Computer Systems Science & Engineering
DOI:10.32604/csse.2021.014929
Article

Tech Science Press

Atrocious Impinging of COVID-19 Pandemic on Software Development Industries

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Received: 28 October 2020; Accepted: 17 November 2020

Abstract: COVID-19 is the contagious disease transmitted by Coronavirus. The majority of people diagnosed with COVID-19 may suffer from moderate-to-severe respiratory illnesses and stabilize without preferential treatment. Those who are most likely to experience significant infections include the elderly as well as people with a history of significant medical issues including heart disease, diabetes, or chronic breathing problems. The novel Coronavirus has affected not only the physical and mental health of the people but also had adverse impact on their emotional well-being. For months on end now, due to constant monitoring and containment measures to combat COVID-19, people have been forced to live in isolation and maintain the norms of social distancing with no community interactions. Social ties, experiences, and partnerships are not only integral part of work life but also form the basis of human evolvement. However, COVID-19 brought all such communication to a grinding halt. Digital interactions have failed to support the fervor that one enjoys in face-to-face meets. The COVID-19 disease outbreak has triggered dramatic changes in many sectors, and the main among them is the software industry. This paper aims at assessing COVID-19's impact on Software Industries. The impact of the COVID-19 disease outbreak has been measured on the basis of some predefined criteria for the demand of different software applications in the software industry. For the stated analysis, we used an approach that involves the application of the integrated Fuzzy ANP and TOPSIS strategies for the assessment of the impact of COVID-19 on the software industry. Findings of this research study indicate that Government administration based software applications were severely affected, and these applications have been the major apprehensions in the wake of the pandemic's outbreak. Undoubtedly, COVID-19 has had a considerable impact on software industry, yet the damage is not irretrievable and the world's societies can emerge out of this setback through concerted efforts in all facets of life.

Keywords: Coronavirus; software industry; safety; COVID-19 monitoring; fuzzy ANP-TOPSIS

1 Introduction

Humans all around the globe have been living in a state of perpetual fear ever since COVID-19 disease was declared a global pandemic. This pandemic has had a massive and unprecedented impact on the lives of millions across the globe, triggering feelings of isolation, confusion, frustration and hopelessness. This apprehension coupled with the economic meltdown is also because many people are experiencing severe symptoms of depression. The spread of COVID-19 is a significant threat to the society both as a result of the possibility that people may suffer from financial distress and due to its unknown mental stress. The pandemic is assumed to be this century's most fatal world health calamity as well as the biggest obstacle being faced by the humanity since the Second World War [1]. The World Health Organization (WHO) declared COVID-19 a Public Health Emergency of International Concern (PHEIC) on January 31, 2020. This meant that the disease could result in significant harm to several countries and required an immediate, collaborative worldwide response [2]. Further to the announcement, the WHO confirmed the outbreak of COVID-19 as a "pandemic public health menace" on 11 March 2020. COVID-19 cases have grown alarmingly in several countries across the globe [3].

Premature findings demonstrate that marginalized people suffer significantly from the financial and health consequences of the COVID-19. The absence of face-to-face interactions and virtual confinement due to shutdowns has led to anxiety, depression, psychiatric illnesses, impacting the health of individuals as well as the social system as a whole [4]. The COVID-19 disease outbreak is much more than just a health emergency; at its core it affects the economy and the society. Although the effects of this pandemic may vary significantly from country to country, economic inequality and imbalances would most probably increase on a worldwide scale. The global spread of COVID-19 has also produced several privacy, data safety, and security concerns for the software industry [5–7].

The COVID-19 disease outbreak has affected the markets and different industries around the world. Software industry has registered a substantial rise in demand for software applications. This rise can be directly attributed to COVID-19 disease outbreak, and its industrial consequences have attracted considerable attention from the academicians and researchers. Every human being goes through wellness and illness throughout their lifespan [8]. While illnesses are personal, the infection starts affecting the patients and family members first and then the entire social group. Gradually, the struggle of many individuals from illnesses over a period of time along with the synchronous replication of illnesses by interpersonal social layers, the socio-cultural consciousness of the illnesses, and the imbalances encountered in accessing healthcare services become the major crisis areas. These issues call for a societal standpoint. More specifically, in case of a pandemic, since many individuals are infected by the same contagion, they impact populations differently as against the classical illnesses. Pandemics are seen as dreadful phenomena in social histories [8–10]. They are known to cause enormous panic among common people, compelling them to live in a state of fear and uncertainty. Pandemics disrupt life's natural process, and everyone has a specific experience of the disease outbreak. Therefore, health information begins to emerge that is passed on from one generation to another.

Hence, this research attempts to implement a hybrid method that uses the integration of fuzzy and fuzzy Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) to calculate the effect of Coronavirus dispersion on numerous factors of software industry. Using the Multi-Criteria Decision

Making (MCDM) approach, we selected different software industry's factors that were affected by COVID-19 pandemic on the basis of some specified criteria. MCDM is Operation Research's most significant component through which people can take their daily decisions in a nuanced manner. Several researchers are modeling many of the MCDM instruments. All these MCDM ideas are built on decision-making behavioral issues. Individuals pick the best alternative options in the MCDM procedure with regard to certain factors. These MCDM techniques have also been used to solve different decision making issues due to COVID-19 pandemic [11–14]. Thus, to obtain accurate and conclusive results, the present study also employs the MCDM technique for the intended estimation.

The rest of this paper has been arranged as follows: Section 2 discusses the impact of novel COVID-19 on software industry. Section 3 deliberates upon the materials and methods used in this research study. Section 4 presents the empirical analysis and findings of the proposed study. The results' sensitivity analysis and comparison with different approaches are detailed in Section 5. Section 6 discusses the findings of this research study. Finally, Section 7 presents the conclusion.

2 The Impact of COVID-19 on Software Industry

Pandemics have always damaging effect on industries at all levels. COVID-19 pandemic is not only a worldwide health emergency; it is also the biggest cause of economic upheavals across the globe now. As the world grapples with the crisis and works towards containing the spread of the virus, the policymakers should also plan for the next step. The next "natural" is not however. However, there is no definitive pattern or standard available to aid the decisions of the strategists. Moreover, the standard operating procedure in the case of preventive measures for Coronavirus like social distancing, wearing masks is not accessible to everyone. The modern reality is made of ambiguity, confusion and possibilities. Unfortunately, the pandemic has further underscored these debacles. In such a scenario, organizations have to be flexible and agile with robust mechanisms that can help them to adjust and survive. COVID-19 has had a significant impact on the software industry, affecting the supply of resources, interrupting the production chain of the consumer products, besides triggering inflation risk in goods. In a positive way, the interruption led to acceleration in the phenomenon of working remotely, like work-from-home is the new norm in most of the organizations now. In this process, the end-to-end chain has been tested and made risk-free. Moreover, limited or no travel in the recent months implied less vehicular pollution. Thus, decrease in carbon emissions may contribute to a renewed emphasis on sustainable growth.

The Coronavirus outbreak has pointed to revamped tech expenditure growth estimates in 2020. A survey's findings published on Statista Portal demonstrate the effect of COVID-19 pandemic on the consumer spending trend from May 2020. Though most customers foresee no adjustments in their tech spending, the majority of the respondents reported a decrease in spending than a rise in spending. This trend of decline in spending covers nearly all the industries [5]. The graphical representation of this study can be seen in Fig. 1. Most software developers do have action plans; however, these plans do not completely resolve the rapidly evolving uncontrollable factors of an emergency such as COVID-19. Standard safety measures are structured to ensure operating efficiency following, among many other items, natural disasters, cyber-attacks and power failures. Normally, they do not take into consideration the common quarantines, prolonged university shutdowns and additional travel bans in the emergency situation for healthcare systems. Hence, the impact of the pandemic on the software industry has been detrimental in more ways than one.

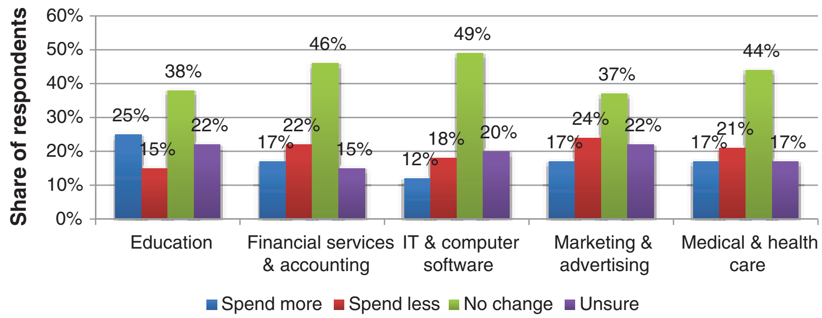

Figure 1: Industry-wise impact of COVID-19 on software spending worldwide

3 Materials and Methods

3.1 Criteria and Alternatives Selection

Review of the existing literature and experienced and professional questionnaire-based surveys were designed for conducting this research paper's empirical calculations. We analyzed approximately 30 publications to select those factors of the software industry that have been affected by the spread of COVID-19 pandemic. It is demonstrated in previous studies that each of the selected factors has somehow been influenced by Coronavirus. Therefore, we premised our literature search on the essential criteria for selecting the alternatives in this study. Since our target was the analysis of the impact on the software, academic experts play an important role in this research. Opinions of several academicians and researchers from trusted organizations were sought for selecting the most relevant factors required to conduct this research work. Around 43 valid responses of 60 experts and researchers have been collated to select the highly affected software industry factors by COVID-19 pandemic.

It is supposed that the impact of software industry is based on seven criteria- the (ICi), and is responsible for seven alternatives solutions (SAi). The seven main criteria are: Functionality (IC1), Reliability (IC2), Flexibility (IC3), Costs (IC4), R&D (IC5), Concept Conflict (IC6) and Risks (IC7). Seven alternatives are: Non-profit (SA1), Government Administration (SA2), Healthcare (SA3), Education (SA4), Insurance (SA5), IT & Security (SA6), and Financial (SA7). In the second stage of the current process, because of COVID-19 pandemic spread, the alternatives were chosen as impacted factors in the society. These factors were identified by reviewing of the existing relevant literature, and then selected by a panel of specialists. Tab. 1 explicates all the identified criteria for evaluating the impact of pandemic on software industry factors. Fig. 2 shows the hierarchy representation of our decision problem.

Table 1: Evaluation criteria for the impact of COVID-19 on software industry

Criteria	Description	References
Functionality (IC1)	The functionality of a software application shows how useful it is or how many functions it can perform. Marketing departments use the versatility of a software product to define service offerings, and encourage a customer to have a collection of capabilities. Functionality can be simple to use, or complex.	[10–12]
Reliability (IC2)	Reliability is a characteristic of any software application that operates reliably as per its specified requirements. It must be considered when producing, purchasing or using a software product.	[15,16]

Table 1 (continued).

Criteria	Description	References
Flexibility (IC3)	A distinguishing characteristic of software application is the versatility of software designs, especially where methods of software development require the use of a variety of abilities.	[17,18]
Costs (IC4)	This includes expenses on the development of software applications, testing, distribution, and reporting.	[19,20]
R&D (IC5)	Research and Development is more than anything else, an analysis that seeks to create something new – A finding which would lead to a new software service or product, or one that would boost or strengthen an available product.	[21,22]
Concept Conflict (IC6)	An issue which occurs when two programmes cannot run simultaneously on the same machine. Levels of software development can lead to software designers competing in different positions. Concept conflict has varying consequences for early investors vs. many organizations.	[23,24]
Risks (IC7)	In software industry, risk can be described as the probability that the actual results of an event or investment would vary from the intended results or returns. Risk involves a possible loss of any or all of an initial investment.	[25,26]

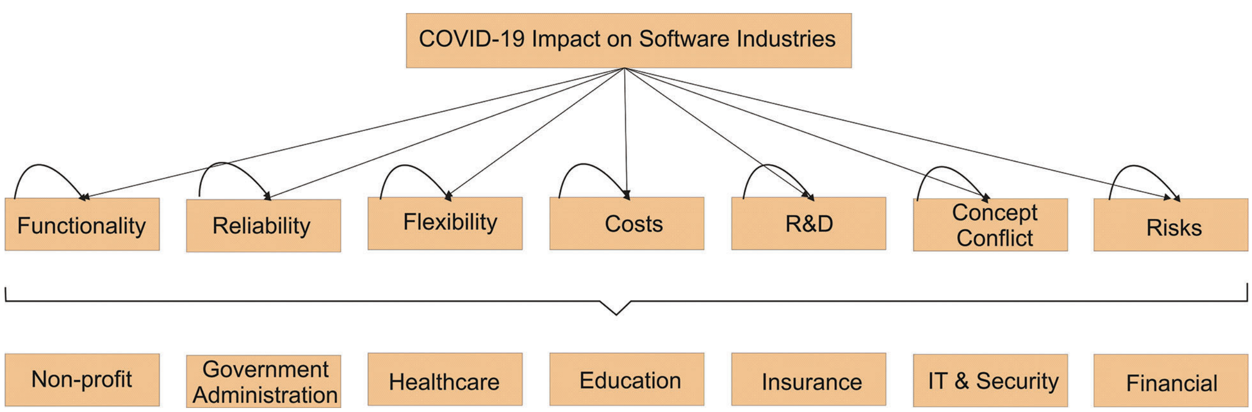

Figure 2: ANP structure of the evaluation of the impact of COVID-19 on software industry

3.2 Fuzzy ANP-TOPSIS Method

3.2.1 Fuzzy ANP

ANP was initiated by Saaty. It reflects a common analytical hierarchy (AHP) method [11]. Although AHP is a system with a unidirectional structured AHP arrangement, it is the ANP that enables effective interconnections between the levels as well as attributes of decisions. The ANP recommendations strategy substitutes hierarchies through networks that do not simply reflect the associations among levels as low or high, superior or inferior, implicit or explicit [12]. For example in a structure, the meaning and value of alternatives not only determines the meaning of the parameters, but it also may affect the validity of the parameters [11]. Furthermore, a continuous top-to-bottom design is not appropriate for a complicated process. AHP is a robust system intended to deal with logical, sensible and unreasonable choices, with or without assurance for a variety of alternatives, if we take multi-objective, multi-criteria and multi-actor choices. AHP's fundamental principles are that it is capable of using its entire lower portion and the parameters or objects in each category in the functional ability of the upper portion or group of the structure [12]. Most policy challenges cannot be hierarchically structured since the association and reliance of higher-level entities on low-level elements are involved [11,13–15]. Responses between clusters are possible through the structuring of a functional dependency problem. It is a feature of the network. Saaty [11] proposed the utilization of AHP to fix the alternatives or parameters as independent issues including the use of ANP to overcome the question of alternatives or parameters' dependency. The main transformation among ANP and AHP is that the structural weight can be accomplished through the creation of a "supermatrix" in order to handle interdependencies among the decision rates and parameters [14,27–29].

3.2.2 Fuzzy TOPSIS

TOPSIS is among the most successful MCDM approach currently and has performed successfully in many application domains. Hwang and Yoon [15] were the first to cite an approach to overcome MCDM problems. According to them, the basic concept of this approach was to rank the alternative at the shortest distance from the given positive range as the best or the ideal solution, and the one at the farthest distance, the worst solution. Subsequently, Chen [16] expanded the TOPSIS system into a floating setting by replacing the numerical linguistic ranking and weighting rates by using TFNs (triangular fuzzy numbers). After the system propositioned by Chen, a variety of approaches were suggested for the modifications of the Fuzzy TOPSIS. For this paper, we have used the decision making process that was carried out by Chen [16], Fuzzy TOPSIS system. This approach is very appropriate in the fuzzy setting, particularly for solving the ambiguities that arise due to decision making by a group. Within this system, linguistic methods are considered as the weights of specific parameters and qualitative parameters scores [18,19]. The step-by-step process for determining the weights of the selected factors/attributes as well as the priority ranking obtained with the help of Fuzzy ANP-TOPSIS is defined as given below:

Step 1: The linguistic words were converted first into simple quantitative data, and subsequently into Triangular Fuzzy Numbers (TFNs). In this research analysis the TFNs are indicated as (t1, t2, t3), in which (t1 t2 = t3) and (t1, t2, t3) the least, intermedium and maximum value parameters in the TFNs are indicated. Suppose that A is a deceptive number which could also be shown by Eqs. (1) and (2) and also in Fig. 3 [26].

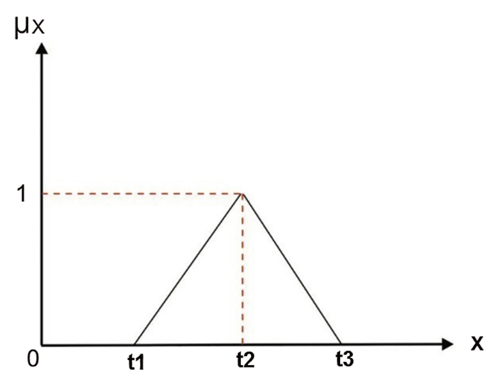

Figure 3: Triangular fuzzy number

$$\mu_A(x) = F \rightarrow [0,1] \tag{1}$$

$$\mu_A(x) = \begin{cases} \frac{x - t1}{t2 - t1}, & t1 \le x \le t2 \\ \frac{t3 - x}{t3 - t2}, & t2 \le x \le t3 \\ 0, \quad x > t3 & Otherwise \end{cases} \tag{2}$$

Firstly, 50 specialists took differing opinions. All such specialists come from IT firms and academia and have a range of production and testing backgrounds with each set of characteristics and associated data. In a digital conference setting the specialists were asked to gather and evaluate their viewpoints and to be aware of the spectrum of qualities according to the various nationalities and standards.

With the appropriate support of the information recorded, authors from this study derived the network architecture. Various software industries were evaluated by the architecture to determine the weights of the properties of the effect of COVID-19. The specialists expressed their opinion by qualities that influence one another in a measurable way, with the help of a predefined scale which can be seen in Tab. 2.

Table 2: Scale of triangular fuzzy numbers

Numerical Values	Triangular Fuzzy Numbers	
1	Equally significant	(1, 1, 1)
3	Weakly significant	(2, 3, 4)
5	Fairly significant	(4, 5, 6)
7	Strongly significant	(6, 7, 8)
9	Absolutely significant	(9, 9, 9)
2	Intermittent values between two adjacent scales	(1, 2, 3)
4		(3, 4, 5)
6		(5, 6, 7)
8		(7, 8, 9)

Triangular fuzzy number (TFN) is constructed from precise numerical process variables using Eqs. (3)–(6) (t1ij, t2ij, t3ij), where t1ij mean lower level, t2ij means average level, and t3ij means maximum level. Triangular fuzzy number is produced from t2ij. The word TFN [ηij], from the other hand, is as follows:

$$\eta_{ij} = \left(t1_{ij},\ t2_{ij},\ t3_{ij}\right) \tag{3}$$

where, $\quad t1_{ij} \le t2_{ij} \le t3_{ij}$

$$t1_{ij} = \min\left(J_{ijd}\right) \tag{4}$$

$$t2_{ij} = \left(J_{ij1}, J_{ij2}, J_{ij3}\right)^{\frac{1}{x}} \tag{5}$$

$$\text{and } t3_{ij} = \max\left(J_{ijd}\right) \tag{6}$$

Jijk explains the relative influence of the variables on two variables, as the specialists have determined, described in accordance with the above equations. The term I and j signify a couple of characteristics that specialists decide in this situation. The TFN is determined in accordance with the geometrical mean of the judgment of the domain specialists for a precise reference. Eqs. (7)–(9) consequently enables TFN variables to be combined. There were two TFNs: A1 and A2; A1 = (t11, t21, t31) and A2 = (t12, t22, t32). They are subject to the following operational standards:

$$(t1_1,\ t2_1,\ t3_1) + (t1_2,\ t2_2,\ t3_2) = (t1_1 + t1_2,\ \ t2_1 + t2_2,\ t3_1 + t3_2) \tag{7}$$

$$(t1_1,\ t2_1,\ t3_1) \times (t1_2,\ t2_2,\ t3_2) = (t1_1 * t1_2,\ \ t2_1 * t2_2,\ t3_1 * t3_2) \tag{8}$$

$$(t1_1,\ t2_1,\ t3_1)^{-1} = \left(\frac{1}{t3_1}, \frac{1}{t2_1}, \frac{1}{t1_1}\right) \tag{9}$$

Step 2: With the support of input from domain specialists, a matrix for a pair-wise comparison is constructed. Assessment of the Consistency Index (CI) is conducted employing Eq. (10) formula according to following:

$$CI = (\gamma_{max} - c)/(c - 1) \tag{10}$$

In Eq. (10), the term CI is the Consistency Index and c is the range of factors comparable. The following step consists of a random index (RI) calculation of the consistency ratio (CR). This can be achieved by the following Eq. (11):

$$CR = CI/RI \tag{11}$$

When CR < 0.1, the matrix generate outcome is relatively consistent. Where the random index (RI) taken from the Saaty Random Index.

Step 3: Through the defuzzification procedure, after processing of a remarkably consistent matrix, the TFN values are converted into observable values. In this study the procedure of defuzzification has been used [26] as described in Eqs. (12)–(14), commonly known as *alpha-cut* method.

$$\mu_{\alpha,\beta}(\eta_{ij}) = \left[\beta.\eta\alpha(c1_{ij}) + (1 - \beta).\ \eta\alpha(c3_{ij})\right] \tag{12}$$

where, $0 \le \alpha \le 1$ and $0 \le \beta \le 1$

Such that,

$$\eta\alpha(c1_{ij}) = (c2_{ij} - c3_{ij}).\alpha + c1_{ij} \tag{13}$$

$$\eta\alpha(c3_{ij}) = c3_{ij} - (c3_{ij} - c2_{ij}).\alpha \tag{14}$$

For the identification of the domain specialist options, the previously measurements equations were applied by α *and* β.

Step 4: The ANP approach discusses dependence among both within a cluster and between different clusters. The objective of this strategy is to formulate the *supermatrix* resulted from comparative analysis between groups such as goal, factors, sub-factors and alternative solutions originating from the choice vector.

Step 5: To determine an alternative's overall performance for a TOPSIS fixed factor, this formula needs that the whole decision matrix must be in normalized form.

$$X_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \tag{15}$$

In the above Eq. (15), $i = 1, 2, \ldots m$; *and* $j = 1, 2, \ldots n$.

Afterward, the Normalized Weighted-Decision Matrix is generated (Eq. (16)).

$$M_{ij} = w_i X_{ij} \tag{16}$$

where, i = 1, 2, … m and j = 1,2, … n.

Step 6: Assessment of *I+ matrix positive-ideal solution*, and *I- matrix negative-ideal solution*.

$$\begin{aligned} I^+ &= z_1^+, z_2^+, z_3^+ \ldots\ldots z_n^+ \\ I^- &= z_1^-, z_2^-, z_3^- \ldots\ldots z_n^- \end{aligned} \tag{17}$$

In the above Eq. (17), z_j^+ *is Max zij if j* is an improvement aspect, *and Max zij if j* is a cost aspect; z_j^- is Min zij if j is an improvement aspect as well as Min zij if j is a cost aspect.

Step 7: The very next move is to measure the discrepancy among the importance of each option and the positive and also the negative-ideal solution:

The positive-ideal solution:

$$D_i^+ = \sqrt{\sum\nolimits_{j=1}^{m} \left(z_i^+ - z_{ij}\right)^2}\ ; i = 1, 2, 3 \ldots .m \tag{18}$$

The Negative-ideal solution:

$$D_i^- = \sqrt{\sum\nolimits_{j=1}^{m} \left(z_{ij} - z_i^-\right)^2}\ ; \quad \text{where, } i = 1, 2, 3 \ldots .m \tag{19}$$

In the above Eq. (18), D_j^+ *expresses the Positive-Ideal solution distance for i selection*, and also in Eq. (19) D_i^- *is the distance from the ideal-negative approach*. Quantify the value of every alternative solution of the performance (Pi) (Eq. (20)).

$$P = \frac{D_i^-}{D_i^- - D_i^+} \tag{20}$$

In Eq. (20), i = 1, 2, 3….m

The step-wise sequential evaluation process referred to above would be followed by the implementation of the Fuzzy-ANP TOPSIS method, with a set of available alternatives to determine the effect of the COVID-19 on various software industries.

4 Data Interpretation and Findings

The impact of COVID-19 on different software industry factors evaluated with the help of fuzzy-ANP-TOPSIS method. This process includes Eqs. (1)–(20), and is detailed below:

The authors in this article produced some statistical findings with the help of uniform Saaty scale shown in the Tab. 2 along with the use of Eqs. (1)–(9), converted the textual words into numeric measurable representation. The triangular fuzzy numeric (TFN) values were then combined. Eqs. (3)–(6) were used to turn correct numerical values into fuzzy TFN values. In addition, the Level-1 variable comparative matrix is calculated in the pairs. Afterward, Eqs. (10)–(20) were used for evaluating both the accuracy metrics and the random index (RI) of the formulas. A matrix for pair-wise comparisons has a random index of below 0.1, which implies that the matrix is pair-wise (Tabs. 3–8).

According to the findings of this research study as presented in Tab. 8 and Fig. 4, the Closeness Coefficient (Ci) of different alternatives is estimated as- 0.31215, 0.32425, 0.21245, 0.27859, 0.27854, 0.28457 and 0.25658 for SA1, SA2, SA3, SA4, SA5, SA6 and SA7, respectively. The findings show that SA2 software industry factor is highly affected by the impact of COVID-19 pandemic.

Table 3: Fuzzy based pairwise comparison matrix

	IC1	IC2	IC3	IC4	IC5	IC6	IC7
IC1	1.00000, 1.00000, 1.00000	0.56110, 0.66120, 0.75130	1.74140, 2.34130, 2.91440	0.61740, 0.93574, 1.06457	0.49475, 0.65457, 0.84472	1.04525, 1.00470, 1.00747	0.4450, 0.51450, 0.66450
IC2	0.50140, 0.65450, 0.94254	1.00000, 1.00000, 1.00000	1.18450, 1.47560, 1.87527	0.79598, 0.96856, 1.14858	1.46145, 1.86450, 2.22450	1.33788, 1.52785, 1.80787	1.55450, 2.20450, 2.85045
IC3	1.16140, 1.67120, 1.96130	0.53045, 0.68450, 0.85470	1.00000, 1.00000, 1.00000	1.09858, 1.34859, 1.87898	1.61547, 2.34758, 3.15478	0.34778, 0.43775, 0.57857	1.40470, 1.82478, 2.45759
IC4	0.34170, 0.43150, 0.58650	0.88457, 1.04457, 1.26470	0.53470, 0.74450, 0.53456	1.00000, 1.00000, 1.00000	1.54578, 1.93589, 2.35589	0.95859, 1.08865, 1.64589	1.25457, 1.64457, 2.03458
IC5	0.32250, 0.41250, 0.59230	0.45456, 0.54450, 0.69450	1.14580, 1.56459, 1.81589	0.42089, 0.52079, 0.67077	1.00000, 1.00000, 1.00000	1.19860, 1.54880, 2.03589	1.14581, 1.49447, 1.90548
IC6	0.38220, 0.48230, 0.63240	0.56750, 0.66470, 0.75470	1.74010, 2.34020, 2.99030	0.61078, 0.93075, 1.06075	0.49459, 0.65589, 0.84568	1.00000, 1.00000, 1.00000	0.40457, 0.51457, 0.66441
IC7	1.10240, 1.56470, 1.81457	0.35745, 0.45457, 0.64758	0.41040, 0.55070, 0.71047	0.49047, 0.61045, 0.80045	0.53589, 0.67589, 0.84586	1.51568, 1.96589, 2.51568	1.00000, 1.00000, 1.00000

Table 4: Defuzzification by using alpha-cut method

	IC1	IC2	IC3	IC4	IC5	IC6	IC7	Weightage
IC1	1.00000	1.77145	0.89145	2.56478	2.66458	2.34474	0.93652	0.28800
IC2	0.56245	1.00000	1.72541	1.21145	1.85452	1.79475	2.41145	0.18900
IC3	1.12457	0.57100	1.00000	0.98457	2.60454	0.69457	2.12124	0.16500
IC4	0.39454	0.82457	1.01475	1.00000	2.17744	0.77745	1.89425	0.13300
IC5	0.37457	0.54741	0.38585	0.45589	1.00000	1.82457	1.76745	0.25740
IC6	0.42741	0.55457	1.44745	1.29765	0.54457	1.00000	1.43645	0.11890
IC7	1.07156	0.41245	0.47357	0.52652	0.56652	0.69458	1.00000	0.09046
								CR = 0.07200

5 Validations of Results

5.1 Sensitivity Analysis

For every scientific research study, an interpretation of the findings obtained from the various viewpoints is crucial. The procedure of sensitivity analysis is one of the most efficient and reliable methods for authenticating the relevance of the outcome [21,23,24]. The proposed analysis utilized seven experimental studies in this research study to evaluate sensitivity, since the first level of hierarchy does have seven factors. At the time of testing, the sensitivity weights of all aspects were dissimilar, and at the same time, the other weights and degree of satisfaction were constant. The assessed outcome of the significant sensitivity analysis step can be seen in Tab. 9.

Table 5: Global weights

Attributes	Global weights	Global priorities
IC1	0.189124	2
IC2	0.207457	1
IC3	0.185145	3
IC4	0.165471	4
IC5	0.112455	5
IC6	0.072456	6
IC7	0.067892	7

Table 6: Subjective cognition results of evaluators in linguistic terms

Attributes/ Alternatives	SA1	SA2	SA3	SA4	SA5	SA6	SA7
IC1	6.27000, 8.27000, 9.45000	3.91000, 5.91000, 7.55000	3.18000, 5.18000, 7.00000	1.64000, 3.36000, 5.36000	1.18000, 3.00000, 5.00000	4.45000, 6.45000, 8.00000	1.18000, 3.00000, 5.00000
IC2	3.18000, 5.18000, 7.00000	1.64000, 3.36000, 5.36000	1.18000, 3.00000, 5.00000	4.45000, 6.45000, 8.00000	1.18000, 3.00000, 5.00000	3.00000, 4.82000, 6.55000	0.64000, 2.27000, 4.27000
IC3	4.82000, 6.82000, 8.27000	1.00000, 2.64000, 4.64000	0.64000, 2.27000, 4.27000	3.00000, 4.82000, 6.55000	0.64000, 2.27000, 4.27000	3.55000, 5.36000, 7.00000	0.36000, 1.73000, 3.73000
IC4	4.09000, 6.09000, 7.73000	0.73000, 2.27000, 4.27000	0.36000, 1.73000, 3.73000	3.55000, 5.36000, 7.00000	0.36000, 1.73000, 3.73000	4.45000, 6.45000, 8.00000	1.18000, 3.00000, 5.00000
IC5	3.18000, 5.18000, 7.00000	1.64000, 3.36000, 5.36000	1.18000, 3.00000, 5.00000	4.45000, 6.45000, 8.00000	1.18000, 3.00000, 5.00000	3.00000, 4.82000, 6.55000	0.73000, 2.45000, 4.45000
IC6	3.55000, 5.55000, 7.27000	0.82000, 2.45000, 4.45000	0.73000, 2.45000, 4.45000	3.00000, 4.82000, 6.55000	0.73000, 2.45000, 4.45000	3.00000, 4.82000, 6.55000	0.64000, 2.27000, 4.27000
IC7	4.82000, 6.82000, 8.27000	1.00000, 2.64000, 4.64000	0.64000, 2.27000, 4.27000	3.00000, 4.82000, 6.55000	0.64000, 2.27000, 4.27000	3.55000, 5.36000, 7.00000	0.36000, 1.73000, 3.73000

Table 7: The weighted normalized fuzzy-decision matrix

Attributes/ Alternatives	SA1	SA2	SA3	SA4	SA5	SA6	SA7
IC1	0.02800, 0.07200, 0.12000	0.07400, 0.10700, 0.13400	0.06800, 0.10400, 0.13400	0.02800, 0.07200, 0.12000	0.07400, 0.10700, 0.13400	0.06800, 0.10400, 0.13400	0.04800, 0.08700, 0.12900
IC2	0.01300, 0.04500, 0.08200	0.03800, 0.06200, 0.08300	0.03800, 0.06500, 0.09000	0.01300, 0.04500, 0.08200	0.03800, 0.06200, 0.08300	0.03800, 0.06500, 0.09000	0.06800, 0.10400, 0.13400
IC3	0.01300, 0.04700, 0.09000	0.04400, 0.07100, 0.09600	0.04400, 0.07500, 0.10600	0.01300, 0.04700, 0.09000	0.04400, 0.07100, 0.09600	0.04400, 0.07500, 0.10600	0.03800, 0.06500, 0.09000
IC4	0.02400, 0.04600, 0.07000	0.04400, 0.06600, 0.08400	0.01100, 0.03500, 0.06700	0.00500, 0.02800, 0.06100	0.04000, 0.06100, 0.07900	0.02400, 0.04600, 0.07000	0.06800, 0.10400, 0.13400
IC5	0.01400, 0.04300, 0.07900	0.01300, 0.04500, 0.08200	0.03800, 0.06200, 0.08300	0.03800, 0.06500, 0.09000	0.01300, 0.04500, 0.08200	0.03800, 0.06200, 0.08300	0.03800, 0.06500, 0.09000
IC6	0.02000, 0.05500, 0.09500	0.01300, 0.04700, 0.09000	0.04400, 0.07100, 0.09600	0.04400, 0.07500, 0.10600	0.01300, 0.04700, 0.09000	0.04400, 0.07100, 0.09600	0.04400, 0.07500, 0.10600
IC7	0.05100, 0.07000, 0.08300	0.02400, 0.04600, 0.07000	0.04400, 0.06600, 0.08400	0.01100, 0.03500, 0.06700	0.00500, 0.02800, 0.06100	0.04000, 0.06100, 0.07900	0.02400, 0.04600, 0.07000

Table 8: Closeness coefficients to the aspired level among the different alternatives

Alternatives	d+i	d−i	Ci
SA1	0.16142	0.07552	0.31215
SA2	0.24124	0.11895	0.32425
SA3	0.23458	0.07545	0.21245
SA4	0.45457	0.16658	0.27859
SA5	0.47758	0.17569	0.27854
SA6	0.17596	0.06785	0.28457
SA7	0.34578	0.09578	0.25658

5.2 Comparison of Results

Comparative analysis is also an essential part for confirming the effectiveness of the tactics applied by a researcher. We have used other associated method called the classical ANP-TOPSIS to undertake a comparative analysis of the results. We used this data for evaluation to gauge the observations via these techniques. It shows the reflection of the results collected from multiple different methods on the radar chart. The study results outlined in the following table show a strong similarity between all the observations from other techniques [21]. It indicates that the Fuzzy-based method provides similar research results over the regular methods. The following Tab. 10 demonstrates the comparison of fuzzy ANP-TOPSIS results with the Classical ANP-TOPSIS approach.

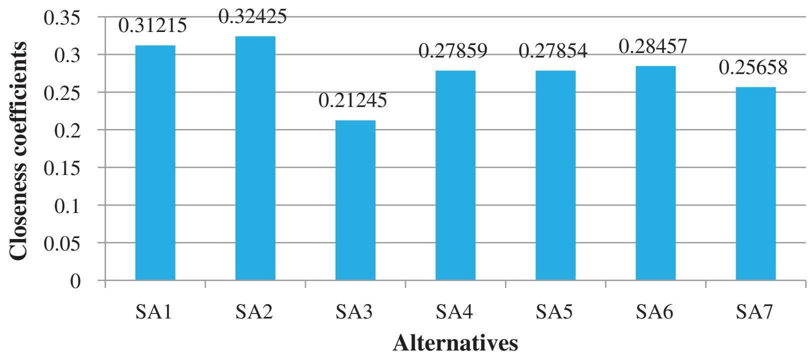

Figure 4: Graphical representation of the closeness coefficients for alternatives

Table 9: Sensitivity analysis

Alternatives	Original weights	IC1	IC2	IC3	IC4	IC5	IC6	IC7
SA1	0.34600	0.30140	0.24810	0.28200	0.29230	0.24810	0.28200	0.29230
SA2	0.35940	0.34600	0.30700	0.31230	0.31340	0.30700	0.31230	0.31340
SA3	0.24300	0.35940	0.33200	0.31530	0.30800	0.33200	0.31530	0.30800
SA4	0.30140	0.24300	0.20240	0.21360	0.21820	0.20240	0.21360	0.21820
SA5	0.34600	0.30700	0.31230	0.31340	0.30700	0.31230	0.31340	0.31450
SA6	0.35940	0.33200	0.31530	0.30800	0.33200	0.31530	0.30800	0.31610
SA7	0.24300	0.20240	0.21360	0.21820	0.20240	0.21360	0.21820	0.21460

Table 10: Comparison through classical ANP-TOPSIS technique

Alternatives	Fuzzy ANP-TOPSIS	Classical ANP-TOPSIS
SA1	0.31215	0.29645
SA2	0.32425	0.30475
SA3	0.21245	0.19745
SA4	0.27859	0.27859
SA5	0.27854	0.25265
SA6	0.28457	0.28458
SA7	0.25658	0.26548

6 Discussion

In order to prevent the transmission of COVID-19, all regional and federal governments worldwide suspended both the international and domestic travel. Besides this, most of the countries adopted temporary phases of shutdowns/lockdowns as a means to break the chain of transmission and reduce the Coronavirus cases. Numerous religious, educational, cultural, professional, sports and mass political conventions such as the conferences, festivals, Olympic games, etc., were cancelled. These countermeasures have undoubtedly been successful in containing the spread of the pandemic. As per the findings of this study, the software industry did not respond to the pandemic with increased responsiveness. Notably, as per the experts, ambivalence is not appropriate for the industry structure amidst the looming threat of the pandemic and the alerts about hand-washing and cleanliness, social separation and staying home need to be adhered to. Respondents also noted that perhaps the software industry does have a remarkable ability to follow the rules. Moreover, the respondents have faith in the government, the healthcare system and medical facilities and the consistency of the nation's decisions in fighting the COVID-19 pandemic. In addition, the respondents were also mindful of the information being disseminated by the media platforms about the accurate implementation of strategies to contain COVID-19. The findings show that the *Government administration based software application* is the *worst* affected factor due to the pandemic. This is software application or the administration constraints that the people are now facing due to COVID-19 pandemic. The other Software application categories that have been influenced can be ranked in the following descending order as per their ranking: *Non-profit, IT & Security, Education, Insurance, Financial and Healthcare*.

The battle against COVID-19 is a prolonged one and is likely to affect different spectrums of software industry. Moreover, given the magnitude of disruption and upheaval that this pandemic has unleashed, some of the consequences could be far reaching and may be tabulated at a much later date. In such an unpredictable scenario, individuals require perseverance and strength to preserve positive communication and also to satisfy their essential necessities without any problems. Our study has been carried out in the early stages. It is very important that individuals who are stranded in different places or facing isolation due to quarantine impositions remain perseverant so as to thrive in the prevalent social construct at this tragic time. Most pertinently perhaps, information should be given or action needs to be taken to improve the service trust associated with economic initiatives.

7 Conclusion

In summary, COVID-19 is a worldwide concern which calls for workable and prompt solutions from not only each country's governments but citizens and communities as well. Government agencies must provide the public with exact information that would help them to cope up with this serious infection. Citizens in turn must religiously follow the guidelines laid down by their respective State governments. Continuous medical research and dedicated management initiatives to restrict the spread of the COVID-19 are mandatory. Any further damage likely to be done by COVID-19 pandemic can be controlled through sustained preventive mechanisms that will be successful only with societal participation. The COVID-19 disease outbreak has had a number of different impacts on the whole planet. Every individual has been hit in one form or another; some have gone bankrupt, others have lost their loved ones. The Software industry has not been and is not likely to be debilitated by COVID-19 in the near future, but, like every other industry, due to the worldwide pandemic it has certainly seen some adjustments. The Software industry has already dealt with negative issues and has emerged more resilient than before. Coronavirus tends to intensify the introduction of technology in the workplaces and the increase is likely to persist even after the COVID-19 disease outbreak. Implementing robots and AI has the potential to keep companies running in the phases of social distancing as well as significantly reduce security related risks to the users. Hence the overall impact of the pandemic on the software industry has not been voluminous. Moreover, should the industry invest in more AI mechanisms, better outcomes can be accomplished.

Acknowledgement: The authors would like to thank the Deanship of Scientific Research at Taif University, Kingdom of Saudi Arabia, for their funding support under Grant No.: 1-441-53.

Funding Statement: The Deanship of Scientific Research at Taif University, Kingdom of Saudi Arabia.

Conflicts of Interest: The authors declare that they have no Conflicts of Interest to report regarding the present study.

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