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Transition Supply Chain 4.0 to Supply Chain 5.0: Innovations of Industry 5.0 Technologies Toward Smart Supply Chain Partners

Mona Mohamed [1,*], Karam M. Sallam [2], and Ali Wagdy Mohamed [3]

[1] Higher Technological Institute, 10th of Ramadan City 44629, Egypt; mona.fouad@hti.edu.eg.
[2] School of IT and Systems, Faculty of Science and Technology, University of Canberra, Canberra, Australia; karam.sallam@canberra.edu.au.
[3] Operations Research Department, Faculty of Graduate Studies for Statistical Research, Cairo University, Giza 12613, Egypt; aliwagdy@staff.cu.edu.eg.

* Correspondence: mona.fouad@hti.edu.eg.

Abstract: Industry 4.0 provides businesses with the tools they need to meet difficulties such as fluctuating demand and unstable markets. Additionally, Industry 4.0 refers to the connectivity of computers, various materials, and artificial intelligence (AI) with minimum involvement from humans in the decision-making process. Although Industry 4.0 has a significant potential for the expansion of the industrial sector, it faces several hurdles, including integration of technology, problems with human resources, problems with supply chains, and data security concerns. The human-centered approach that Industry 5.0 took meant that many of the problems that plagued Industry 4.0 could finally be solved. In the previous generation, known as Industry 4.0, the emphasis was placed on scalability and volume of production; however, in the next generation, known as Industry 5.0, human centricity is the key focus. We have included a list of the different technical improvements that are part of Industry 5.0 as well as the technological advancements that are part of Industry 4.0. The problems that plagued Industry 4.0 have been addressed head-on in Industry 5.0, including concerns over data protection and the integration of new technologies. This study would serve as a foundation for academics and companies to learn about the technologies of Industry 4.0, their obstacles, the technical advancements, and the methods by that Industry 5.0 addressed the issues of Industry 4.0. Also, we constructed an appraiser model to appraise manufacturers as partner in supply chain. We selected manufacturers which are interested in deploying Industry 5.0 in their operation. Analytic Hierarchy Process (AHP) and Complex Proportional Assessment (COPRAS) are contributed to construct appraiser model under authority of uncertainty theory entailed in single value neutrosophic sets (SVNSs) to support AHP and COPRAS in ambiguity situations.

Keywords: Industry 5.0; Industry 4.0; Technical Improvements; Human Centricity; Data Security; AHP; COPRAS; Single Value Neutrosophic sets.

1. Introduction

Prior to the advent of the Industrial Revolution, production was conducted through traditional methods that may have been more optimal for large-scale production [1]. The advent of steam power and mechanized systems precipitated the onset of the First Industrial Revolution, a transformative period characterized by a significant augmentation in production, reaching an eightfold increase. The onset of the Second Industrial Revolution was marked by the introduction of novel technological innovations, such as electrical, mechanical, and electronic devices within the industrial sector. The implementation of partial automation within the context of industry and production marked the inception of what is commonly referred to as Industry 3.0. This enhancement resulted in increased reliability and efficiency in the production process [2]. The advent of computer numerical control brought about the implementation of a semi-automatic software system that effectively automates the process of machining parts. This technological advancement has proven to be instrumental in enhancing production volume. The advancement of Industry 3.0 necessitated substantial quantities of materials and diverse resources, coupled with the enhancement of prevailing methodologies, thereby giving rise to the emergence of Industry 4.0. The integration of manufacturing systems with Information and Communication Technology in Industry 4.0 has led to the automation of various processes. The advent of Industry 4.0 has significantly enhanced the efficacy of strategic decision-making processes by virtue of its real-time data analysis capabilities.

The advent of Industry 4.0 has brought forth a multitude of novel technologies, including but not limited to additive manufacturing, artificial intelligence, augmented reality, blockchain, and Cybersecurity [3]. Additionally, it aids in the mitigation of diverse obstacles, such as fluctuations in demand and volatility in the market. Industry 4.0 encompasses the integration of computer systems, materials, and artificial intelligence, aiming to minimize human involvement in decision-making processes. The impetus for the Industrial Revolution emerged from the necessity to transform conventional machinery into autonomous learning machines capable of enhancing performance, maintenance, and management through the utilization of contextual interactions. The advent of Industry 4.0 has also facilitated the implementation of digital food traceability systems, which have proven effective in mitigating instances of food fraud and enhancing the efficiency of food-related information dissemination. Amidst the Covid-19 pandemic, Industry 4.0 offered a diverse range of digital solutions to address pressing challenges.

Industry 5.0 is a paradigm that integrates the cognitive abilities of human beings with the accuracy and productivity of artificial intelligence in the context of industrial manufacturing processes. The emergence of Industrial 5.0 can be attributed to its potential to address the obstacles encountered in the context of Industry 4.0. This new paradigm places a strong emphasis on human-centricity and the fulfilment of societal requirements [4]. The implementation of this solution has the potential to effectively address the discrepancy that exists between manufacturing practices and the societal demands. The advancement of the Industrial Revolution to its fifth iteration necessitates the implementation of more advanced technological systems, including Network Sensor Data Interoperability, smart houses, Cobots, and other intelligent systems. Operators have the option to utilize collaborative robots, also known as Cobots, in order to enhance their efficiency and precision. Industry 5.0 prioritizes the integration of humans in manufacturing and industrial production processes, thereby offering workers more substantial and fulfilling employment opportunities.

1.1 Relevance of the study

Industry 5.0 has the potential to effectively address the obstacles encountered during the Industrial Revolution 4.0. Industry 4.0 paradigm does not offer the necessary framework for attaining Europe's objectives by 2030 due to its potential to establish a technological monopoly within the market. Industry 5.0 encompasses the anticipation of future disruptions that may be encountered by the industry, such as the COVID-19 pandemic, while also incorporating the principles of sustainability. In the context of industrial development, Industry 4.0 placed emphasis on sustainability, while Industry 5.0 shifts its focus towards human centricity.

1.2 Aims of the study

The objective of this study is to investigate the ways in which Industry 5.0 and its emerging innovations contribute to addressing the obstacles encountered in the context of Industry 4.0. Industry 5.0 has not only facilitated the implementation of diverse novel technologies, but it is also aiding in the resolution of the limitations encountered in Industry 4.0. Therefore, the primary objective is to examine the obstacles encountered by Industry 4.0 and subsequently investigate the diverse technologies associated with Industry 5.0 in order to assess their potential for implementation and integration within the industrial sector. This analysis aims to address the limitations and enhance the collaboration between these technologies and the human workforce. Another objective represents in evaluating manufacturers which embracing technologies of industry 5.0 in its operations and chain.

2. Obstacles Faced by Industry 4.0

Integration of technology is a big obstacle for Industry 4.0, among other important problems. The manufacturing of low-quality goods is a possible outcome of using technology that do not possess the capability to deal with the effects of digitalization. Additionally, additional effort is required in order to successfully deploy new information technology. In addition, standardized protocols will need to be developed so that machines can communicate with one another effectively.

Another significant obstacle that firms must overcome is keeping their data and information secure. The Internet of Things has the potential to make enterprises more susceptible to industrial espionage and unauthorized access.

The problem of human resources is just another difficulty that Industry 4.0 must overcome. To be able to operate in such an atmosphere, the staff members need the appropriate training.

Additionally, certain supply chain problems arose as a result of Industry 4.0. The process of digitizing and automating supply networks is gaining momentum. Both the accuracy of market forecasts and the capacity to track individual items have seen significant increases as a direct result of increased precision in both areas. This has resulted in a decrease in the number of planning cycles. The most difficult obstacle that must be overcome in supply chain management is the management of data integration and privacy.

3. Industry 5.0 as a solution to the problems that have been caused by Industry 4.0

There are several difficulties associated with Industry 4.0, all of which are effectively addressed by Industry 5.0.

3.1 Supply chain problem

Supply chain 4.0 takes into account a variety of issues, including its tactics, technologies that are disruptive to the industry, and numerous ramifications for the supply chain's performance [5]. Supply chain 4.0 is mostly focused on technological advancements, but supply chain 5.0 takes into account the interaction of people and technology. The new supply chain, known as version 4.0, is predicated on the concept of mass customization as well as improved supply chain performance attained via increased transparency, flexibility, and waste reduction. The objective of Industry 5.0 is to preserve these advantages while also generating additional value via mass personalization. The Internet of Things, artificial intelligence, and blockchain are the primary technologies used by supply chain 4.0. On the other hand, Industry 5.0 utilizes similar technologies but with more advanced characteristics in terms of technology, particularly AI and the utilization of cobots. The management of the supply chain for Industry 5.0 also has an emphasis on sustainability. Table 1 exhibits the positive impact of Industry 5.0 toward supply chain 5.0.

Table 1. Influence Industry 5.0 Technologies on Supply Chain.

Ref #	**Utilized Industry 5.0 Technology**	**Technology's influence on the supply chain**
Govindan etal [6], Al-Talib etal [7], Qader et al. [8]	Internet of Things (IoT)	• When a disruptive event is noticed, IoT can give precise information and enable quick treatment.

		• Reduced lead times. • Higher service rate. • Enhanced inventory velocity through improved inventory picking procedures
Govindan et al. [6]	Cyber-Physical Systems (Cyb-PSs)	• More transparent and traceable distribution. • Eliminate waste and practice lean manufacturing.
Zouari et al.[9]	Big Bata Analytics (BDAs)	•With the use of BDA, disturbances may be tracked back to their source and their spread can be observed. •Information sharing.
Karl et al. [10], Singh et al. [11]	Digital Twins (DIT)	• Improve client engagement to boost service rate. • Risk management.
Goel et al. [12]	Industrial Robotics (Ind R)	• A comprehensive change of the production and manufacturing phase is being brought about by Ind R. • Assist employees do their duty by utilizing various forms of cooperation. • Security
Ivanov et al. [13], Ding [14]	Additive Manufacturing (AM)	• Rapid and on-demand production. • Expedite the construction of multiple sophisticated prototypes that may be employed in the manufacturing process.

3.2 Human resource problem

The traditional methods of production were more easily automated as a result of Industry 4.0. Therefore, the employees have need for proper training to be supplied to them. Industry 5.0, on the other hand, places an emphasis on human centricity and is predicated on effective communication between people and robots. In this regard, the contributions made by cobots have been significant. In order to accomplish the goal at hand, these robots coordinate their efforts with human workers. As a result, they contribute to increased levels of productivity and efficiency in the workforce. In addition, the employees can participate in activities that add more value to the product without having to do duties that are boring or be engaged in professions that are hazardous. However, in order to safeguard these devices from future malfunctions, predictive maintenance has to be performed on them regularly.

Typically and according to [15] when investing in new technology, businesses now have many goals in mind. When a corporation, for instance, demands both improved information exchange and information security at the same time, the decision-making process may be complicated by the presence of numerous, sometimes at odds, criteria.

Thus, this study attempts to enhance the decision-making process by utilizing MCDM techniques as AHP [16] to evaluate the sustainability of the supply chain. Others benefited from the ability of fuzzy sets (FSs) to strengthen MCDM techniques in uncertain situations. For instance, [17] combined interval-valued intuitionistic Fuzzy (IVIF) Sets with AHP to appraise criteria weights and the IVIF Additive Ratio Assessment (ARAS) technique utilized for evaluating the alternatives. In a similar vein, [18] hesitant fuzzy AHP (HF-AHP) was employed for evaluating criteria and sub-criteria of BC in the supply chain, HF- Technique for Order Preference by Similarity to Ideal Solution (HF-TOPSIS) for ranking alternatives.

Although FS with its various versions has been widely used for supporting decision makers (DMs) in ambiguated decisions and situations through combination with MCDM methods. Another uncertainty theory is used as Neutrosophic theory with MCDM techniques in appraising the process for the supply chain.

Hence, this study serves as an appraiser for influencing Industry 5.0 in the supply chain especially the manufacturing sector as a partner in the supply chain. Also ranking, and appraising alternatives of manufacturers and recommend the most optimal one.

4. Evaluation Procedure Methodology

Herein, we are analyzing and evaluating the implications regarding employing digital technologies in the supply chain according to Industry 5.0's considerations. The process of analyzing and evaluating is conducted through a set of steps by various techniques.

4.1 Basic Industry 5.0's Considerations

The initial and vital step in our study is determining the major considerations related to implementing Industry 5.0 technologies in supply chain.

Step 1: we identify considerations of Industry 5.0 technologies which contribute to analyzing and evaluating the manufacturers that embracing Industry 5.0 technologies in its operations and supply chain.

Step 2: we are selecting members of experts who are interested in our search scope and forming an expert panel. This panel is volunteering to rate manufacturers based on the identified considerations of Industry 5.0.

4.2 Judgement of Considerations

The initial and vital step in our study is determining the major considerations related to implementing Industry 5.0 technologies in supply chain.

Step 3: the confirmed panel is rating the identified considerations based on scale is listed in [19]. This scale is constructed based on interpreting crisp values into approximate values and considering measuring the degree of belonging (truth), non-belonging (falsity), and indeterminacy. This interpretation falls under the phenomenon of single-value neutrosophic sets (SVNSs). This phenomenon belongs to uncertainty theory is neutrosophic theory.

Step 4: decision matrices are produced by the previous step. These matrices are transformed into crisp matrices according to the score function represented in Eq. (1).

$$s(\text{con}_{ij}) = \frac{(2+\text{Tr}-\text{In}-\text{Fl})}{3} \tag{1}$$

Where:

$s(\mathrm{con_{ij}})$ refers to score function. whilst $\mathrm{Tr, Fl, In}$ refers to truth, false, and indeterminacy respectively.
Step 5: the produced crisp decision matrices are aggregated into aggregated decision matrix through calculating average of these matrices as in Eq. (2).

$$\mathrm{New\ con_{ij}} = \frac{(\sum_{j=1}^{\mathrm{Exp}} \mathrm{con_{ij}})}{\mathrm{Exp}s} \tag{2}$$

Where:
$\mathrm{con_{ij}}$ refers to value of Industry 5.0's consideration in decision matrices, where Exps refers to number of experts.

4.3 Generalization of considerations' weights via AHP technique

The initial and vital step in our study is determining the major considerations related to implementing Industry 5.0 technologies in supply chain.
Step 6: AHP technique is working under authority of SVNSs to compute weights of industry 5.0's considerations. Eq. (3) operate to normalize aggregated decision matrix after that normalized decision matrix is generated.

$$\mathrm{Q_{ij}} = \frac{\mathrm{con_j}}{\sum_{j=1}^{m}(\mathrm{con_j})}, \mathrm{j} = 1,2, \dots \dots \mathrm{n} \tag{3}$$

Where:
$\mathrm{Q_{ij}}$ is a normalized decision matrix. Whilst $\mathrm{con_j}$ is element/consideration in aggregated decision matrix, and $\sum_{j=1}^{m}(\mathrm{con_j})$ is the sum of considerations per column in the aggregated matrix.
Step 7: Eq. (4) plays an important role in obtaining considerations' weights as:

$$\mathrm{weig\_con_i} = \frac{\sum_{i=1} \mathrm{Q_i}}{\mathrm{N\_con}} \tag{4}$$

Where:
$\mathrm{weig\_con_i}$ refers to consideration's weight, $\mathrm{N\_con}$ indicates to number of considerations =8, $\sum_{i=1} \mathrm{Q_i}$ sum of considerations per raw in normalized matrix.
Step 8: Check consistency ratio (Con R) through calculating consistency index (Con I) and a random consistency index (Ran I) based on following Eq. (5).

$$\text{Con R}=\frac{\text{Con I}}{\text{Ran I}} \tag{5}$$

4.4 Recommending Optimal Alternative based on Ranker Technique

Herein, subjective technique has been applied as COPRAS under authority of SVNSs to appraise set of alternatives which deploying Industry 5.0 based on determined considerations. Afterthat rank it and recommend best one through deploying the following steps:
Step 9: we are cooperating with the formed expert panel to appraise alternatives based on determined industry 5.0's considerations. Neutrosophic decision matrices have been constructed through rating alternatives via utilizing scale in [19].
Step 10: converting neutrosphic decision matrices into crisp matrices through Eq. (1) and aggregated it into single decision matrix. Based on Eq. (2).
Step 11: Eq. (6) plays an important role in normalizing single decision matrix.

$$\mathrm{Norm_{Agg}} = [\mathrm{s_{ij}}]_{m \times n} = \frac{\mathrm{p_{ij}}}{\sum_{i=1}^{m} \mathrm{p_{ij}}} \tag{6}$$

Where:
$\mathrm{Norm_{Agg}}$ is normalized of aggregated decision matrix. $\mathrm{p_{ij}}$ considers value of consideration for alternatives in aggregated decision matrix. $\sum_{i=1}^{m} \mathrm{p_{ij}}$refers to sum of consideration per column.
Step 12: weighted decision matrix is generated through Eq. (7).

$$\mathrm{weig\_\,dec_{ij}} = \mathrm{weig\_con_i} * \mathrm{Norm_{Agg}} \tag{7}$$

Step 13: Sum of weighted decision matrix calculated according to Eqs. (8) and (9).

$$\mathrm{Sum\_weig_{+i}} = \sum_{j=1}^{n} \mathrm{weig\_\,dec_{+ij}}, \text{ for beneficial criteria} \tag{8}$$

$$\mathrm{Sum\_weig_{-i}} = \sum_{j=1}^{n} \mathrm{weig\_\,dec_{-ij}}, \text{ for nonbeneficial criteria} \tag{9}$$

Step 14: the relative importance of alternatives is calculated through Eq. (10).

$$Q_i = Sum\_weigs_{+i} + \frac{Sum\_weig_{-min} \sum_{i=1}^{m} Sum\_weig_{-i}}{Sum\_weig_{-i} \sum_{i=1}^{m} (Sum\_weig_{-m}/Sum\_weig_{-i})} \quad (10)$$

Step 15: quantity utility U_i for each alternative is computed based on Eq. (11) to rank the alternatives.

$$U_i = \left[\frac{Q_i}{Q_{max}}\right] \times 100\% \quad (11)$$

5. Case Study: Empirical Evidence

In this study, we implemented our proposed model on real manufacturers on the 10th of Ramadan City, Egypt to prove model's validity. The candidates of manufacturers have different activities. Herein, we cooperate with four manufacturers (alternatives) that embrace the technologies of Industry 5.0 in their operations and its chain. These alternatives have been appraised through our proposed model based on determined Industry 5.0's considerations.

- Firstly, the considerations of industry 5.0 are determined.
  - In this study, eight considerations (Con(n)) have been determined to contribute to appraisal operation as in Figure 1.
  - The expert panel is formed to rate determined considerations which consists of three members.
- Secondly, considerations' valuation.
  - Neutrosophic decision matrices are constructed based on experts' rating.
  - Deneutrosopic these matrices into crisp values based on Eq. (1) and aggregated it into single aggregated matrix is listed in Table 2.
  - Table 3 represents normalization for aggregated decision matrix.
  - We leveraged normalized decision matrix to obtain considerations' weights based on Eq. (4) as in Figure 2.
  - According to Figure 2, Con 8 is highest weight value based on AHP and SVNSs otherwise, Con1 with least value.

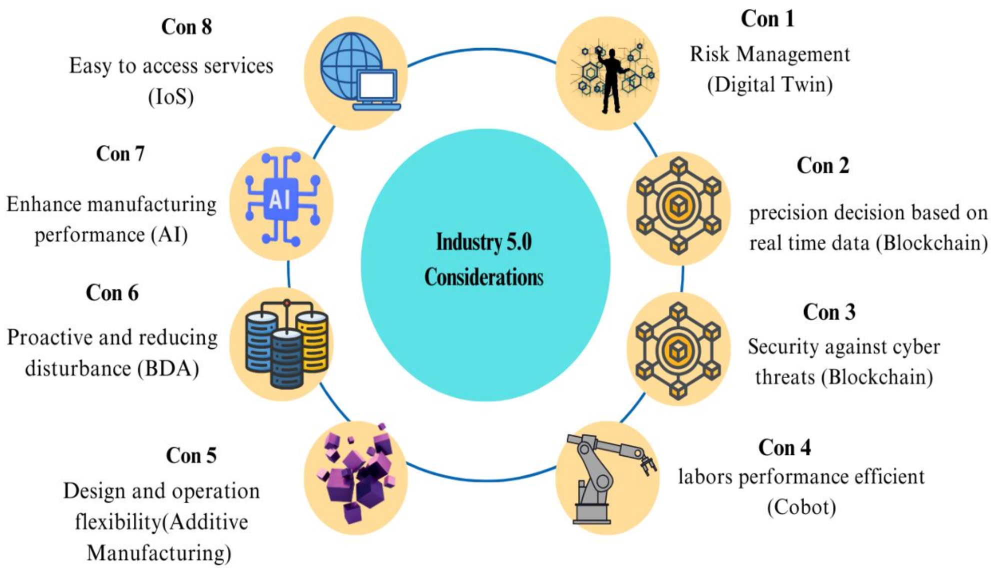

Figure 1. Determined Industry 5.0 considerations.

Table 2. Aggregated decision matrix AHP based on SVNSs.

	Con_1	Con_2	Con_3	Con_4	Con_5	Con_6	Con_7	Con_8
Con_1	0.5	0.761	0.728	0.428	0.667	0.69	0.61	0.46
Con_2	1.033	0.5	1	0.93	0.7	0.694	0.47	0.69
Con_3	2.533	1	0.5	0.967	0.87	0.521	0.87	0.73
Con_4	5.533	1.067	1.033	0.5	1	0.97	0.9	0.74
Con_5	4.033	4	1.2	1	0.5	0.97	0.7	0.97
Con_6	2.5667	2.567	3.067	1.033	1.03	0.5	0.94	0.97
Con_7	4.133	4.33	1.133	1.133	1.13	1.1	0.5	0.76
Con_8	4.867	2.567	2.533	1.367	1.03	1.033	1.57	0.5

Table 3. Normalized aggregated decision matrix AHP based on SVNSs.

	Con_1	Con_2	Con_3	Con_4	Con_5	Con_6	Con_7	Con_8
Con_1	0.019	0.045	0.065	0.058	0.096	0.108	0.092	0.079
Con_2	0.041	0.03	0.07	0.127	0.101	0.1072	0.072	0.119
Con_3	0.101	0.06	0.05	0.131	0.126	0.080	0.133	0.125
Con_4	0.219	0.06	0.09	0.068	0.144	0.149	0.137	0.128
Con_5	0.160	0.24	0.11	0.136	0.072	0.1493	0.107	0.166
Con_6	0.102	0.15	0.27	0.14	0.149	0.077	0.143	0.167
Con_7	0.164	0.26	0.101	0.154	0.163	0.169	0.076	0.131
Con_8	0.193	0.153	0.226	0.186	0.1489	0.159	0.238	0.086

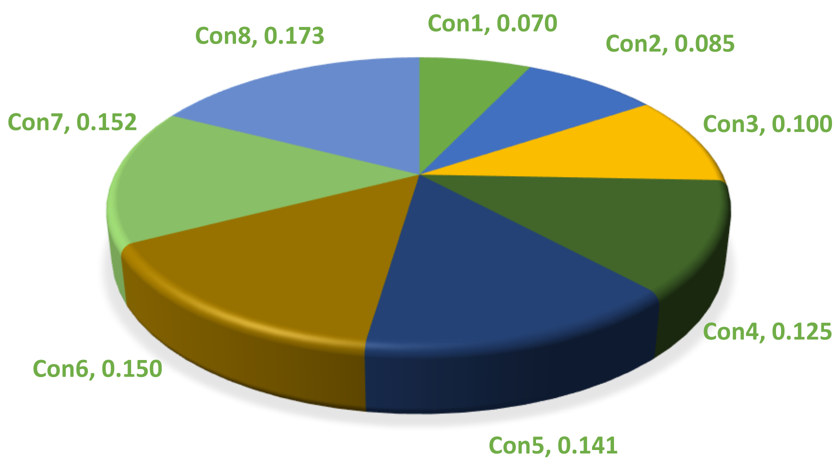

Figure 2. Considerations Weights AHP based on SVNSs.

- Thirdly, Recommending Optimal Alternative
  - According to preferences of expert panel for alternatives based on Industry 5.0, we constructed neutrosophic decision matrices.
  - Score function in Eq. (1) utilized to deneutrosophic the constructed matrices.
  - Then these matrices aggregated into decision matrix based on Eq. (2) as listed in Table 4.
  - According to Eq. (6) to normalize the aggregated decision matrix as in Table 5.

- Each element in generated normalized decision matrix is multiplied by weights of AHP based on SVNSs and produce weighted decision matrix as in Table 6.
- In this study, determined considerations are considered beneficial. Thus, Eq. (8) is utilized to get S_{+i} values. Thus, S_{-i} values= zero. Subsequently, the value of S-min/S-i is zero, where S-min is zero. So, the relative importance of alternatives (Q_i) based on Eq. (10), $Q_1 = 0.24533810603.$ $Q_2 = 0.30649300022.$ $Q_3 = 0.16555453,$ $Q_4 = 0.209908098.$
- Eq. (11) is applied to calculate quantitative utility (U_i) for alternatives where its values are exhibiting in Figure 3. According to these values manufacturer 2 (A2) is optimal one. Otherwise, manufacturer 3 (A3) is the worst.

Table 4. Aggregated decision matrix COPRAS based on SVNSs.

	Con1	Con2	Con3	Con4	Con5	Con6	Con7	Con8
A1	0.81	0.65	0.33	0.62	0.39	0.37	0.72	0.84
A2	0.81	0.74	0.69	0.54	0.1	0.84	0.27	0.71
A3	0.72	0.62	0.81	0.1	0.81	0.81	0.51	0.81
A4	0.9	0.81	0.72	0.28	0.71	0.62	0.9	0.53

Table 5. Normalized aggregated decision matrix COPRAS based on SVNSs.

	Con1	Con2	Con3	Con4	Con5	Con6	Con7	Con8
A1	0.25	0.23	0.13	0.40	0.19	0.13	0.29	0.29
A2	0.33	0.34	0.31	0.58	0.06	0.37	0.16	0.34
A3	0.15	0.15	0.19	0.05	0.23	0.2	0.13	0.19
A4	0.22	0.22	0.22	0.16	0.26	0.19	0.27	0.16

Table 6. Weighted decision matrix COPRAS based on SVNSs.

	Con1	Con2	Con3	Con4	Con5	Con6	Con7	Con8
A1	0.016	0.019	0.013	0.05	0.028	0.021	0.045	0.051
A2	0.024	0.029	0.031	0.07	0.0083	0.056	0.025	0.060
A3	0.010	0.0125	0.019	0.01	0.033	0.030	0.020	0.033
A4	0.015	0.019	0.022	0.02	0.04	0.028	0.041	0.027

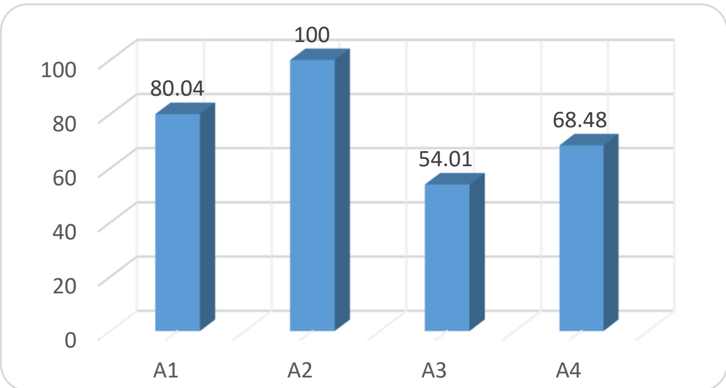

Figure 3. Alternatives' quantitative utility by COPRAS based on SVNSs.

6. Discussion

Industry 4.0 is characterized by a strong emphasis on technology, while Industry 5.0 seeks to enhance these technological advancements by incorporating human-centric elements. One such area where Industry 5.0 demonstrates this shift is in the supply chain. In this context, Industry 5.0 retains the advantages of Industry 4.0, such as mass customization, while also introducing the concept of collaborative robots, which ensures that humans remain an integral part of the supply chain process. The unauthorized access and manipulation of data through piracy represent a significant challenge within the context of Industry 4.0. However, the implementation of Blockchain Middleware offers a promising solution to effectively address this issue.

Hence, it is important for any supply chain and its participants to embrace the technologies of Industry 5.0 toward gain competitive advantages and to be sustainable in global markets. For this, the appraising process for manufacturers that deploy such technologies in their operations and throughout their chain.

Herein, we conducted a survey for these manufacturers which are interested in applied modern technologies. The results of the survey were represented by four manufacturers (alternatives) which contributed to the appraising process. These alternatives are considered the major factor in this process. Another factor is the considerations that are utilized to rate the alternatives.

These rates are treated as input for techniques of constructed appraisal models. AHP based on SVNSs is analyzing these rates and obtaining considerations' weights. The results of AHP based on SVNSs are exhibited in Figure 2 where con8 is best with the highest value, followed by con6 whilst con1 is worst with the least value. Implementation of COPRAS based on SVNSs to rank alternatives and recommend optimal ones. According to the results of these techniques which are showcased in Figure 3, A2 is optimal whilst A3 is the worst.

7. Conclusions

This work focuses on researching the problems that were encountered by Industry 4.0 and the solutions that were found for them in Industry 5.0. Industry 5.0 is still in the process of being developed, and there is only a small amount of material available. Therefore, Industry 5.0 presents a tremendous potential for research to be carried out, particularly in the fields of Data Security and Integration. This is because the integration of things with the Internet, also known as The Industrial Internet of Things, is often regarded as the most critical difficulty. Ideas that are more environmentally friendly may also be created for Industry 5.0. The era of automation and digitalization has made it simpler to examine the data created by sensors used in businesses. This has made it possible to eliminate the many hurdles that had been preventing companies from increasing their production and efficiency.

Data availability

The datasets generated during and/or analyzed during the current study are not publicly available due to the privacy-preserving nature of the data but are available from the corresponding author upon reasonable request.

Conflict of interest

The authors declare that there is no conflict of interest in the research.

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

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