low relative impact on SDGs 4 and 16. As shown in Fig. 5, activation of this strategy enhances the achievement of SDGs 10, 13, 14, and 15. These SDGs are not subject to negative effects even in the presence of COVID-19 at the high activation level, which corresponds to strongly worsening the pandemic situation. Furthermore, although implementing Strategy B directly affects SDG 2 with a medium to high relative impact, no effect on this SDG can be seen in Fig. 5. This may be because SDG 2 on one hand is mostly affected by SDGs 1, 8, 10, and 16 with an upper-medium level of relative impact, by SDGs 4 and 12 with a medium level of relative impact and eventually, by SDGs 3, 9, 13 and 17 with a low level of relative impact. This SDG on the other hand is imposed to a high negative impact from the pandemic, since the negative impacts of the COVID-19 on the economy affect both the purchasing power of the people and the activities related to the food supply chains. In addition, SDGs 1, 8, and 10, which have the greatest impact on SDG 2, are almost neutral against Strategy B (SDGs 1 and 8) or slightly impacted by this strategy (SDGs 10). Therefore, the accumulation of these effects leads to not observing a significant effect on SDG 2 by implementing Strategy B.

4.2.3. Activation of Strategy C: *Energizing the labor market*

As can be seen in sections (a), (c) and (e) of Fig. 6, by implementing Strategy C while the pandemic situation experiences a medium improvement, a lower number of SDGs would face a negative relative change. Besides, Fig. 6 (b), (d), and (f) indicate that more SDGs would be affected negatively even by implementing this strategy if the pandemic situation becomes worse.

SDGs 1, 5 (Gender equality), 8, 10, and 16 are affected positively by applying Strategy C. Interestingly, positive relative changes are observed in the SDGs that have been directly addressed by this strategy, except SDGs 2 and 3. This result may not be unexpected for SDG 3, since it is weakly influenced by Strategy C. However, it is unexpected regarding SDG 2, which is moderately influenced by Strategy C. The reason for such a result may be the high vulnerability of SDG2 originating from both the pandemic and other political and economic policies. Another notable point regarding this strategy is that SDG1 experiences a positive relative change, which is only achieved by applying Strategy C among all proposed strategies. Therefore, if SDG1 is a priority for policy-makers, special attention should be devoted to implementing Strategy C.

4.2.4. Activation of Strategy D: *Inclusive education*

Sections (b) and (d) of Fig. 7 indicate that all the SDGs experience negative relative changes in the presence of Strategy D ($L_{\mathrm{D}}^{0} = \mathrm{L}^{+}$) or D($L_{\mathrm{D}}^{0} = \mathrm{M}^{+}$), however Strategy D ($L_{\mathrm{D}}^{0} = \mathrm{H}^{+}$) leads to positive relative changes in SDGs 4 and 5. The medium level of COVID-19 affects the SDGs more slightly and lets Strategy D change four SDGs positively, including SDGs 4, 5, 10, and 16. This strategy mainly addresses SDG 4 and to a lesser extent SDGs 5, 10, and 16. As can be seen in Fig. 7, activation of this strategy at the high level leads to positive relative changes in all the mentioned

SDGs. It is noticeable that although SDG 5 is moderately affected by Strategy D, it shows the most positive relative change among the addressed ones. This can be explained by the fact that although Strategy D has the most direct impact on SDG 4 and weak impacts on SDGs 5, 10, and 16, SDGs 4, 10, and 16 have high impacts on SDG 5, which refers to gender equality. Thus, SDG 5 is subject to the direct impact of the inclusive education strategy and the indirect impact received from other addressed SDGs in this strategy. Other mentioned SDGs are weakly influenced by Strategy D and also the other addressed SDGs. Furthermore, the COVID-19 pandemic slightly affects SDG 5 while it has a high negative impact on other SDGs.

4.2.5. Activation of Strategy E: *Supporting research and technology initiatives in the energy sector*

Strategy E is the only strategy among the implemented strategies, which can cause a positive relative change in the SDGs even with a medium activation level (see section (c) of Fig. 8). This strategy leads to a positive relative change in six SDGs, including SDGs 7, 9, 10, 11, 12, and13 in both medium and high activation levels of COVID-19 (see section (e) and (f) of Fig. 8).

Eventually, this strategy results in a positive relative change in SDG 9, which always suffers from negative relative change even in case of implementing Strategies A to D. Also, the positive relative change of SDG 9 against other SDGs with positive relative change (SDGs 7, 9, 10, 11, 12, and 13) is noteworthy. The main reason may be that SDGs 7 and 13 (with high impacts), SDG 9 (with upper medium impact), and SDGs 10, 11, and 12 (with low impacts) are directly influenced by Strategy E. Furthermore, the high impact of SDG 9, which is focussed on the industry, innovation, and infrastructure, from SDG 7 that targets affordable and clean energy intensifies the impact of SDG 9 from the implementation of this strategy.

4.2.6. Activation of a combination of the proposed strategies

In this section, different possible combinations of strategies A, B, C, D, and E are analyzed. Hereon, the M^+activation level of COVID-19 is considered to test different scenarios (combinations of strategies). First, the activation level for all the five strategies is set to be $L^0 =$ L^+. This is because activating each strategy needs a sufficient budget and government supervision and therefore, it is not possible to activate all the strategies simultaneously at the high or medium levels. Activating all the outgoing arcs from the strategy nodes leads to relative changes in the SDGs as shown in Fig. 9. As illustrated in this figure, only the relative change of SDG 13 turns positive and SDGs 1, 8, and 17 remain unchanged. Moreover, a relative improvement is observed in SDG 9, and the negative relative changes of SDGs 5, 6, 10, 12, 14, and 15 disappear. In the next step, all combinations of two strategies are tested for M^+ and H^+ activation levels. As stated previously, it is not possible to activate more than one strategy at a high level. Scenarios based on Strategy A are examined in detail, as an instance to show the analysis approach. Table 4 shows the results of tests for implementing Strategy A and also a combination of Strategy A with other strategies. Results indicate that SDG 1 always experiences a negative relative change except in case of implementing Strategy C ($L_C^0 = H^+$) and also in case of the implementation the combination of Strategy A ($L_A^0 = M^+$) and Strategy C ($L_C^0 = H^+$). Moreover, Table 4 shows that applying the single Strategy A ($L_{\mathrm{A}}^0 = H^+$) affects most of the SDGs. Applying the combination of two strategies that include Strategy A may on one hand cause some positive relative changes to disappear, and on the other hand, eliminate some negative relative changes. Therefore, it can not be concluded that a given scenario is absolutely better than the others. Besides, no synergetic or redundancy relationships are observed between the scenarios presented in this table.

The results of similar tests for the combination of all the proposed strategies are illustrated in Fig. 10. As can be seen in various sections of this figure, the combination of Strategies D and B are not satisfactory in comparison with the other tested strategy combinations. However, the combinations of Strategy A with Strategy B or E are more satisfactory than the others in terms of the improvements in achieving more SDGs. As can be seen, by implementing each combination, the achievement of some SDGs is improved, some are unchanged, and some are worsened. Therefore, policy-makers should select the combination that has the highest favorable effect on the prioritized SDGs with respect to national/international interests.

The effects of implementing a combination of three strategies on the SDGs are also analyzed in this section to provide a clearer picture of the effect of the proposed policies on the SDGs achievement in Iran. In this regard, the implementation of a combination of a given strategy at the medium activation level and two other strategies at the low activation levels are studied to account for the limitations of budget and the government supervision capacity. Table 5 shows the results of simulating the effect of implementing a combination of strategies, which include A(M^+). As can be seen, scenarios $A(M^+)/B(L^+)/C(L^+)$, $A(M^+)/B(L^+)/D(L^+)$ and $A(M^+)/D(L^+)/E(L^+)$ are dominated by other scenarios and should be eliminated from more considerations. Other scenarios reported in the table are temporarily kept to be compared with scenarios analyzed regarding the other strategies. In Table 6, the results of simulating different scenarios comprising of three strategies including Strategy B(M^+) are presented. Only two scenarios are non-dominated in this case, which include $B(M^+)/E(L^+)/A(L^+)$ and $B(M^+)/C(L^+)/D(L^+)$. Scenarios $B(M^+)/E(L^+)/C(L^+)$ and $B(M^+)/A(L^+)/C(L^+)$ show the same results as $B(M^+)/E(L^+)/D(L^+)$ and $B(M^+)/A(L^+)/D(L^+)$, respectively. However, all of them are dominated scenarios. Table 7 shows the simulation results for the scenarios composed of three strategies including C(M^+) . As

can be seen, scenarios $C(M^+)/A(L^+)/B(L^+)$, $C(M^+)/A(L^+)/E(L^+)$ and $C(M^+)/B(L^+)/E(L^+)$ are non-dominated. This indicates that combinations of Strategy D do not result in positive changes. In table 8, simulation results are provided for scenarios composed of three strategies based on D(M^+), where scenarios $D(M^+)/A(L^+)/B(L^+)$ and $D(M^+)/A(L^+)/E(L^+)$ are non-dominated. And finally, Table 9 presents scenarios that are composed of three strategies considering E(M^+). Scenarios $E(M^+)/A(L^+)/B(L^+)$ and $E(M^+)/D(L^+)/C(L^+)$ are non-dominated ones based on the results of this table. According to the analyses results provided in Tables 5-9, most scenarios are dominated and should be eliminated from further considerations. Non-dominated scenarios obtained from each table are collected and compared with each other to find ultimate non-dominated scenarios, which include D(L^+)/C(L^+)/A(M^+), C(M^+)/B(L^+)/A(L^+), A(L^+)/C(M^+)/E(L^+), E(L^+)/C(M^+)/B(L^+), E(M^+)/B(L^+)/ $A(L^+)$, and E(M^+)/D(L^+)/C(L^+). Analysis of the results obtained from the simulation of scenarios comprising of three strategies shows that the scenarios based on Strategy B($L_B^0 = M^+$) or D($L_D^0 = M^+$) are totally dominated by other scenarios, while the ones based on Strategy C($L_C^0 = M^+$) have the most non-dominated outcomes.

Comparison of the results obtained from the analysis of the implementation of one, two, and three strategies in the presence of the COVID-19 pandemic shows that activating two strategies at high and medium levels instead of one strategy at the high level does not necessarily lead to a significant improvement. This is also true about the results of combining three strategies in comparison with single strategy implementation. Moreover, the results of implementing a combination of three strategies are poorer than the implementation of two strategies or a single one. More specifically, the analysis in this section revealed that Strategy E has a crucial effect on the achievement of SDG 9 (Industry, innovation, and infrastructure), while other scenarios can not make any changes in the

453 achievement of this SDG. Applying Strategy E($L_{\mathrm{E}}^{0} = M^{+}$) improves the achievement of SDG 9,
454 but the relative change of this SDG remains negative. To achieve a positive relative change in this
455 SDG, only the single Strategy E($L_{\mathrm{E}}^{0} = H^{+}$) should be implemented. Therefore, results confirm
456 that focusing on the implementation of a single strategy provides better performance in the
457 achievement of SDGs post COVID-19 pandemic in comparison with the combination of two or
458 three strategies at low levels.

459 5. Concluding remarks

460 Implementation of international agreements such as the UN's 2030 Agenda for Sustainable
461 Development needs cooperation between different sectors of societies within a system as a whole.
462 Due to the significant effects of the COVID-19 restrictions on the 2030 Agenda and the
463 achievement of its associated SDGs, this research was carried out to support the SDGs
464 achievement post COVID-19 in Iran, as a developing country. Applying a qualitative FCM-based
465 method, the following steps were taken and results were obtained. (1) the key interconnections
466 among the SDGs were specified; (2) potential effects of COVID-19 on the SDGs achievement
467 were synthesized; (3) five strategies were considered, and for each strategy, three scenarios
468 considering different levels of COVID-19 effects were simulated aiming to reduce the negative
469 effects of COVID-19 on the SDGs achievement. Many other scenarios were also considered by
470 combining two or three of the proposed strategies with different activation levels. These strategies
471 include *green management*, *sustainable food systems*, *energizing the labor market*, *inclusive*
472 *education*, and *supporting research and technology initiatives in the energy sector*. Simulations
473 showed that applying each of the five considered strategies or their combination would mitigate
474 the effect of COVID-19 on the SDGs just in case of the medium pandemic level. The outcome of

applying these strategies would be more challenging if the pandemic crisis level goes up drastically. Findings also illustrate that implementing a single strategy at a high activation level leads to better outcomes on the SDGs achievement rather than activating the combinational strategies in low or medium activation levels. Applying a combination of two or more strategies, having a predetermined and restricted budget and governmental supervision, results in less influence on the SDGs. The outcomes of our study, contribute remarkably to the post-COVID-19 recovery action plan for the 2030 Agenda for Sustainable Development in Iran, with a special focus on the SDGs.

Nevertheless, our research comes with some limitations. First, due to the lack of reliable quantitative data, a qualitative simulation modeling approach was adopted. Therefore, conducting quantitative and mathematical modeling with adequate and reliable data is recommended for further studies. Second, this research focused on the 2030 Agenda for Sustainable Development only at the SDGs level of analysis. Further research is recommended to be carried out on the targets and their specific indicators, as well. Third, the case of our study was Iran, as a developing country in the Middle East. The same research for the other developing countries or even less-developed countries is recommended for making a comparison between the results and evaluating the generalizability of the considered policies in our research. Finally, the scope of our research was the whole 17 SDGs to identify SDGs affected by COVID-19. More in-depth studies on the effects of the pandemic on each one of the identified SDGs affected by COVID-19 in our research are encouraged to be conducted to provide a better understanding and develop suitable recovery strategies.

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Figure Captions

688 **Fig. 1.** Research framework

689 **Fig. 2.** The designed FCM diagraph

690 **Fig. 3.** Relative change of SDGs considering different levels of activation for COVID-19

691 **Fig. 4.** Relative changes of SDGs considering different activation levels for COVID-19 and
692 Strategy A

693 **Fig. 5.** Relative changes of SDGs considering different activation levels for COVID-19 and
694 Strategy B

695 **Fig. 6.** Relative changes of SDGs considering different activation levels for COVID-19 and
696 Strategy C

697 **Fig. 7.** Relative changes of SDGs considering different activation levels for COVID-19 and
698 Strategy D

699 **Fig. 8.** Relative changes of SDGs considering different activation levels for COVID-19 and
700 Strategy E

701 **Fig. 9.** Relative changes of SDGs considering $L^0_{\mathrm{COVID-19}} = M^+$ and $L^0 = L^+$ for the strategies

702 **Fig. 10.** Relative changes of SDGs considering $L^0_{\mathrm{COVID-19}} = M^+$ and combinations of two
703 strategies with different activation levels

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705

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Table Captions

Table 1. Linguistic terms and corresponding TFN for the weight of relationships between each pair of SDGs

Table 2. Expert panel characteristics

Table 3. Type and metrics of the model components

Table 4. Summary of the SDGs relative changes in the studied scenarios involving Strategy A

Table 5. Applying Strategy A at the medium level and two other strategies at the low level

Table 6. Applying Strategy B at the medium level and two other strategies at the low level

Table 7. Applying Strategy C at the medium level and two other strategies at the low level

Table 8. Applying Strategy D at the medium level and two other strategies at the low level

Table 9. Applying Strategy E at the medium level and two other strategies at the low level

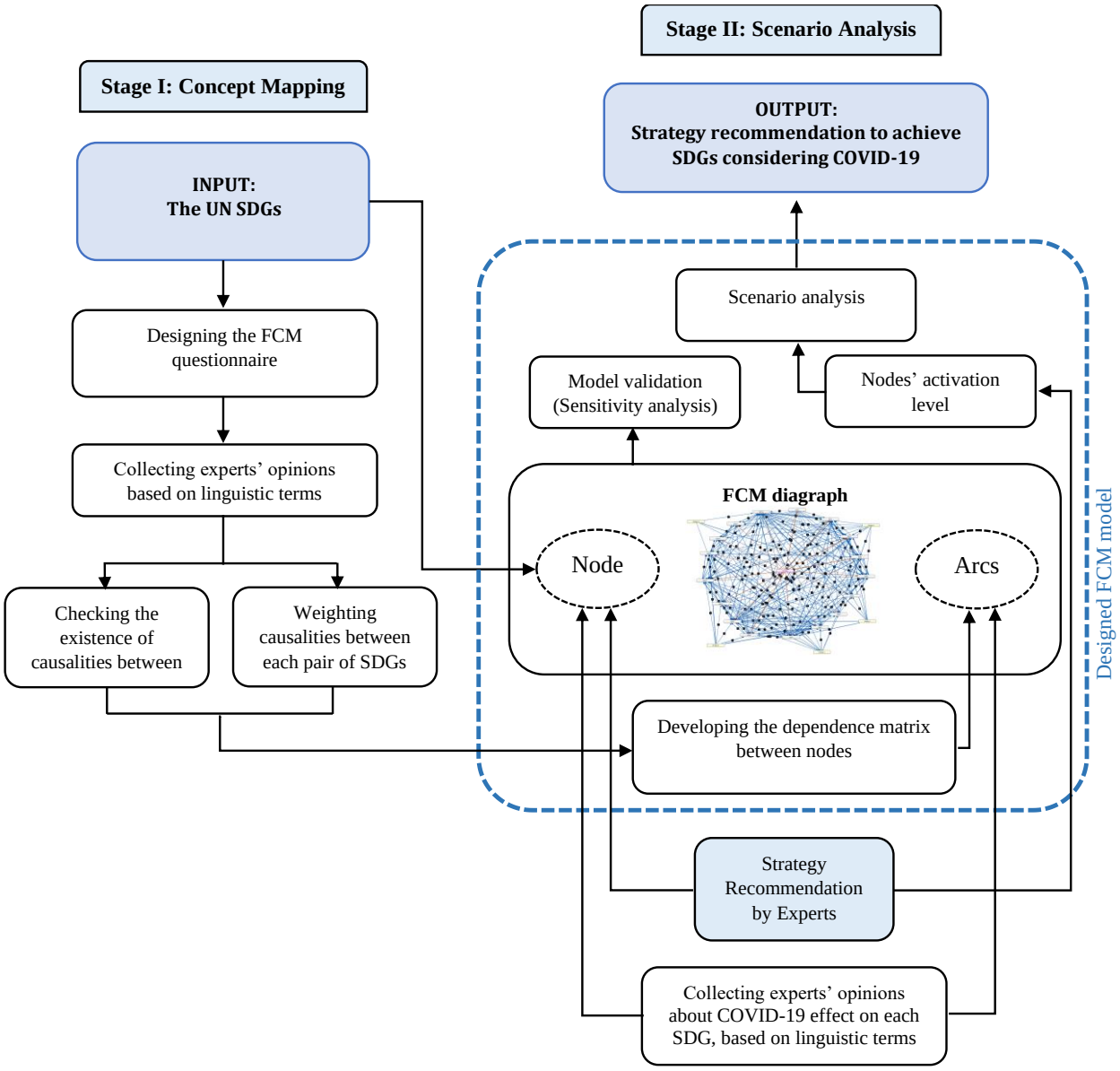

Stage II: Scenario Analysis
Stage I: Concept Mapping
OUTPUT:
Strategy recommendation to achieve SDGs considering COVID-19
INPUT:
The UN SDGs
Scenario analysis
Designing the FCM questionnaire
Model validation (Sensitivity analysis)
Nodes' activation level
Collecting experts' opinions based on linguistic terms
FCM diagraph
Node
Arcs
Checking the existence of causalities between
Weighting causalities between each pair of SDGs
Developing the dependence matrix between nodes
Designed FCM model
Strategy Recommendation by Experts
Collecting experts' opinions about COVID-19 effect on each SDG, based on linguistic terms

Figure 1

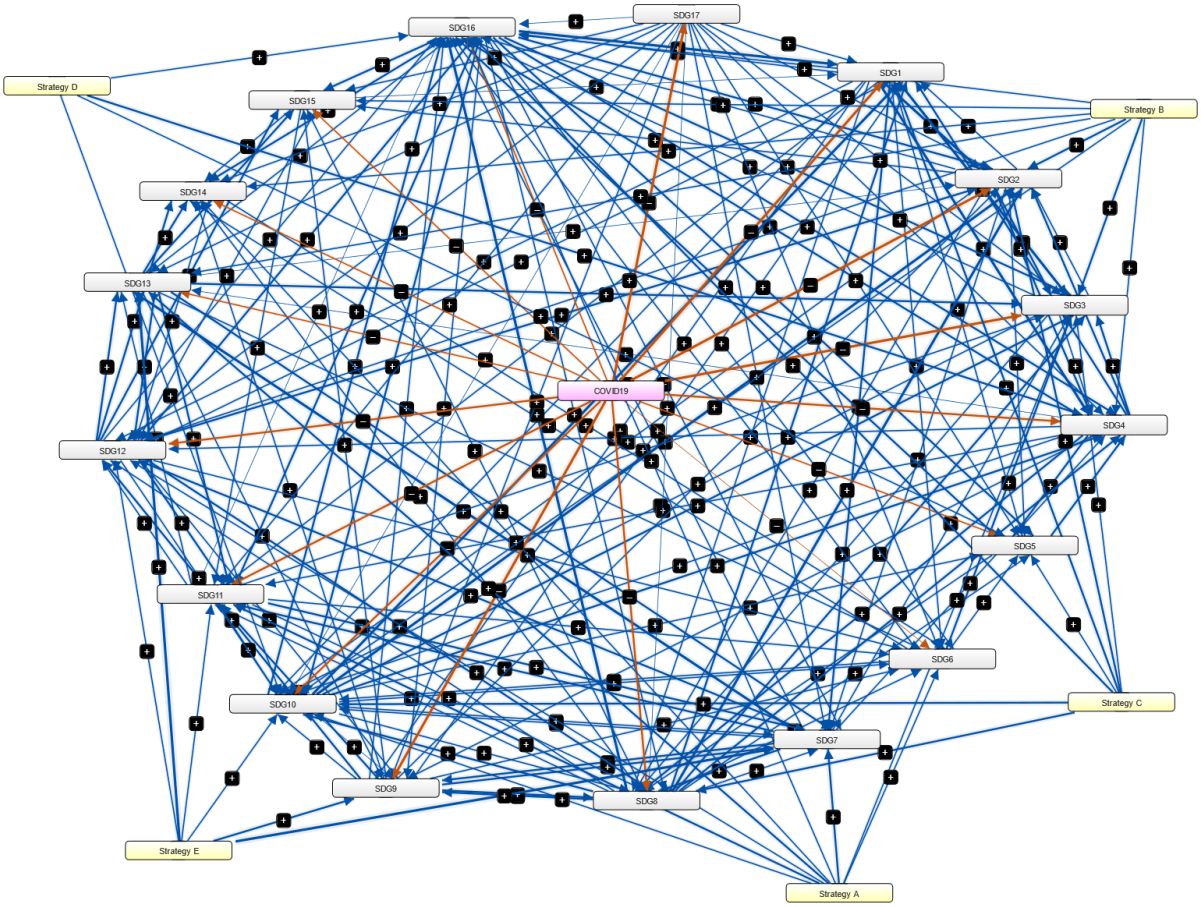
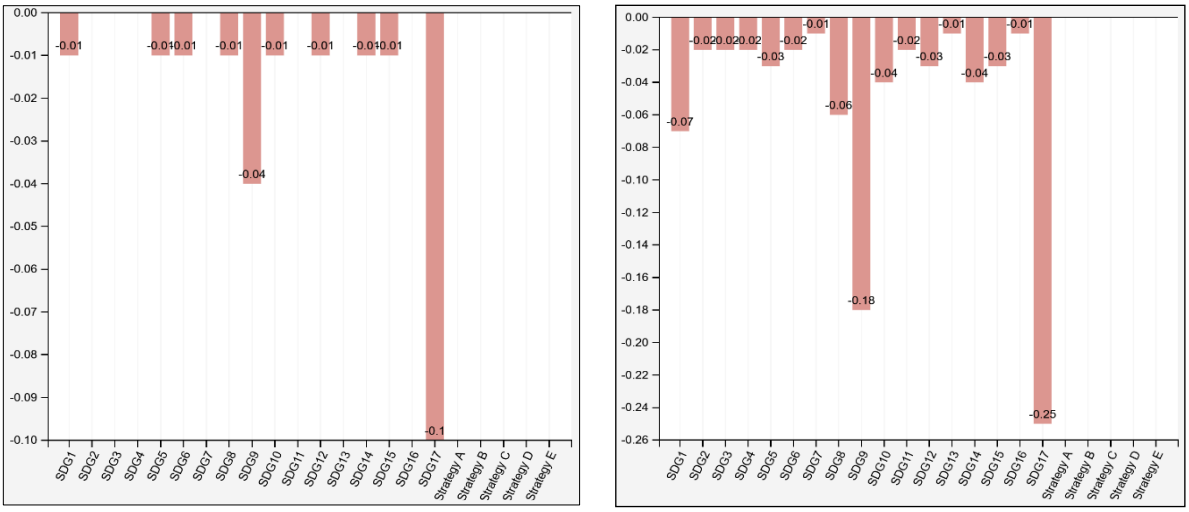
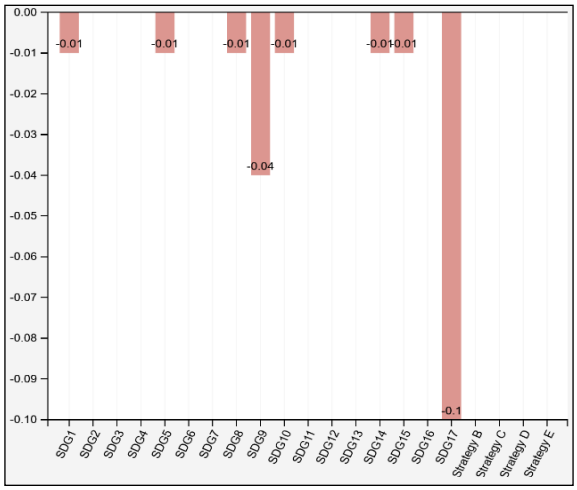

SDG17
SDG16
SDG1
Strategy D
SDG15
Strategy B
SDG2
SDG14
SDG13
SDG3
COVID19
SDG4
SDG12
SDG5
SDG11
SDG6
SDG10
Strategy C
SDG7
SDG9
SDG8
Strategy E
Strategy A

Figure 2

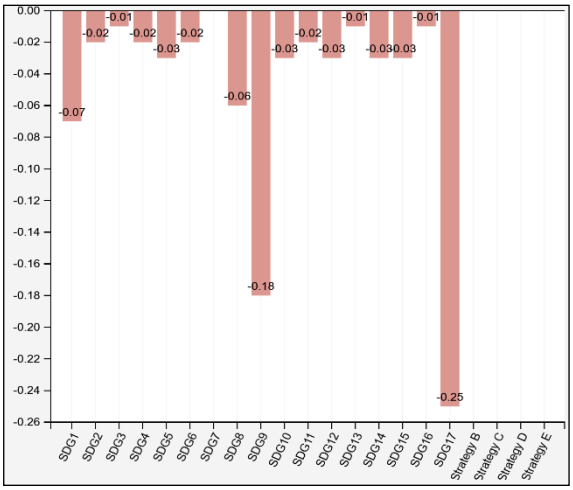


(a) $L^0_{\text{COVID}-19} = M^+$ (b) $L^0_{\text{COVID}-19} = H^+$

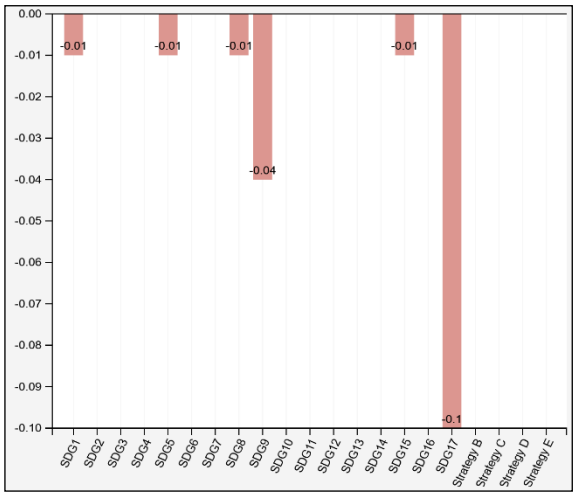
Figure 3



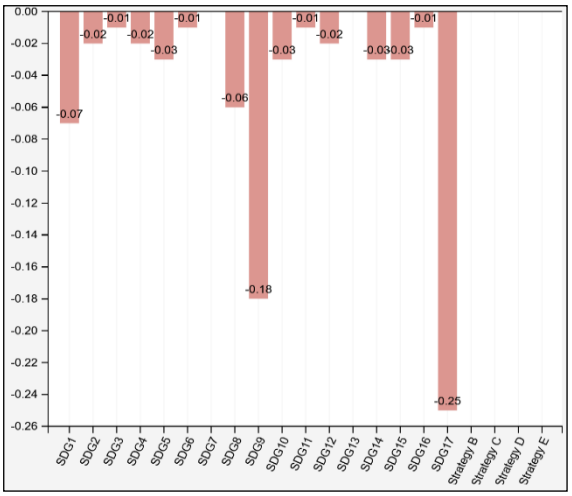
(a) $L^0_{\mathrm{COVID-19}} = M^+, L^0_{\mathrm{A}} = \mathrm{L}^+$



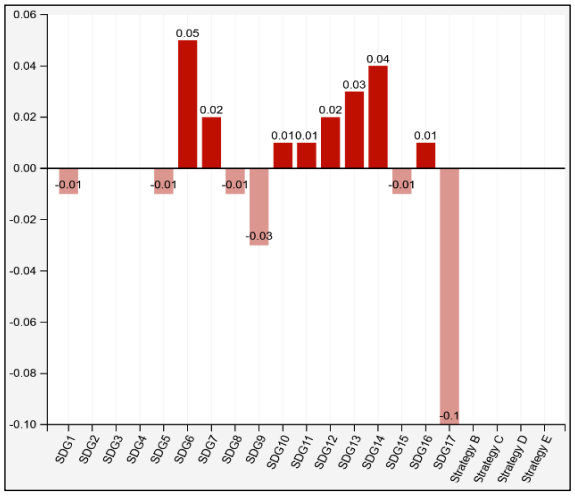
(b) $L^0_{\mathrm{COVID-19}} = H^+, L^0_{\mathrm{A}} = \mathrm{L}^+$



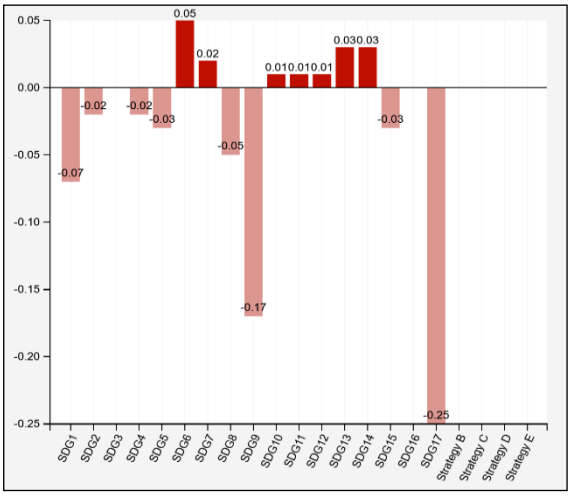
(c) $L^0_{\mathrm{COVID-19}} = M^+, L^0_{\mathrm{A}} = \mathrm{M}^+$



(d) $L^0_{\mathrm{COVID-19}} = H^+, L^0_{\mathrm{A}} = \mathrm{M}^+$

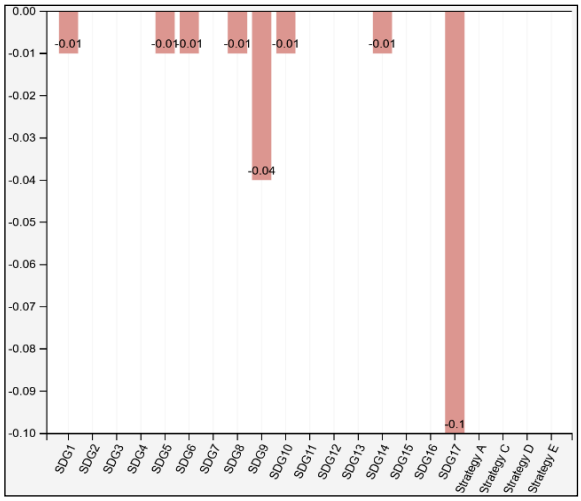


(e) $L^0_{\mathrm{COVID-19}} = M^+, L^0_A = \mathrm{H}^+$

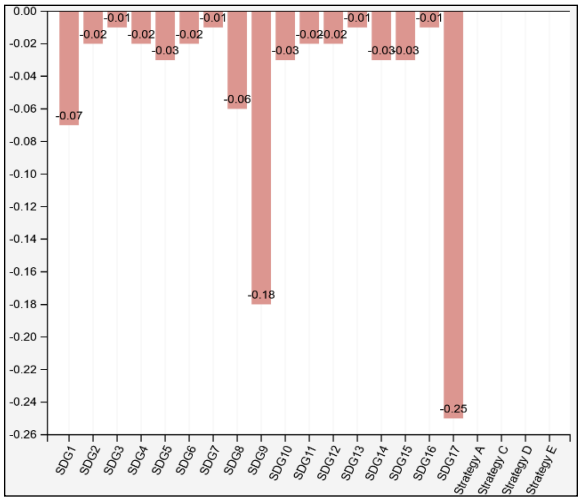


(f) $L^0_{\mathrm{COVID-19}} = H^+, L^0_A = \mathrm{H}^+$

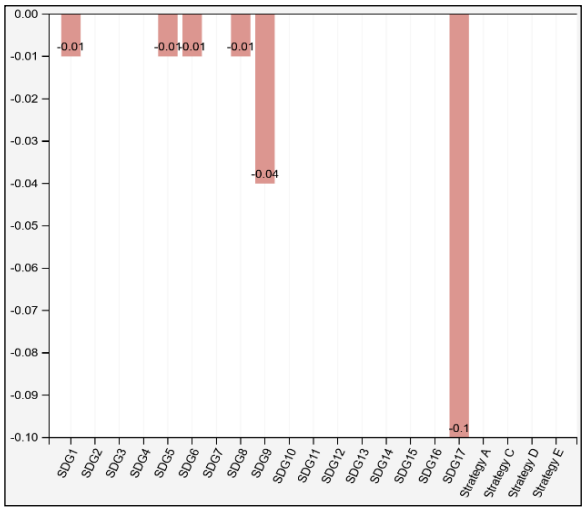
Figure 4



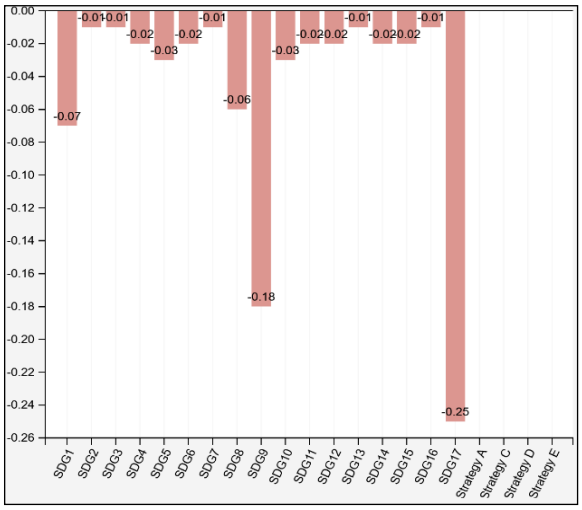
(a) $L^0_{\mathrm{COVID-19}} = M^+, L^0_{\mathrm{B}} = \mathrm{L}^+$



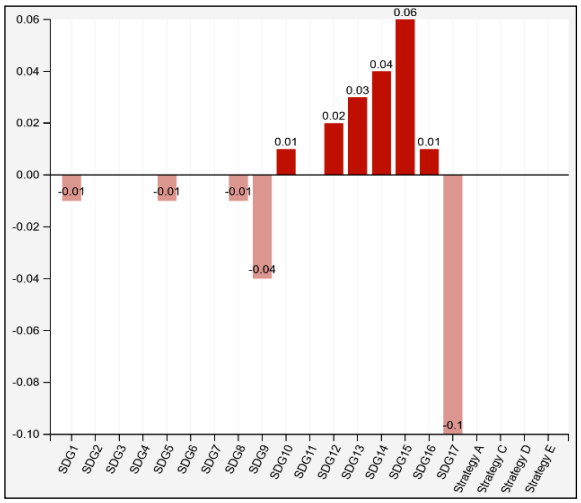
(b) $L^0_{\mathrm{COVID-19}} = H^+, L^0_{\mathrm{B}} = \mathrm{L}^+$



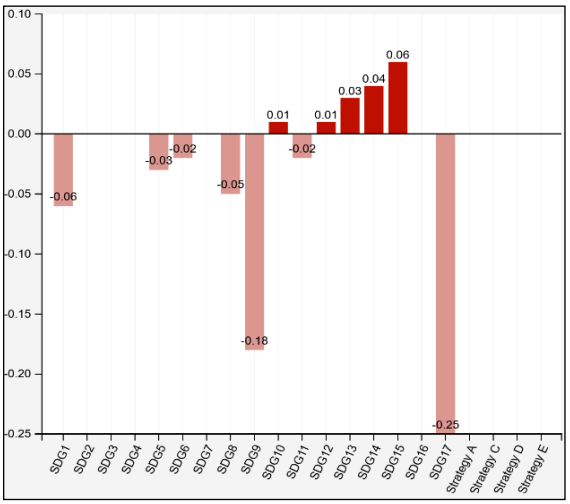
(c) $L^0_{\mathrm{COVID-19}} = M^+, L^0_{B} = \mathrm{M}^+$



(d) $L^0_{\mathrm{COVID-19}} = H^+, L^0_{\mathrm{B}} = \mathrm{M}^+$

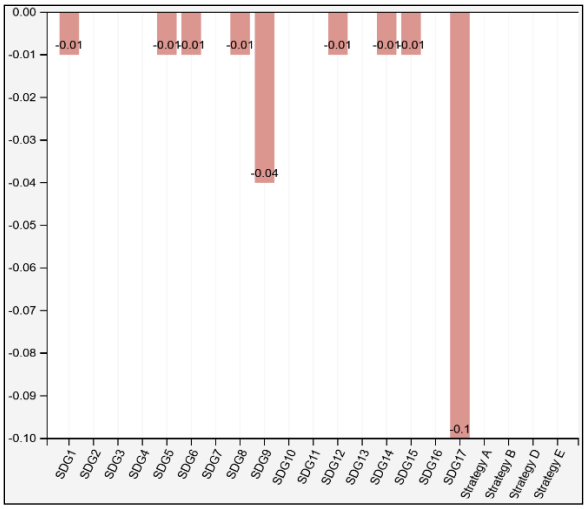


(e) $L^0_{\mathrm{COVID-19}} = M^+, L^0_{B} = \mathrm{H}^+$

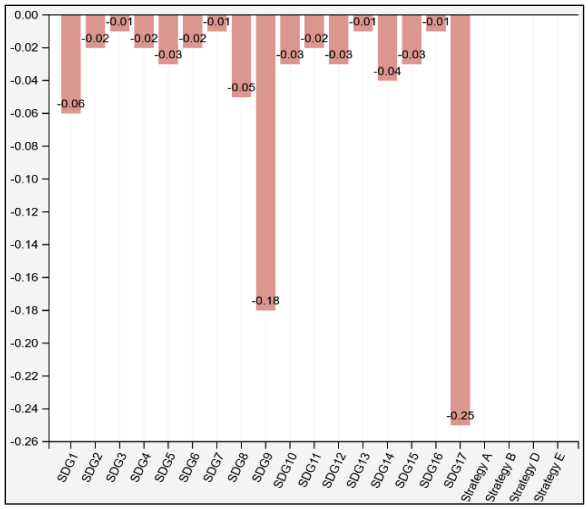


(f) $L^0_{\mathrm{COVID-19}} = H^+, L^0_{B} = \mathrm{H}^+$

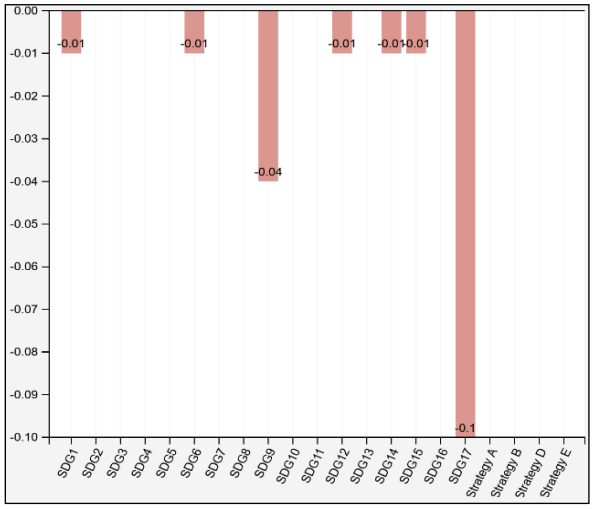
Figure 5



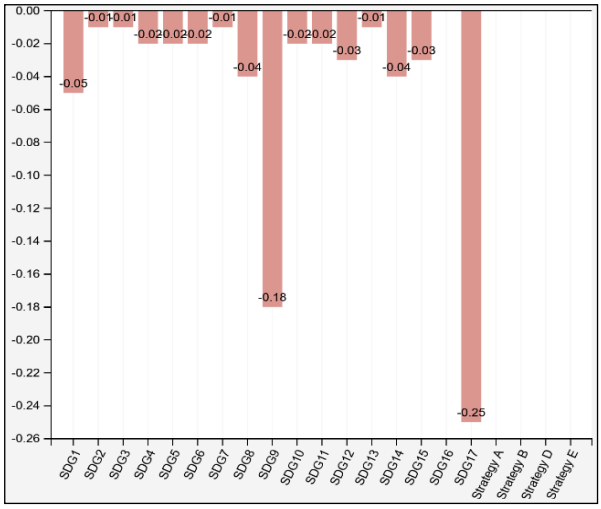
(a) $L^0_{\mathrm{COVID-19}} = M^+, L^0_{\mathrm{C}} = \mathrm{L}^+$



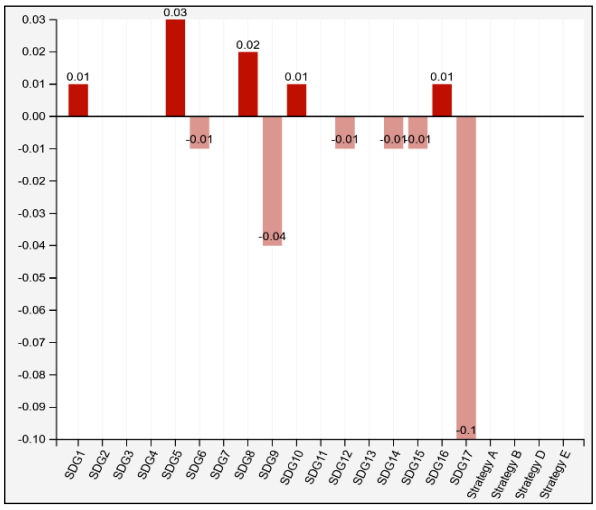
(b) $L^0_{\mathrm{COVID-19}} = H^+, L^0_{\mathrm{C}} = \mathrm{L}^+$



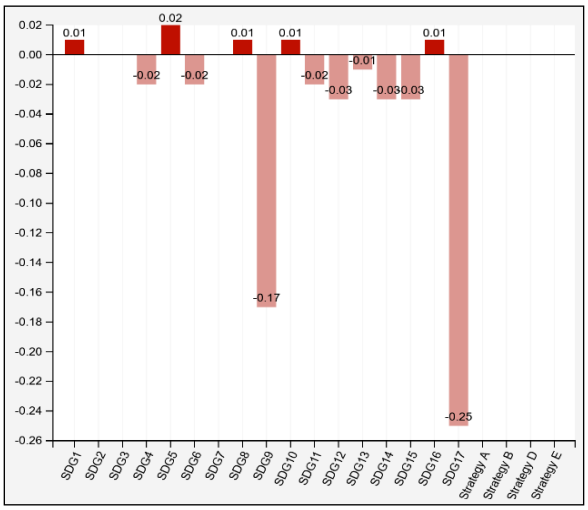
(c) $L^0_{\mathrm{COVID-19}} = M^+, L^0_{\mathrm{C}} = \mathrm{M}^+$



(d) $L^0_{\mathrm{COVID-19}} = H^+, L^0_{\mathrm{C}} = \mathrm{M}^+$

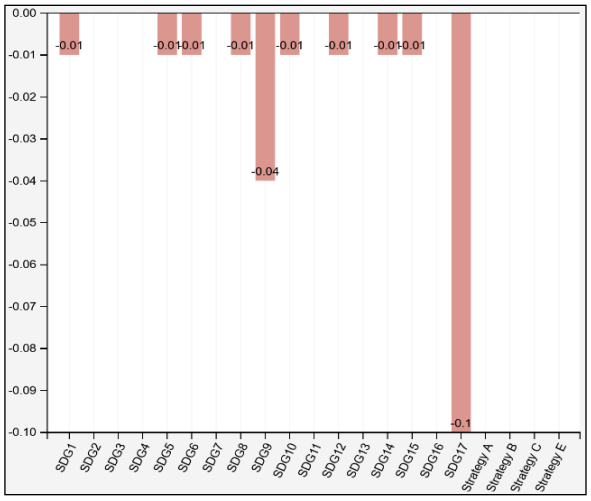


(e) $L^0_{\mathrm{COVID-19}} = M^+, L^0_{\mathrm{C}} = \mathrm{H}^+$

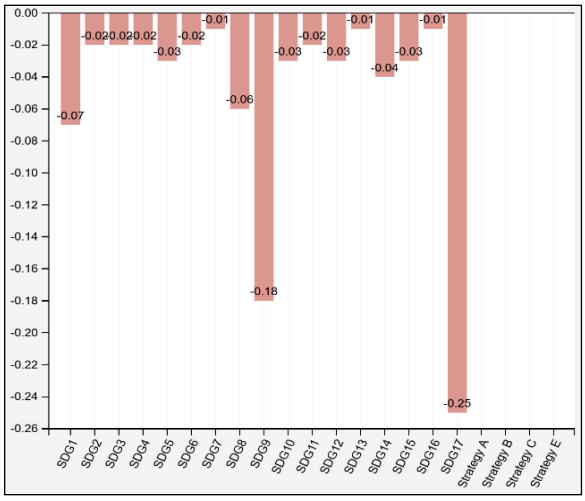


(f) $L^0_{\mathrm{COVID-19}} = H^+, L^0_{\mathrm{C}} = \mathrm{H}^+$

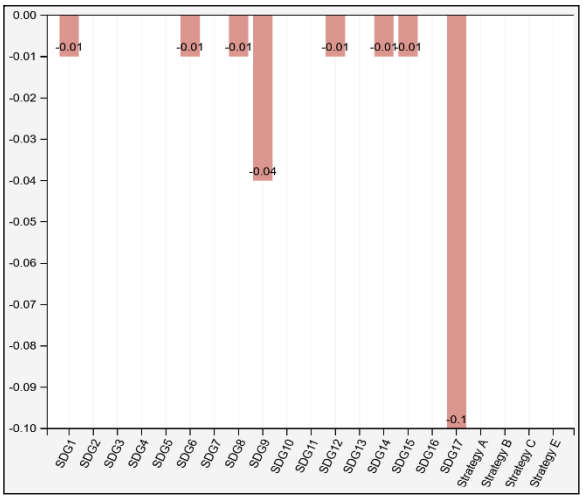
Figure 6



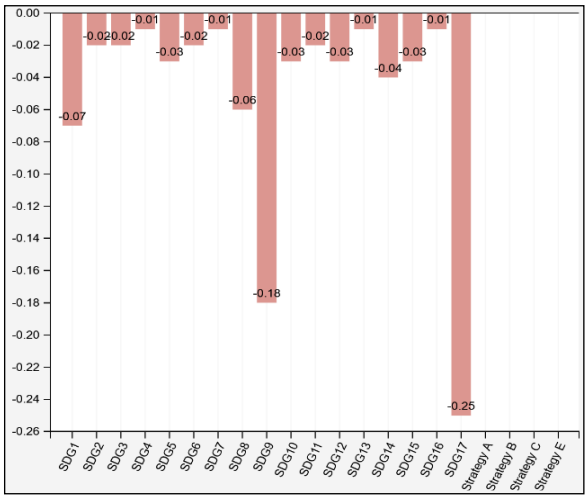
(a) $L^0_{\mathrm{COVID-19}} = M^+, L^0_{\mathrm{D}} = \mathrm{L}^+$



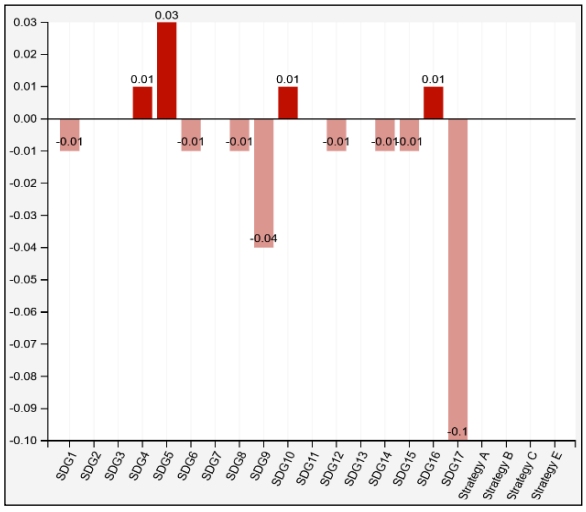
(b) $L^0_{\mathrm{COVID-19}} = H^+, L^0_{\mathrm{D}} = \mathrm{L}^+$



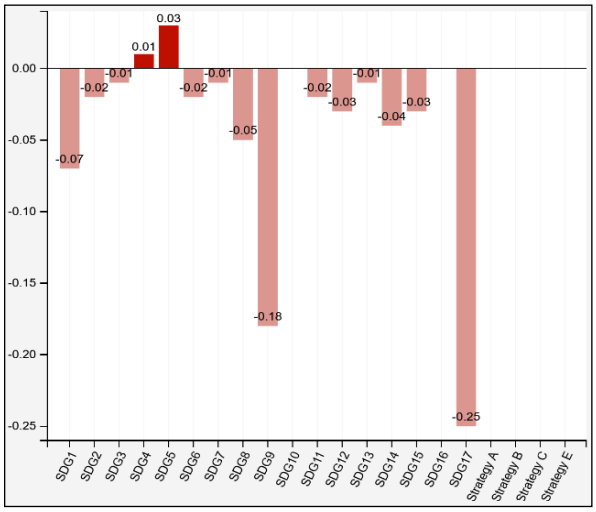
(c) $L^0_{\mathrm{COVID-19}} = M^+, L^0_{\mathrm{D}} = \mathrm{M}^+$



(d) $L^0_{\mathrm{COVID-19}} = H^+, L^0_{\mathrm{D}} = \mathrm{M}^+$

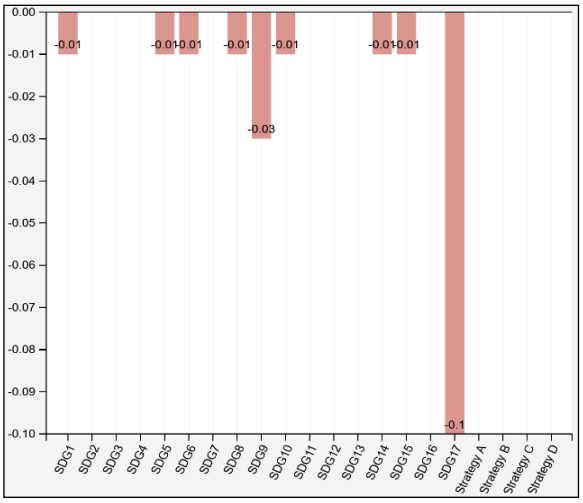


(e) $L^0_{\mathrm{COVID-19}} = M^+, L^0_{\mathrm{D}} = \mathrm{H}^+$

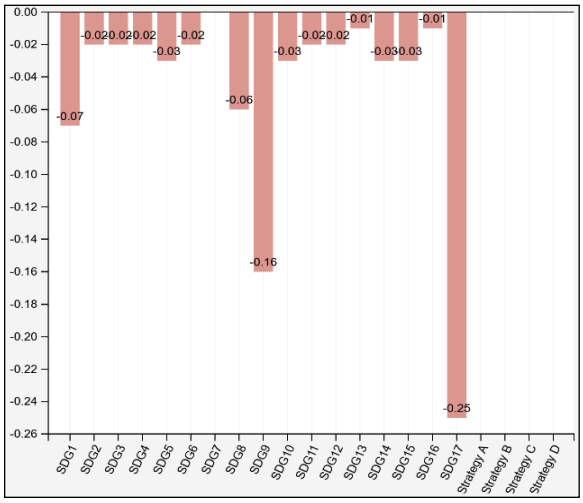


(f) $L^0_{\mathrm{COVID-19}} = H^+, L^0_{\mathrm{D}} = \mathrm{H}^+$

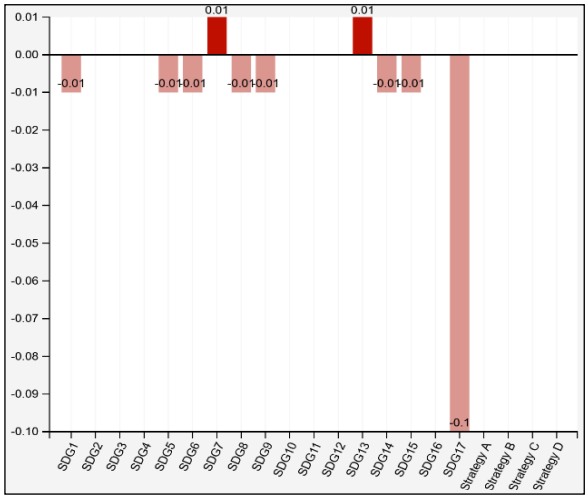
Figure 7



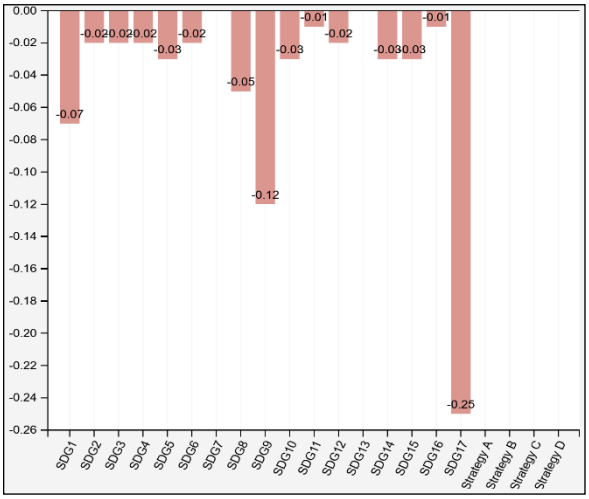
(a) $L^0_{\text{COVID}-19} = M^+, L^0_E = \text{L}^+$



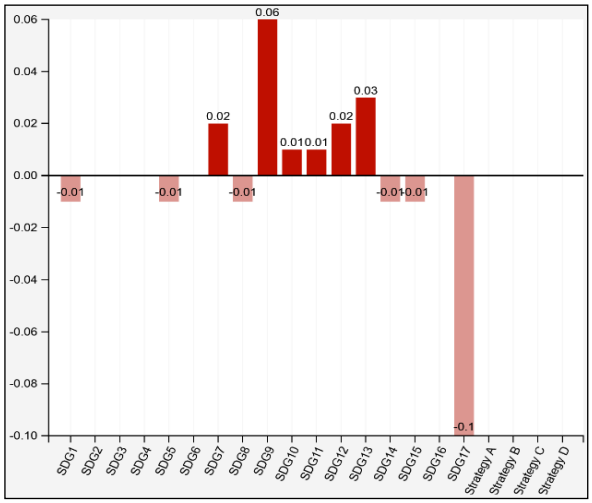
(b) $L^0_{\text{COVID}-19} = H^+, L^0_E = \text{L}^+$



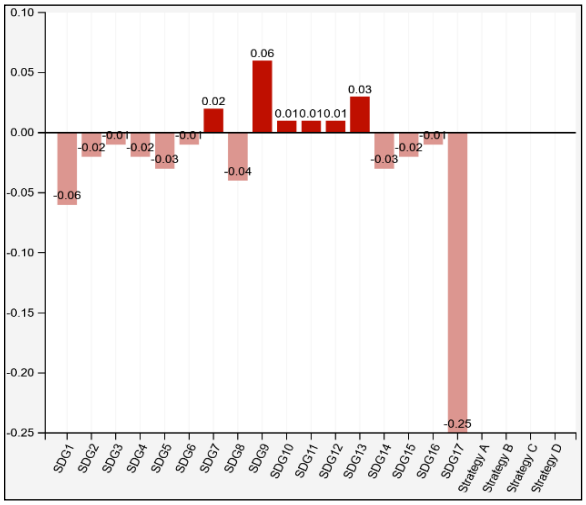
(c) $L^0_{\text{COVID}-19} = M^+, L^0_{\text{E}} = \text{M}^+$



(d) $L^0_{\text{COVID}-19} = H^+, L^0_{\text{E}} = \text{M}^+$

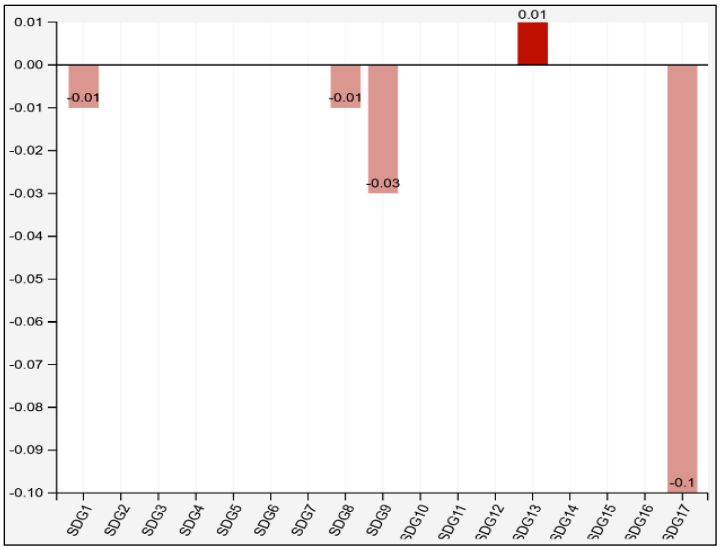


(e) $L^0_{\text{COVID}-19} = M^+, L^0_E = \text{H}^+$



(f) $L^0_{\text{COVID}-19} = H^+, L^0_{\text{E}} = \text{H}^+$

Figure 8


0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.01
-0.01
-0.03
0.01
-0.1
SDG1
SDG2
SDG3
SDG4
SDG5
SDG6
SDG7
SDG8
SDG9
SDG10
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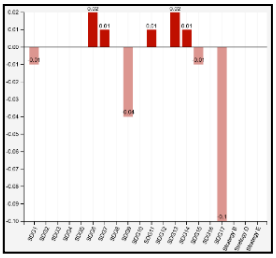
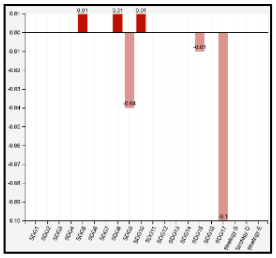
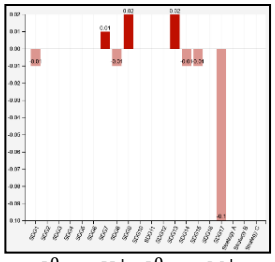
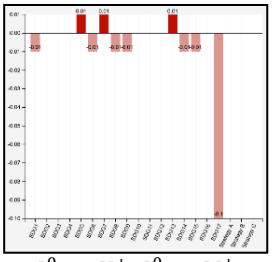
SDG13
SDG14
SDG15
SDG16
SDG17

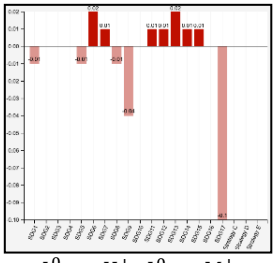
Figure 9

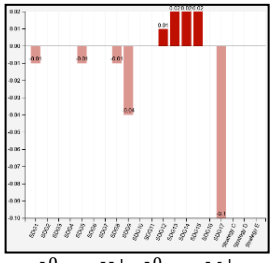

$L_{\mathrm{A}}^{0} = H^{+}, L_{\mathrm{C}}^{0} = \mathrm{M}^{+}$

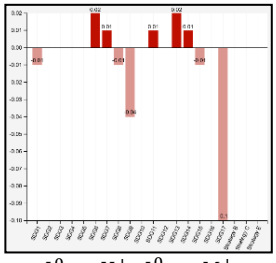

$L_{\mathrm{A}}^{0} = M^{+}, L_{\mathrm{C}}^{0} = \mathrm{H}^{+}$

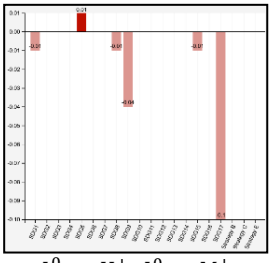

$L_{\mathrm{E}}^{0} = H^{+}, L_{\mathrm{D}}^{0} = M^{+}$

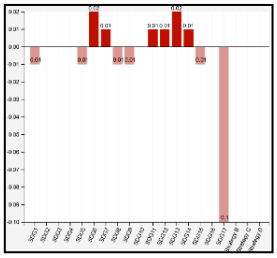

$L_{\mathrm{D}}^{0} = H^{+}, L_{\mathrm{E}}^{0} = M^{+}$

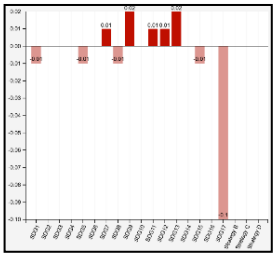

$L_{\mathrm{A}}^{0} = H^{+}, L_{B}^{0} = M^{+}$

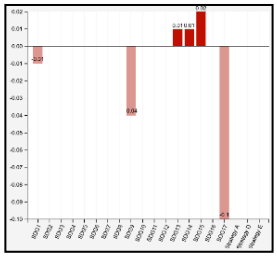

$L_{\mathrm{B}}^{0} = H^{+}, L_{\mathrm{A}}^{0} = M^{+}$

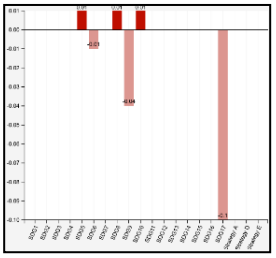

$L_{A}^{0} = H^{+}, L_{\mathrm{D}}^{0} = M^{+}$

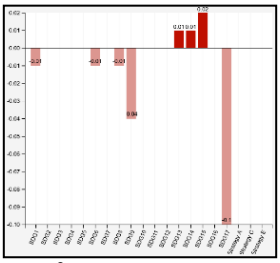

$L_{\mathrm{D}}^{0} = H^{+}, L_{A}^{0} = M^{+}$

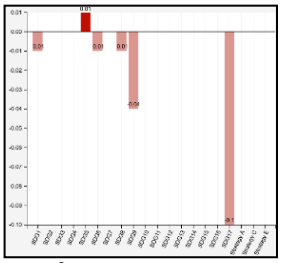

$L_{A}^{0} = H^{+}, L_{\mathrm{E}}^{0} = M^{+}$

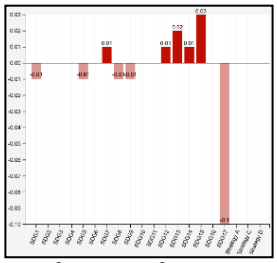

$L_{E}^{0} = H^{+}, L_{A}^{0} = M^{+}$

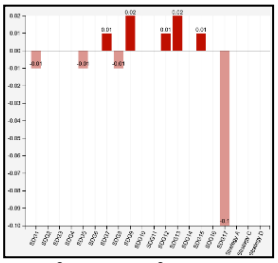

$L_{\mathrm{B}}^{0} = H^{+}, L_{\mathrm{C}}^{0} = M^{+}$

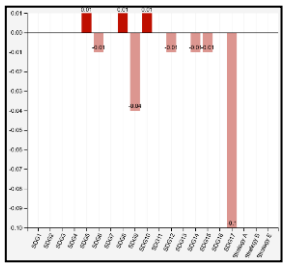

$L_{\mathrm{C}}^{0} = H^{+}, L_{B}^{0} = M^{+}$

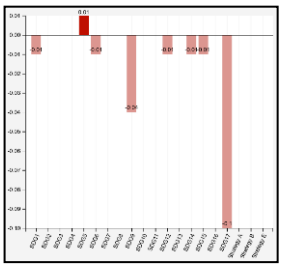

$L_{\mathrm{D}}^{0} = M^{+}, L_{B}^{0} = H^{+}$

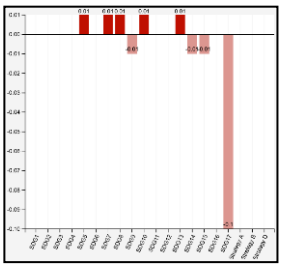

$L_{\mathrm{D}}^{0} = H^{+}, L_{B}^{0} = M^{+}$


$L_{E}^{0} = M^{+}, L_{B}^{0} = H^{+}$


$L_{E}^{0} = H^{+}, L_{B}^{0} = M^{+}$


$L_{\mathrm{C}}^{0} = H^{+}, L_{\mathrm{D}}^{0} = M^{+}$


$L_{\mathrm{D}}^{0} = H^{+}, L_{\mathrm{C}}^{0} = M^{+}$


$L_{E}^{0} = M^{+}, L_{\mathrm{C}}^{0} = H^{+}$

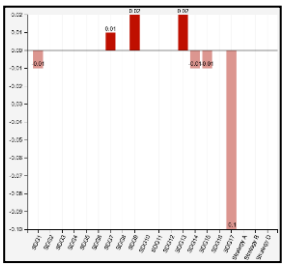

$L_{E}^{0} = H^{+}, L_{\mathrm{C}}^{0} = M^{+}$

Figure 10

Table 1

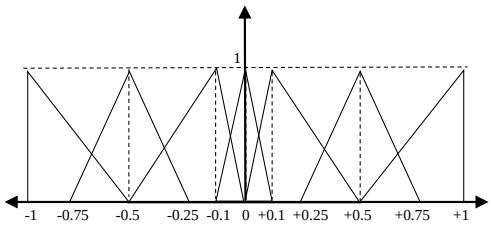
Linguistic term	Corresponding TFN	TFN for the considered seven-point scale questionnaire
High- negative (H^-)	(-1, -1, -0.75)	
Medium- negative (M^-)	(-0.75, -0.5, -0.25)	
Low- negative (L^-)	(-0.5, -0.1, 0)	
No effect (N)	(-0.1, 0, +0.1)	
Low- positive (L^+)	(0, +0.1, +0.5)	
Medium- positive (M^+)	(+0.25, +0.5, +0.75)	
High- positive (H^+)	(+0.5 +1, +1)	

Table 2

Field of activity	Academia/ research center	Industry / NGOs	Social media	Government sector	**Average years of work experience**
Environment	1		1		14.5
Energy		1		2	13.3
Economy	1		1		8.5
Education				1	8
Women's rights	1				6
No. of experts	3	1	2	3	

Table 3

Component	Type	Indegree Index	Outdegree Index	Centrality Index
SDG1- No poverty	Ordinary	6.10	5.70	11.80
SDG2- Zero hunger	Ordinary	8.00	3.00	11.00
SDG3- Good health and well-being	Ordinary	8.10	1.20	9.30
SDG4- Quality education	Ordinary	6.70	4.4	11.10
SDG5- Gender equality	Ordinary	3.55	1.50	5.05
SDG6- Clean water and sanitation	Ordinary	3.29	1.70	4.99
SDG7- Affordable and clean energy	Ordinary	5.10	4.80	9.90
SDG8- Decent work and economic growth	Ordinary	5.49	7.30	12.80
SDG9- Industry, innovation, and infrastructure	Ordinary	4.80	4.20	9.00
SDG10- Reduced inequalities	Ordinary	6.60	4.79	11.39
SDG11- Sustainable cities and communities	Ordinary	5.70	2.40	8.10
SDG12- Responsible consumption & production	Ordinary	5.50	4.80	10.30
SDG13- Climate action	Ordinary	5.00	4.99	10.00
SDG14- Life below water	Ordinary	3.90	0.40	4.30
SDG15- Life on land	Ordinary	3.30	0.70	4.00
SDG16- Peace, justice & strong institutions	Ordinary	6.39	7.80	14.20
SDG17- Partnerships for the goals	Ordinary	0.90	3.60	4.50
COVID-19	Driver	0	9.75	9.75
Strategy A- Green management	Driver	0	3.35	3.35
Strategy B- Sustainable food systems	Driver	0	3.45	3.45
Strategy C- Energizing the labor market	Driver	0	3.40	3.40
Strategy D- Inclusive education	Driver	0	1.60	1.60
Strategy E- Supporting research and technology initiatives in the energy sector	Driver	0	3.59	3.59

Table 4

	$L^0_{COVID-19} = M^+$	$L^0_A = L^+$	$L^0_A = M^+$	$L^0_A = H^+$	$L^0_A = H^+$, $L^0_C = M^+$	$L^0_A = M^+$, $L^0_C = H^+$	$L^0_A = H^+$, $L^0_B = M^+$	$L^0_A = M^+$, $L^0_B = H^+$	$L^0_A = H^+$, $L^0_D = M^+$	$L^0_A = M^+$, $L^0_D = H^+$	$L^0_A = H^+$, $L^0_E = M^+$	$L^0_A = M^+$, $L^0_E = H^+$
SDG1	-0.01	-0.01	-0.01	-0.01	-0.01	0	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
SDG2												
SDG3												
SDG4												
SDG5	-0.01	-0.01	-0.01	-0.01		0.01	-0.01	-0.01		0.01	-0.01	-0.01
SDG6	-0.01			0.05	0.02		0.02		0.02		0.02	
SDG7				0.02	0.01		0.01		0.01		0.01	0.01
SDG8	-0.01	-0.01	-0.01	-0.01		0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
SDG9	-0.04	-0.04	-0.04	-0.03	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.01	-0.02
SDG10	-0.01		0.01		0.01							
SDG11				0.01	0.01		0.01	0.01	0.01		0.01	0.01
SDG12	-0.01			0.02			0.01	0.02			0.01	0.01
SDG13				0.03	0.02		0.02	0.02	0.02		0.02	0.02
SDG14	-0.01	-0.01		0.04	0.01		0.01	0.02	0.01		0.01	
SDG15	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.01		-0.01	-0.01	-0.01	-0.01
SDG16				0.01								
SDG17	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1

Table 5

	A B C	A B E	A B D	A C D	A C E	A D E
SDG1	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
SDG2						
SDG3						
SDG4						
SDG5	-0.01	-0.01	-0.01		-0.01	-0.01
SDG6				0.05		
SDG7		0.01			0.01	0.01
SDG8	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
SDG9	-0.04	-0.03	-0.04	-0.04	-0.02	-0.03
SDG10						
SDG11						
SDG12						
SDG13	0.01	0.01	0.01		0.01	0.01
SDG14						
SDG15				-0.01	-0.01	-0.01
SDG16						
SDG17	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1

Table 6

	A B C	A B E	A B D	B C D	B C E	B D E
SDG1	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
SDG2						
SDG3						
SDG4						
SDG5	-0.01	-0.01	-0.01		-0.01	-0.01
SDG6				-0.01	-0.01	-0.01
SDG7						
SDG8	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
SDG9	-0.04	-0.04	-0.03	-0.04	-0.03	-0.03
SDG10						
SDG11						
SDG12						
SDG13			0.01		0.01	0.01
SDG14						
SDG15						
SDG16						
SDG17	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1

Table 7

	A B C	A C D	A C E	B C D	B C E	C D E
SDG1	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
SDG2						
SDG3						
SDG4						
SDG5						
SDG6				-0.01	-0.01	-0.01
SDG7						
SDG8						
SDG9	-0.04	-0.04	-0.02	-0.04	-0.03	-0.03
SDG10						
SDG11						
SDG12						
SDG13						
SDG14		-0.01	-0.01	-0.01	-0.01	-0.01
SDG15		-0.01	-0.01			-0.01
SDG16						
SDG17	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1

Table 8

	A B D	A C D	A D E	B C D	B D E	C D E
SDG1	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
SDG2						
SDG3						
SDG4						
SDG5						
SDG6				-0.01	-0.01	-0.01
SDG7						
SDG8	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
SDG9	-0.04	-0.04	-0.03	-0.04	-0.03	-0.03
SDG10						
SDG11						
SDG12						
SDG13						
SDG14		-0.01	-0.01	-0.01	-0.01	-0.01
SDG15		-0.01	-0.01			-0.01
SDG16						
SDG17	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1

Table 9

	A B E	A C E	A D E	B C E	B D E	C D E
SDG1	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
SDG2						
SDG3						
SDG4						
SDG5	-0.01	-0.01	-0.01	-0.01	-0.01	
SDG6				-0.01	-0.01	-0.01
SDG7	0.01	0.01	0.01	0.01	0.01	0.01
SDG8	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
SDG9	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
SDG10						
SDG11						
SDG12						
SDG13	0.01	0.01	0.01	0.01	0.01	0.01
SDG14		-0.01	-0.01	-0.01	-0.01	-0.01
SDG15		-0.01	-0.01			-0.01
SDG16						
SDG17	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1