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Abstract

COVID-19 outbreak is a reminder of the fact that the pandemics have happened in the past and will also occur in the future. The COVID-19 not only has affected the economy; but also it has affected the livelihood, which leads to the changes in businesses. This study aims to identify the most significant indicator (or parameter) that impacts the sustainability of industries. The study should also develop a real-time monitoring system for the sustainability of industries affected by COVID 19. In this work, the Polynomial Neural Network (PNN) and cosine similarity measure under SVPNS (Single-Valued Pentapartitioned Neutrosophic Set) environment have found their use in analyzing the sustainability of the industry.

Keywords: COVID-19; SVPNS; cosine similarity measure; Polynomial Neural Network; sustainability.

1. Introduction

The Currently, a lethal virus of the name Corona Virus is engulfing the whole of the world. Both economic outcomes and social outcomes are jeopardised owing to the said virus [1]. WHO, i.e. World Health Organization says that it is a widespread disease [2]. As per the report rendered to this organization, a great many cases of pneumonia because of a cause which was not known were reported to have been in the city of Wuhan belonging to China on the 31st day of the month of December of the year of 2019 [3, 4]. In the month of January 2020, the virus which enabled the outbreak to appear was detected, and 2019 Novel Corona Virus is the name attributed to it. In the month of February of 2020, Corona Virus Disease 2019 is the name which was attributed to this virus by WHO because of its appearance in the year of 2019 [5]. Human beings' lungs are its first prey, and the symptoms pneumonia and influenza are impregnated with are had by it [6]. How COVID-19 transmits from one man to another is unknown, but its transmission method is like other respiratory diseases' transmission method [7, 8]. Environmental factors play a pivotal role in its movement [9]. Reports say that till 10th August 2020, the number of confirmed cases are 20,025,245 out of which 733,997 expired and 12,899,801 came round [10]. The health as well as livelihood, especially employment of people are put at stake by the COVID-19 [11]. Companies are precluded from smoothly running consequent upon lockdown's having been imposed by many a country. As UNESCO reports universities, colleges and, schools have been closed by more than 100 countries, and consequently the education of the majority of the students of the world has got adversely affected [12]. The environment has been permitted to restore because of this lockdown, which closes industries and reduces the of vehicles, thus improving the quality of the air of the world.

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1.1. Motivation:

The International Labour Organization gauged that more than 400 million human beings will lose their full-time jobs due to this pandemic [13]. Many industries are unable to run smoothly in this pandemic situation. Many developed countries like G7 countries, sharing 65% of the manufacturing of the world, 60% of the world's demand and supply (GDP), and 41% of world exports are overdone by the pandemic same as other countries. Besides developed countries, many developing countries are also fighting to give wages to the factory workers of their nations. So, people are becoming jobless. There are various factors responsible that have emerged due to COVID-19 for the downfall of the industrial sector around the world. As a result, in this work, we have studied various parameters responsible for the risk in the sustainability of the industry. Although all the parameters are responsible, in reality, all these parameters are not equally responsible for the downfall of a company. So, our objective is to identify the most significant indicator (or parameter) which influences the sustainability of the industries, to suffer a lot. Also in this study, we develop a real-time system for monitoring the sustainability of any industry affected by COVID 19 as the impacts of corona are long term. Moreover, every parameter which influences the sustainability of the industries is not equally responsible for the changing of the performances of the industries. An automated framework is designed to estimate the value of the function continues to represent sustainability using PNN based GMDH training algorithm. To develop a continuous sustainability monitoring system in real-time by applying cosine similarity measure under SVPNS method and a PNN-based predictive model, we developed an approach to evaluating sustainability in real-time. Using such a method provides many advantages, including the consistency and accuracy of the predictive models developed based on the technique, in comparison to conventional linear or non-linear predictive models. In the predictive model, it is possible to assess sustainability unbiasedly since the indicator's priority is hidden and unchangeable.

1.2. Novelty:

The novelty of this work lies in three folds. Firstly, we have analyzed the problem dealing with the sustainability of any industry in the recent worst phase of COVID-19 in the light of the economy, efficiency, and location of the industry, which are immensely affected by this COVID-19. Secondly, for the first time, we have applied the cosine similarity measure under SVPNS-environment to analyze the sustainability of the industry. Lastly, we have introduced a framework for the continuous assessment of sustainability for any industry affected by COVID-19.

2. Literature Review

In 1965, Zadeh invented the fuzzy set (FS) to deal with real-world problems involving uncertainty [14]. The membership value of each element in an FS lies within the interval [0, 1]. As a consequence, Atanassov found that establishing the notion of the intuitionistic fuzzy set (IFS) by generalizing the notion of the fuzzy set (FS) is crucial for reducing the uncertainty in problems [15]. There are two types of membership, membership, and non-membership in every IFS, and both values lie in the interval [0, 1]. Numerous researchers around the world have applied FS, IFS, and their extensions in both theoretical and practical research. The idea of crisp sets, FS, and IFS cannot explain the indeterminacy part of uncertainty events. Consider the fact that Smarandache [16] generalized the concept of FS and IFS to deal with uncertain events having indeterminacy to formulate the neutrosophic set (NS). NS has three types of membership values: truth, indeterminacy, and false. Each value is between 0 and 1. A single-valued neutrosophic set (SVNS) was introduced by Wang et al. [17] in 2010 by extending the concept of NS. The SVNS concept is more effective for events with indeterminate information and uncertainty.

Mallick and Pramanik developed the concept of single-valued pentapartitioned neutrosophic set (SVPNS) by dividing the indeterminacy membership function into three independent membership functions, namely contradiction membership function, ignorance membership function, and unknown membership function [18].

Based on the cosine similarity measure under SVPNS-environment, Majumder et al. [19] identified the most significant COVID-19 risk factors in the economy in 2021. An analysis of COVID-19 medical diagnosis with a decision-making method in a single-valued neutrosophic soft set setting in 2022 was performed by Das et al. [20].

The use of new Plithogenic sub cognitive maps in the diagnostic model for COVID-19 with mediated effects of factors [21]. An intuitionistic fuzzy logic approach to the prediction of Covid-19 time series [22]. The use of fuzzy inference to make decisions regarding Corona's prognosis [23]. After the pandemic,

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warehouse location decisions in the medical sector changed [24]. Modeling and predicting COVID-19 time series using a hybrid intelligent parameter tuning approach [25]. Using q-Rung Orthopair Fuzzy Soft Bonferroni Mean Operators to Minimize the Death Rate Due to COVID-19 [26]. The TOPSIS method is used to predict human behavior [27]. A model for pattern recognition using the Fermatean fuzzy modified composite relation [28].

3. Definitions of Relevant Terms:

Here is an overview of some of the results and definitions.
The discourse sphere is V. This is the definition of an SVPNS [1]:

$\square'' = \{(j'', \zeta'''_{\square''}(j''), \Xi'''_{\square''}(j''), \aleph'''_{\square''}(j''), \ell'''_{\square''}(j''), \lambda'''_{\square''}(j'')) : j'' \in \psi'''\}$.

Here, $\zeta'''_{\square''}(j''), \Xi'''_{\square''}(j''), \aleph'''_{\square''}(j''), \ell'''_{\square''}(j'')$ and $\lambda'''_{\square''}(j'')$

Are the truth, contradiction, ignorance, unknown and false membership functions from V to the unit interval [0, 1] respectively i.e., $\zeta'''_{\square''}(j''), \Xi'''_{\square''}(j''), \aleph'''_{\square''}(j''), \ell'''_{\square''}(j'')$ and $\lambda'''_{\square''}(j'') \in [0,1]$, for each $j'' \in \psi'''$. So, $0 \le \zeta'''_{\square''}(j'') + \Xi'''_{\square''}(j'') + \aleph'''_{\square''}(j'') + \ell'''_{\square''}(j'') + \lambda'''_{\square''}(j'') \le 1$, for each $j'' \in \Psi'''$.

Based on a fixed set AA, the following will be the norms for the null SVPNS (0PN) and the absolute SVPNS (1PN) [42].

(a) $1_{PN} = \{(j'', 1, 1, 0, 0, 0) : j'' \in \psi'''\}$,

(b) $0_{PN} = \{(j'', 0, 0, 1, 1, 1) : j'' \in \psi'''\}$.

Let

$\square'' = \{(j'', \zeta'''_{\square''}(j''), \Xi'''_{\square''}(j''), \aleph'''_{\square''}(j''), \ell'''_{\square''}(j''), \lambda'''_{\square''}(j''))) : j'' \in \psi'''\}$,

$\square'' = \{(j'', \zeta'''_{\square''}(j''), \Xi'''_{\square''}(j''), \aleph'''_{\square''}(j''), \ell'''_{\square''}(j''), \lambda'''_{\square''}(j''))) : j'' \in \psi'''\}$ be any two [42] SVPNSs over *V*. Then,

(a) $\square'' \subseteq \square''$ if and only if $\zeta'''_{\square''}(j'') \le \zeta'''_{\square''}(j'')$, $\Xi'''_{\square''}(j'') \le \Xi'''_{\square''}(j'')$, $\aleph'''_{\square''}(j'') \ge \aleph'''_{\square''}(j'')$, $\ell'''_{\square''}(j'') \ge \ell'''_{\square''}(j'')$, $\lambda'''_{\square''}(j'') \ge \lambda'''_{\square''}(j'')$, for all $j'' \in \psi'''$.

(b) $\square''^{c} = \{(j'', \lambda'''_{\square''}(j''), \ell'''_{\square''}(j''), 1 - \aleph'''_{\square''}(j''), \Xi'''_{\square''}(j''), \zeta'''_{\square''}(j'')) : j'' \in \psi'''\}$;

(c)

$$\square'' \cup \square'' = \left\{\left(j'', \max\left\{\zeta'''_{\square''}(j''), \zeta'''_{\square''}(j'')\right\}, \max\left\{\Xi'''_{\square''}(j''), \Xi'''_{\square''}(j'')\right\}, \min\left\{\aleph'''_{\square''}(j''), \aleph'''_{\square''}(j'')\right\}, \min\left\{\ell'''_{\square''}(j''), \ell'''_{\square''}(j'')\right\}, \min\left\{\lambda'''_{\square''}(j''), \lambda'''_{\square''}(j'')\right\}\right) : j'' \in \psi'''\right\}$$

(d)

$$\square'' \cap \square'' = \left\{\left(j'', \min\left\{\zeta'''_{\square''}(j''), \zeta'''_{\square''}(j'')\right\}, \min\left\{\Xi'''_{\square''}(j''), \Xi'''_{\square''}(j'')\right\}, \max\left\{\aleph'''_{\square''}(j''), \aleph'''_{\square''}(j'')\right\}, \max\left\{\ell'''_{\square''}(j''), \ell'''_{\square''}(j'')\right\}, \max\left\{\lambda'''_{\square''}(j''), \lambda'''_{\square''}(j'')\right\}\right) : j'' \in \psi'''\right\}$$

Consider the case where $\square''$ = {(r', 0.71, 0.41, 0.51, 0.11, 0.31), (s', 0.61, 0.31, 0.41, 0.31, 0.21)} and $\square''$ = {(r', 0.81, 0.51, 0.61, 0.21, 0.51), (s', 0.81, 0.51, 0.61, 0.41, 0.41)} would correspond to two SVPNSs over a set of discourses V = {r', s'}.

Then,

(i) $\square'' \subseteq \square''$;

(ii) $\square''^{C}$ = {(*r'*, 0.31, 0. 11, 0.51, 0.41, 0.71), (*s'*, 0.21, 0.31, 0.61, 0.31, 0.41)} and $\square''^{C}$ = {(*r'*, 0.51, 0.21, 0.41, 0.51, 0.21), (*s'*, 0.41, 0.41, 0.41, 0.51, 0.81)};

(iii) $\square'' \cup \square''$ = {(*r'*, 0.81, 0.51, 0.51, 0.11, 0.31), (*s'*, 0.81, 0.51, 0.41, 0.31, 0.21)};

(iv) $\square'' \cap \square''$ = {(*r'*, 0.71, 0.41, 0.61, 0.21, 0.51), (*s'*, 0.61, 0.31, 0.61, 0.41, 0.41)}.

4. Method Used:

There are two parts to this section. The first sub-section 3.1 discusses decision-making process, and the second sub-section 3.2 discusses the PNN model.

4.1. MADM Strategy Using SVPNWESM under SVPNS Environment:

With the help of SVPNWESM, an MADM model is proposed to be made under SVPNS environment in this section.

Let us consider in a MADM problem two sets of alternatives and attributes $\Gamma = \{\square_1, \square_2, \square_3, ..., \square_n\}$ and $\rho = \{\varphi_1, \varphi_2, \varphi_3, ..., \varphi_m\}$. SVPNS can then be used by decision-makers in order to evaluate each alternat $\square_i\,(i = 1(1)m)$ compared to each attribute $\varphi_j\,(j = 1(1)k)$. A decision matrix (DM) can be created based on

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the whole evaluation information provided by the decision-maker. The MADM Strategy based on SVPNS is depicted in Figure 1.

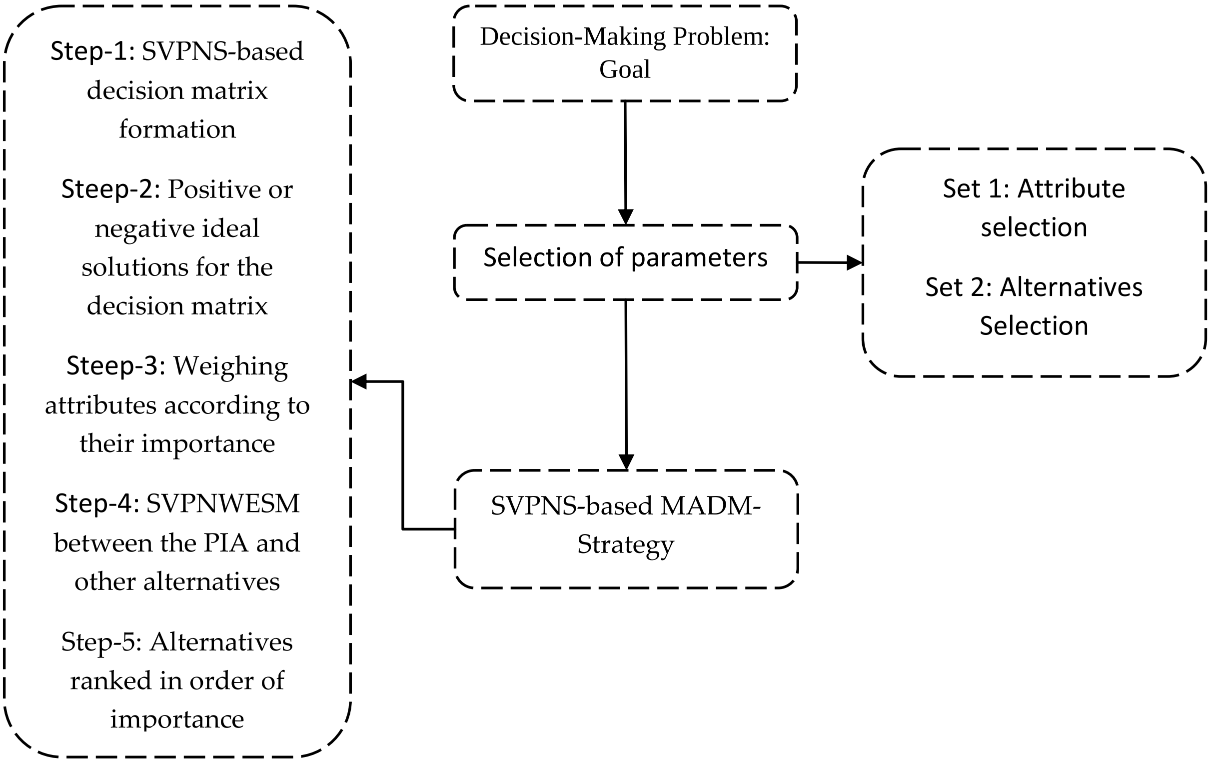

Figure 1: MADM-Strategy based on SVPNS

Step-1: Decision matrix (DM) formation using SVPNS.

The construction of a decision matrix through making use of the evaluation information which is $\mathrm{M}_{\square_i} = \left\{ \left(\varphi_j, \alpha_{\varphi_{ij}}\left(\square_i, \varphi_j\right), \beta_{\varphi_{ij}}\left(\square_i, \varphi_j\right), \delta_{\varphi_{ij}}\left(\square_i, \varphi_j\right), \gamma_{\varphi_{ij}}\left(\square_i, \varphi_j\right), \lambda_{\varphi_{ij}}\left(\square_i, \varphi_j\right) \right) : \varphi_j \in \rho \right\}$ for each alternative $\square_i \left(i = 1(1)m\right)$ with respect to the attributes $\varphi_j\left(j = 1(1)k\right)$, in which $\left(\varphi_j, \alpha_{\varphi_{ij}}\left(\square_i, \varphi_j\right), \beta_{\varphi_{ij}}\left(\square_i, \varphi_j\right), \delta_{\varphi_{ij}}\left(\square_i, \varphi_j\right), \gamma_{\varphi_{ij}}\left(\square_i, \varphi_j\right), \lambda_{\varphi_{ij}}\left(\square_i, \varphi_j\right) \right) = \left(\square_i, \varphi_j\right)$ (say) $\left(i = 1(1)m \text{ and } j = 1(1)k\right)$ refers to the decision maker's evaluation for alternatives $\square_i \left(i = 1(1)m\right)$ with respect to the attribute $\varphi_j\left(j = 1(1)k\right)$.

These are DM expressions:

$$
\begin{array}{c} \\ \square_1 \\ \square_2 \\ \vdots \\ \square_m \end{array}
\begin{array}{c}
\begin{array}{cccc} \varphi_1 & \varphi_2 & \cdots & \varphi_k \end{array} \\
\begin{pmatrix}
\left(\square_1, \varphi_1\right) & \left(\square_1, \varphi_2\right) & \cdots & \left(\square_1, \varphi_k\right) \\
\left(\square_2, \varphi_1\right) & \left(\square_2, \varphi_2\right) & \cdots & \left(\square_2, \varphi_k\right) \\
\vdots & \vdots & \vdots & \vdots \\
\left(\square_m, \varphi_1\right) & \left(\square_m, \varphi_2\right) & \cdots & \left(\square_m, \varphi_k\right)
\end{pmatrix}
\end{array}
$$

Step-2. Determination of the Weights for Each Attribute.

It is important to determine the weights for every attribute in every MADM strategy. Using the compromise function, a decision-maker can determine the weights for each attribute provided that the

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attributes' weights are not known. For ℓ_j and $\square_j$, the compromise function can be defined as follows:

$$\ell_j = \sum_{i=1}^{m} \frac{\left[3+\alpha_{\varphi_{ij}}\left(\square_i,\varphi_j\right)+\beta_{\varphi_{ij}}\left(\square_i,\varphi_j\right)-\delta_{\varphi_{ij}}\left(\square_i,\varphi_j\right)-\gamma_{\varphi_{ij}}\left(\square_i,\varphi_j\right)-\lambda_{\varphi_{ij}}\left(\square_i,\varphi_j\right)\right]}{5} \text{.......................(1)}$$

The j-th attribute's weight is defined by

$$p_j = \frac{\ell_j}{\sum_{j=1}^{k} \ell_j} \text{.......................(2)}$$

Here $\sum_{j=1}^{k} p_j = 1$.

Step-3. Positive Ideal Alternative (PIA) selection.

A decision-maker can use the maximum operator for all the attributes in this step to create a PIA.

The PIA ∂ consists of the following:

$$\partial = \left(\pi_1, \pi_2, \ldots, \pi_k\right) \text{.......................(3)}$$

Where $\pi_j = \left(\max\left\{\alpha_{\varphi_{ij}}\left(\square_i,\varphi_j\right): i = 1(1)m\right\}, \max\left\{\beta_{\varphi_{ij}}\left(\square_i,\varphi_j\right): i = 1(1)m\right\}, \min\left\{\delta_{\varphi_{ij}}\left(\square_i,\varphi_j\right): i = 1(1)m\right\},\right.$

$\left.\min\left\{\gamma_{\varphi_{ij}}\left(\square_i,\varphi_j\right): i = 1(1)m\right\}, \min\left\{\lambda_{\varphi_{ij}}\left(\square_i,\varphi_j\right): i = 1(1)m\right\}\right),\ j = 1(1)k$.......................(4)

Step-4. Accumulated Measures Values Determination.

To aggregate the SVPNCSM for each alternative, use the accumulated measure function (AMF).

As defined by the AMF,

$$\mathrm{M}_{AMF}\left(\square_i\right) = \sum_{j=1}^{k} p_j \times P_{SVPNCSM}\left(\left(\square_i,\varphi_j\right),\pi_j\right) \text{.......................(5)}$$

Where

$$P_{SVPNCSM}\left(\square,\varphi\right) = 1-\frac{1}{n}\sum_{\phi\in U}\cos\left[\frac{\pi}{10}\left(\begin{array}{l}\left|\alpha_{\square}(\phi)-\alpha_{\varphi}(\phi)\right|+\left|\beta_{\square}(\phi)-\beta_{\varphi}(\phi)\right|+\left|\delta_{\square}(\phi)-\delta_{\varphi}(\phi)\right|\\+\left|\gamma_{\square}(\phi)-\gamma_{\varphi}(\phi)\right|+\left|\lambda_{\square}(\phi)-\lambda_{\varphi}(\phi)\right|\end{array}\right)\right] \text{ and}$$

$$\left(\square_i,\varphi_j\right) = \left(\varphi_j, \alpha_{\varphi_{ij}}\left(\square_i,\varphi_j\right), \beta_{\varphi_{ij}}\left(\square_i,\varphi_j\right), \delta_{\varphi_{ij}}\left(\square_i,\varphi_j\right), \gamma_{\varphi_{ij}}\left(\square_i,\varphi_j\right), \lambda_{\varphi_{ij}}\left(\square_i,\varphi_j\right)\right)$$

Step-5. Alternatives ranked.

The last step is to rank the alternatives descending in the accumulated measure value order. Alternatives which are linked to the lowest accumulated measure value are most apt.

4.2. Polynomial Neural Network (PNN):

Polynomial Neural Networks (PNN) is the most upgraded version of the Artificial Neural Network (ANN). The Group Method of Data Handling (GMDH) algorithm is used to train the PNN network which was firstly suggested by Ivakhnenko [29]. The merits of the technique are the subsequent addition of a new layer and this step will be repeated up to the meeting of the termination criteria. The demerit of GMDH lies in the complexity in the network that is required for the development of relatively simple systems. The governing equation of GMDH is

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$$u_h = P\left(y_i, y_j\right) = a_1 + a_2 y_i + a_3 y_j + a_4 y_i y_j + a_5 {y_j}^2 + a_6 {y_j}^2 \text{............(6)},\ h = 1, 2, ..., p$$

where k is the total number of input. The data are divided into testing and training data sets. The testing data set finds its use to determine the estimated GMDH model and the training data set is utilized to design a GMDH model. Development of $p = \frac{k\left(k-1\right)}{2}$ new variables $\left\{u_1, u_2, ..., u_k\right\}$ in the training data set for all independent variables and selection of partial descriptions (PD) of the GMDH. Conventional GMDH is updated using the polynomial represented by the equation 9 as PD.

5. Methodology:

The most important aim of this study is the construction of a framework to assess stability, estimating the economic stability of an industry at a real-time for the reduction of the time in general required in the judgment of the stability of an arrangement in COVID-19 pandemic situation. In this field of study, a framework is developed using the features representing the performance stability of an industry as a mapping of weight of the important indicators.

Entire methodology is ordered in three stages. First stage includes selecting and arranging alternatives depending upon the importance of theirs and then contributing to represent the stability of any company. Stability is a term which is reciprocal of risk. The risk is the difference between a system's actual stability and intended stability. In a company there are some parameters which are specific and exert an influence on the system's performance. Similar parameters are trustworthy for deviation in the framework execution from the evaluated presentation albeit all the boundaries are not similarly predominant in affecting the framework execution. However upon all the alternatives is dependent is the performance's being evaluated, which not only consumes time but also expensive. RTM (Real-Time Monitoring) is, at any point in time able to monitor of the company's stability provided that in the said, system an automated model becomes designed and gets embedded in order to, via making use of the real time data of the alternatives which are included.

MCDM method's being applied in order to estimate the relative importance of the indicators select, which is made use of for sorting the indicators select that are included in the aggregation function is provided in section 4.1. The automated framework's progress through making use of what is known as PNN technique in order for the single function's being estimated becomes, in Section 4.2, discussed. Section 4.3 delineates prototype RTM's development.

5.1. Application of MCDM:

The focus of this study is the identification of the most significant indicator responsible for the sustainability of a company in the COVID-19 pandemic scenario. Therefore, three sub-sections in total are had by MCDM's being applied. Sub-section 5.1.1 depicts the process involved in selecting criteria and alternatives. The pairwise comparison between the criteria and alternatives is discussed in sub-section 5.1.2. Sub-section 5.1.3 provides the construction of aggregation function which is proportional to the stability of a company.

5.1.1. Selection of Parameter:

The parameters, mainly responsible for the sustainability of the company in the COVID-19 pandemic situation are chosen using an expert survey. Observations from the surveys are compared with the obtained results of the review of the related literature [30, 31].

What is shown by Figure 2 is the reason lying behind selecting the criteria for comparing the alternatives by making use of the decision-making goal attempted to be reached by the investigation on the tapis. Identified parameters with the prospective for the purpose of transmogrifying the indicators select become as the criteria in order to compare the alternatives. The company's stability gets changed by all of the parameters which are capable of transforming the indicators select potential to change the select.

Here, in this case, we consider three criteria namely cost, efficiency and location, and six alternatives which are manpower, state of the machine, raw materials, sales, assets, and liabilities [12, 30, 31, 32, 33]. Due to the widespread of corona the industries have to shut down and as a result, they are forced to fire their workers. Moreover, many workers come to their native places and many have died on the roads due to a shortage of food. Transport facilities are affected causing a massive problem in the sales and importing the raw materials. Due to the shortage of manpower and raw materials many machines are shut down and as a result, due to the lack of their operation, it is a matter of concern about their state. As the number of sales

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comes down, the liabilities of the company will rise up which ultimately affects the assets of the company [30].

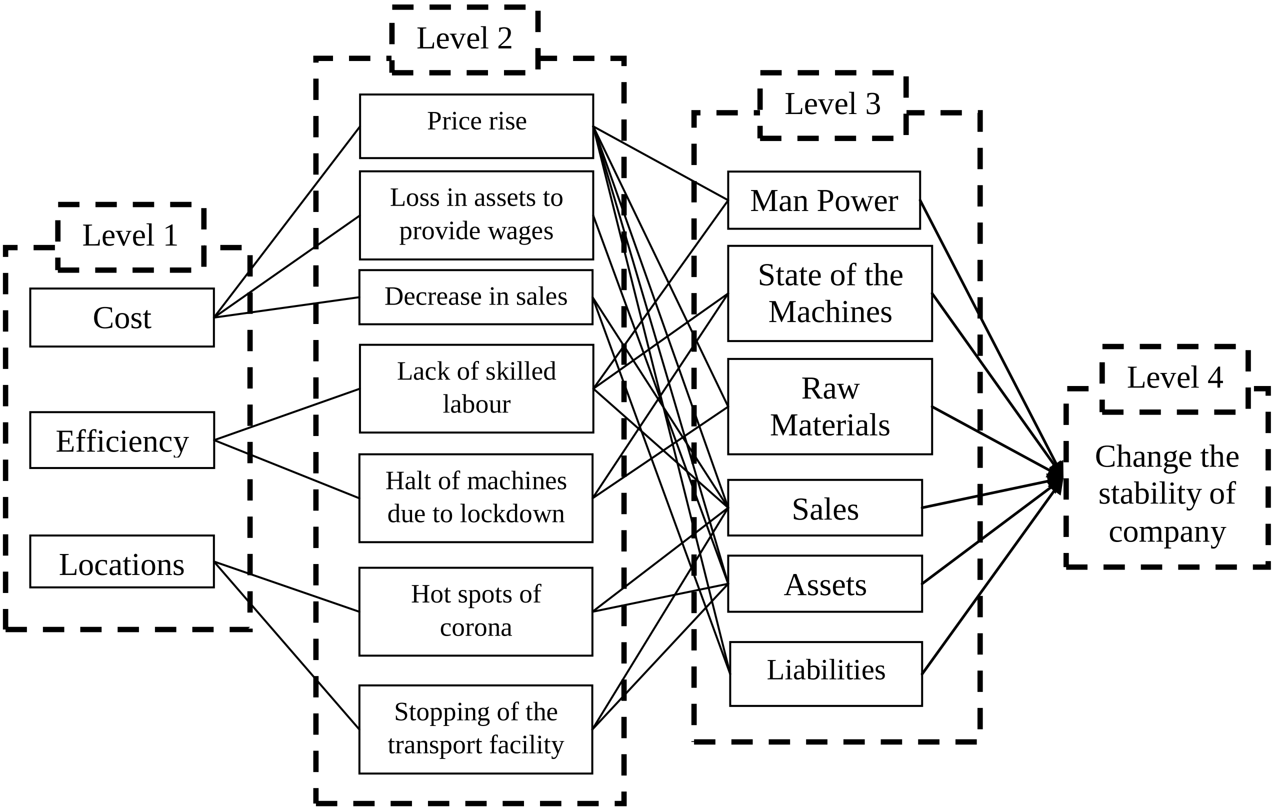

Figure 2: Justification of selection of criteria and alternatives in COVID-19 pandemic situation

5.1.2. Application of cosine similarity measure:

In the study on the tapis, as well as each indicator's local weight (or PV) according to each criterion [15] [19]. Present study considers three criteria (Cost (φ_1), Efficiency (φ_2) and Locations (φ_3)) and six alternative alternatives (Man Power ($\square_1$), State of the Machines ($\square_2$), Assets ($\square_3$), Raw Materials ($\square_4$), Liabilities ($\square_5$) and Sales ($\square_6$))[12, 30, 31, 32, 33]. MADM strategy which is proposed is as follows vouchsafed:

The decision matrix is prepared based on the decision-makers' evaluation information as has been shown in Table 1.

Table 1: Decision Matrix

	φ_1	φ_2	φ_3
$\square_1$	(1, 0.2, 0.2, 0, 0)	(0.8, 0.1, 0.1, 0.1, 0.1)	(0.9, 0, 0.2, 0.1, 0.1)
$\square_2$	(1, 0.1, 0.2, 0.1, 0.2)	(0.9, 0.1, 0.2, 0.2, 0.1)	(0.8, 0.1, 0, 0, 0.1)
$\square_3$	(1, 0.1, 0, 0, 0.1)	(0.9, 0, 0.1, 0.1, 0.2)	(0.9, 0.1, 0.1, 0.1, 0.1)
$\square_4$	(0.9, 0.2, 0.1, 0.1, 0)	(1, 0.1, 0, 0, 0.1)	(0.9, 0.1, 0.1, 0.1, 0.1)
$\square_5$	(1, 0.2, 0.1, 0.1, 0.1)	(0.8, 0.1, 0, 0, 0.1)	(0.7, 0.2, 0, 0.1, 0.1)
$\square_6$	(0.8, 0.1, 0.1, 0.2, 0.1)	(1, 0, 0.1, 0.2, 0.1)	(0.9, 0, 0.2, 0.1, 0.1)

5.1.3. Development of Aggregation Function:

After the completion of the estimation of the weight and the results were validated, the indicators' magnitude and weight had been made use of in order for the index representing a company's stability to be

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estimated and equation 7 depicts it. A company's stability is coherently represented by the way S-mapping had been made. The more the S-mapping's value, the more company's stability, which is implied by that.

$$S = \frac{e^{aI}}{1-e^{-aI}} \text{...........}(7), a \in \mathbb{R}^{+}$$

$$\text{Where, } I = \frac{I_1}{I_2}, I_1 = \frac{\sum_B p_B x_B}{\sum_B p_B}, I_2 = \frac{\sum_{NB} p_{NB} x_{NB}}{\sum_{NB} p_{NB}}$$

Beneficial (B) as well as non-beneficial (NB) indicators' weighted average is here represented by I_1 and I_2 respectively. B as well as NB indicators' PV is represented by p_B and p_{NB} respectively, while the said indicators' magnitude value is represented in the normalized form by x_B and x_{NB}. φ_i's magnitude is here denoted by x_i. In the present study, the indicators, namely assets, sales, raw materials, and state of machines are beneficial, while the indicators liability and manpower are not beneficial.

5.2. Application of PNN:

An objective function is minimized during training or learning of optimum condition weights in PNN models. In the PNN model, the optimum condition weights are determined by minimizing an objective function. In order to develop a PNN model, a training dataset is required, which can be denoted as $T_{DATA} = \{x_i{:}x_i \in [0,1]\}$. Based on the design of the experiment approach, the training data was generated by generating 1000 different combinations of inputs, for which Equation 7 calculates the corresponding output. The weights of the connections of the neural network are randomly generated during training, and the estimated output is compared with the given result. Using a specific technique, the difference between the estimated and actual outputs was minimized. The model was trained using the Group Method of Data Handling. The training results were taken once the minimum difference was identified. In order to predict the output, the weight thus estimated was used as a model. The PNN will find a cognitive equation for estimating the sustainability of the industry. Equation (7) will be encoded in the control center of the interconnected sensors. An algorithm will be set to execute an if-then rule so that the RTM behaves as desired.

6. Result and Discussion:

This study investigates the most significant indicator of the sustainability of any company as well as the monitoring of the sustainability of any industry in real-time. In these aspects, the result of present study divided into four parts namely result from MCDM, parameter estimation results from PNN model and real-time monitoring of sustainability of industry and discussion which are described in section 5.1, 5.2 and 5.3 respectively.

6.1. Result from MCDM:

Now, by using equation (1) and (2), the weights p_1 = 0.343, p_2 =0.329, and p_3 = 0.328 are gotten. Making use of equation (3) and (4) has formed PIA, which Table-2 shows as follows:

Table 2: PIA value

	φ_1	φ_2	φ_3
∂	(1.0,0.2,0.0,0.0,0.0)	(1.0,0.1,0.0,0.0,0.1)	(0.9,0.2,0.0,0.0,0.1)

Presently, by utilizing condition (5), we work out the collected measure upsides of every alternative $\square_1$, $\square_2$, $\square_3$, $\square_4$, $\square_5$ and $\square_6$ as follows:

$P_{AMF}(\square_1) = 0.90141$

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$P_{AMF}(\square_2) = 0.901754$

$P_{AMF}(\square_3) = 0.901298$

$P_{AMF}(\square_4) = 0.90098$

$P_{AMF}(\square_5) = 0.901044$

$P_{AMF}(\square_6) = 0.902163$

The following is the accumulated measure values' order: $P_{AMF}(\square_6) > P_{AMF}(\square_2) > P_{AMF}(\square_1) > P_{AMF}(\square_3) > P_{AMF}(\square_5) > P_{AMF}(\square_4)$. According to the result, we can see that indicate "sales" is the more responsible for the sustainability of an industry.

6.2. Results of estimation of parameter obtained from PNN model:

PNN models are intended to predict S-functions (Equation 7), which indicate the manageability of an industry. Four factors are taken into account when planning the PNN model: hidden layers, enactment work from contribution to covering up to covering up to entry, and the loads of association among neural systems. As part of the preparation stage, boundaries for parameters are set based on a sample informational index or the preparation informational index, and the prepared model is tested with informational indexes that were not used during preparation and with the aid of the informational collection, the model is tested for accuracy. For building up the most precise model, PNN models can recognize the number of shrouded layers and the number of contributions with the assistance of a wellness work and the preparation informational collection. The preparation calculations, such as GMDH, are used to understand the association's load. The model was tested for accuracy once the association's loads were predetermined. The model was tested ion and testing stage, the Absolute Relative Error (ARE) was used as the wellness capacity of exactness for the created model. In Figure 3, real and anticipated S-functions are examined. Show that the created model has a normal exactness of 99.51% and 99.85% which portrays that the precision of the model is marginally more in the testing stage contrasted with the preparation stage. The model condition is shown by equation 8.

This condition was encoded in the control arrangement of the RTM. The advantage of this condition was it can cover up the weightage of significance allocated to the pointer and subsequently unprejudiced forecast of manageability can be conceivable.

S = 0.00194672 - N11*0.585287 + N3*1.58468......................(8)

N3 = 0.364709 - N465*0.117088 + N4*1.00387

N4 = 0.0113612 - N193*0.171125 + N8*1.1676

N8 = 0.0462697 - N305*0.0695867 + N16*1.05522

N16 = -0.467105 + N455*0.161786 + N32*0.98322

N455 = 9.92001 - "x6, cubert"*12.4749 + "x6, cubert"*N498*1.07894

N305 = 2.4685 - N370*0.550213 + N370*N443*0.24387 - N443*0.271623

N193 = 0.974792 + N328*N279*0.0108044 + N279*0.585922

N279 = 1.77231 + N337*N389*0.132478 - N389*0.212736

N389 = -0.24909 + N400*N498*0.338207

N337 = 1.86635 + N370*N461*0.178787 - N461*0.339194

N328 = 1.92819 + N370*N412*0.150056 - N412*0.343041

N370 = 57.5671 - "x1, cubert"*62.6097 + "x1, cubert"*"x6, cubert"*70.5482 - "x6, cubert"*62.8511

N465 = 0.480848 + N477*N494*0.262076

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N494 = 1.34928 + "x5, cubert"*N500*0.754855

N477 = 0.205933 + "x4, cubert"*N500*1.22035

N11 = 0.0386873 - N322*0.0460058 + N17*1.034

N17 = -0.45554 + N456*0.157711 + N32*0.983705

N32 = -1.62904 + N478*0.511716 + N124*0.993993

N124 = 0.320162 + N407*0.110294 + N407*N178*0.0381621 + N178*0.606026

N178 = 1.1165 + N284*0.17753 + N284*N340*0.0167736 + N340*0.320193

N340 = 3.01832 - N414*0.998618 + N414*N435*0.591256 - N435*0.834076

N435 = 0.961143 - "x6, cubert"*N443*0.934851 + N443*1.28706

N443 = 0.430114 + "x4, cubert"*13.0173 - "x4, cubert"*"x6, cubert"*12.5971

N414 = -0.138401 + N424*N498*0.326067

N498 = 1.78612 + "x2, cubert"*"x5, cubert"*2.492

N284 = 2.25844 - N365*0.29977 + N365*N366*0.069583

N366 = -8.44548 + "x6, cubert"*11.5603 - "x6, cubert"*N424*6.72422 + N424*5.96334

N365 = 4.30972 - N424*1.45588 + N424*N461*0.749523 - N461*1.28859

N424 = 11.1728 - "x1, cubert"*11.6685 + "x1, cubert"*"x3, cubert"*1.30673

N407 = -2.25843 + N412*0.99435 + N500*0.706746

N412 = 0.90769 - "x1, cubert"*"x5, cubert"*14.9215 + "x5, cubert"*14.2023

N478 = -0.1265 + N491*N500*0.322998

N491 = 0.392842 + "x4, cubert"*3.6826

N456 = -3.16483 + N461*0.999203 + N500*0.983269

N500 = 2.06765 + "x2, cubert"*"x3, cubert"*2.05317

N322 = 3.8446 - N396*1.4466 + N396*N457*0.731271 - N457*1.08228

N457 = 1.33159 - "x6, cubert"*0.284432 - "x6, cubert"*N461*0.774968 + N461*1.1403

N461 = 9.8986 - "x6, cubert"*8.97134

N396 = -1.80904e-12 + N400*0.511926 + N400*N502*0.151515

N502 = 3.22129

N400 = -3.02752 + "x1, cubert"*4.29884 - "x1, cubert"*"x4, cubert"*19.1814 + "x4, cubert"*18.2679

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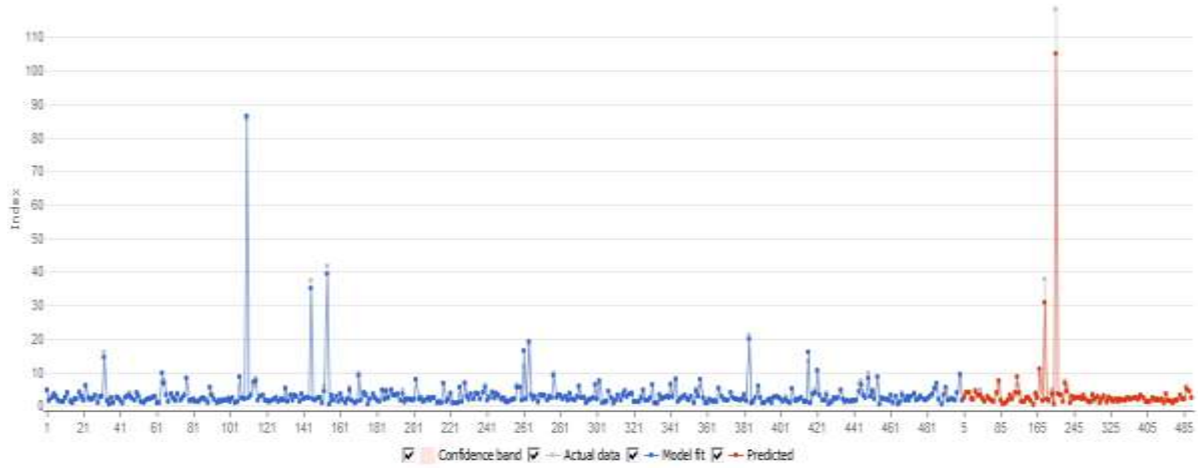

Figure 3: Actual and predicted S-value (using equation 10) from the PNN model during the testing and training phase.

6.3. Real time monitoring of sustainability of an industry:

The Central Control Unit (CCU) here acting as aggregator of the signals using equation 10, and the same data is sent back to the supercomputer to analyse and monitor the sustainability of the industry continuously. The result obtained is sent to CCU, and it passes the signal back to the indicators to adjust their performance indices. The CCU is connected to the supercomputer through the blue line, and the connections between the indicators and CCU are shown by the respective lines. Single arrow line denotes the direct relationship between the indicators and aggregation function and dotted lines denote the inverse relationship between them and a double arrow line indicates the relationship between the indicators. Figure 4 shows the schematic diagram of the real-time monitoring system developed to monitor sustainability of any industry.

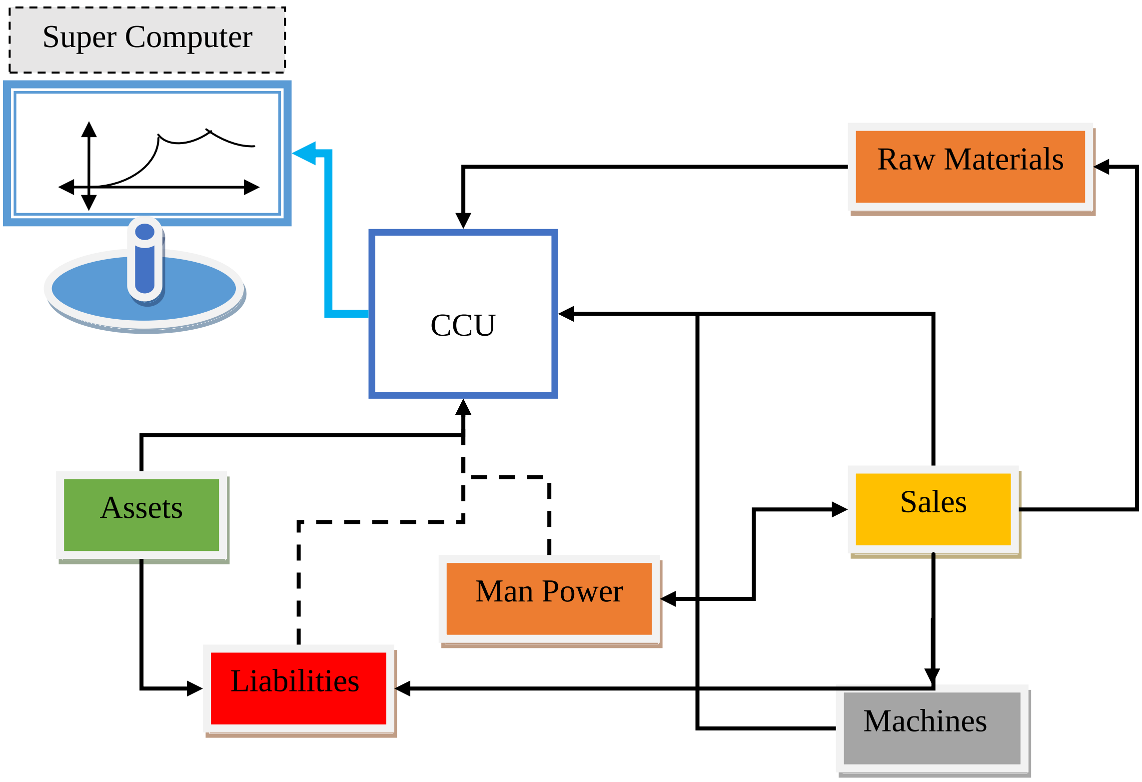

Figure 4: The schematic diagram of the real time monitoring system for monitoring of sustainability of any industry.

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7. Conclusion

The COVID-19 pandemic has brought to mankind many difficulties that include the need for new improved medical treatments, social and economical approaches. The present work uses SF-AHP and PNN to analyze the sustainability of any industry to cope up with the impacts of COVID-19. The flow of work starts with the selection of indicators that are responsible for the downfall of the industry and then it is found that 'sales' is the most significant indicator responsible, using cosine similarity measure under SVPNS and PNN. This method is applicable to various problems related decision-making like biotechnology, biological control system, agriculture, etc.

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