Distance of Similarity Measure under Neutrosophic Sets to Assess the Challenges of IoT in Supply Chain and COVID-19

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Abstract

The globe has been coping with the COVID-19 epidemic, eagerly awaiting the completion of the vaccine process. Despite the Internet of Things (IoT) and its effect on supply networks, the recent epidemic has brought unprecedented supply chain disruptions. To assess the relevance of these issues, we speak with leading specialists. A novel distance-based similarity metric based on neutrosophic set theory is being used in this research to examine IoT challenges in the supply chain. The proofs for each of the properties are provided straightforwardly.

Keywords: Neutrosophic Sets; Similarity Distance; COVID-19; Supply Chain.

1. Introduction

The globe has been coping with the COVID-19 epidemic, eagerly awaiting the completion of the vaccine process. Traditional supply chains for vaccinations are currently under pressure as scientists have created medicines at record speed. When it comes to producing and shipping billions of vaccinations, the supply chain has come under the microscope. Machine-to-machine (M2M) systems had changed supply chains in the aftermath of digitization and intensive computer use during the last several decades (SC). The Internet of Things (IoT) is a term used to describe these M2M information exchanges, which have been dubbed the 4th industrial revolution, or Industry 4.0. (i4.0). In the wake of the pandemic, SCs' revolutionary shift to i4.0 has been further hindered.

Recent research predicts a massive upheaval, and it's easy to see why. The Industrial Internet of Things (IIoT), also known as i4.0, has given rise to a new generation of smart factories that are capable of operating in real-time [1]. Data analytics for complex operations go beyond digitalization by automatically capturing data with sensors and making it accessible to authorized organizations both internally and outside [2]. As a result of the Internet of Things (IoT), these competent factories are filled with state-of-the-art technology, including smart sensors, big data analytics, and law and administration. Autonomous, stand-alone factories with smart capabilities are essential, but the research continues to insist that SCs must be digitalized to realize i4.0 [3]–[5]. This is because all procedures in SCs must be integrated and automated. It's also uncommon for the benefits of the Internet of Things (IoT) to be overestimated and its consequences misunderstood despite the tremendous expansion of IIoT research.

Doi : https://doi.org/10.54216/IJNS.180426
Received: March 28, 2022 Accepted: July 10, 2022

The vast majority of industrial firms have no idea how much IIoT adoption will change their business. Even though research on IIoT technologies consistently highlights their potential advantages [6], the existing literature also posits uncertainty and risk but is not restricted to, general management [7], [8]; environmental (Wang To build flexible and resilient supply chains, it is necessary to identify, assess, and address several elements, risks, and difficulties, all of which are very complicated[9], [10]. The current outbreak of COVID-19 has exacerbated these problems.

Assessment and elimination of supply chain hazards is the goal of Supply Chain Risk Management (SCRM) [11][12].

Research on SCRM and IIoT has been sparse, but the potential advantages of IIoT technologies in supply chains, such as agility, flexibility, and resilience, have gained importance.[7]. The pandemic's effects on IIoT utilization in supply chains must be taken into consideration while constructing more competent supply chains. Supply chains during a pandemic confront unique challenges. In the event of a pandemic, addressing the issues of IIoT technology in supply chains becomes even more critical because of this. Several recent studies have attempted to categorize the obstacles and hazards of the IIoT in SC.

The difficulties of the Internet of Things (IoT) are accompanied by threats. The predicted benefits of IIoT adoption are negatively impacted by problems and hazards that arise as a result of such issues. According to our knowledge, no effort has been made to evaluate the relevance of IIoT and supply chain concerns. The present pandemic's influence on research into these issues might also aid in understanding the development of IIoT in SC.

2. Basic Preliminaries

This part laid the groundwork for several of the concepts that would be used throughout the study[13]–[20].

Definition 1.

$$\begin{gathered} Suppose\ Y\ is\ a\ set\ of\ points\ (objects) \\ in\ which\ Y\ represents\ a\ generic\ element. \\ A\ truth\ Tr_U\ (Y), an\ indeterminacy\ \ Ind_U\ (Y), and\ a\ falsity\ m\ FL_U(Y) \\ describe\ a\ single\ valued\ neutrosophic\ set\ U\ in\ Y. \\ U = \{\langle y, Tr_U(y), Ind_U(y), FL_U(y)\rangle | y \in Y\} \\ Tr_U\ (y), Ind_U\ (y), FL_U\ (y)\ are\ real\ subsets\ of\ [0,1] \end{gathered}$$

Definition 2.

$$\begin{gathered} Normalized\ Hamming\ distance\ measure\ dis_{MG}^{MI}(U,J)\ operator \\ between\ neutrosophic\ set\ U\ and\ J\ is\ defined\ as\ follows: \\ dis_{MG}^{MI}(U,J) = \frac{1}{3m}\sum\nolimits_{a=1}^{m}\begin{pmatrix} |Tr_U\ (y_a) - Tr_J\ (y_a)| + \\ |Ind_U\ (y_a) - Ind_J\ (y_a)| \\ +|FL_U\ (y_a) - FL_J\ (y_a)| \end{pmatrix} \end{gathered}$$

Definition 3.

$$\begin{gathered} Normalized\ Euclidean\ distance\ measure\ dis_{MG}^{MI}(U,J)\ operator \\ between\ neutrosophic\ set\ U\ and\ J\ is\ defined\ as\ follows: \\ dis_{MG}^{MB}(U,J) = \sqrt{\frac{1}{3m}\sum\nolimits_{a=1}^{m}\begin{pmatrix} (Tr_U\ (y_a) - Tr_J\ (y_a))^2 + \\ (Ind_U\ (y_a) - Ind_J\ (y_a))^2 + \\ (FL_U\ (y_a) - FL_{UJ}(y_a))^2 \end{pmatrix}} \end{gathered}$$

Definition 4.

$$An\ extended\ Hausdorff\ Distance\ dis_{MG}^{BI}(U,J)\ operator$$

Doi : https://doi.org/10.54216/IJNS.180426
Received: March 28, 2022 Accepted: July 10, 2022

$$between\ neutrosophic\ set\ U\ and\ J\ is\ defined\ as\ follows:$$
$$dis_{MG}^{BI}(U,J) = \frac{1}{m}\sum_{a=1}^{m} max\left\{\begin{array}{c} |Tr_U\,(y_a) - Tr_J\,(y_a)|, \\ |Ind_J\,(y_a) - Ind_J\,(y_a)|, \\ |FL_U\,(y_a) - FL_J\,(y_a)| \end{array}\right\}$$

Definition 5.

$$\begin{gathered} Let\ U,J\ be\ two\ neutrosophic\ sets\ in\ Y. \\ The\ similarity\ measure\ between\ the\ neutrosophic\ sets\ U\ and\ J \\ can\ be\ evaluate\ from\ distance\ measures, as\ follows: \\ G_M(U,J) = 1 - dis_{MG}(U,J) \\ where\ dis_{MG}(U,J)\ is\ represent\ the\ distance\ measure \\ between\ neutrosophic\ set\ U\ and\ J\ for\ all\ y_a \in Y. \end{gathered}$$

Definition 6.

$$\begin{gathered} The\ distance\ measures\ for\ neutrosophic\ set\ dis_{MG}(U,J) \\ and\ similarity\ measure\ for\ neutrosophic\ set\ G_M(U,J) \\ satisfies\ the\ following\ properties: \\ 0 \le dis_{MG}(U,J) \le 1; \\ 0 \le G_M(U,J) \le 1; \\ (\ dis_{MG}(U,J) = 0\ if\ and\ only\ if\ U\ =\ J; \\ G_M(U,J)) = 1\ if\ and\ only\ if\ for\ U = J; \\ dis_{MG}(U,J) = dis_{MG}(J,U); \\ G_M(U,J) = G_M(J,U); \\ (dis_{MG}(U,P) \le dis_{MG}(U,J)\ and\ dis_{MG}(U,P) \le dis_{MG}(J,P) \\ if\ P\ is\ neutrosophic\ set\ in\ Y\ and \\ U \subseteq J \subseteq P; \\ G_M(U,P) \le G_M(U,J)\ and\ G_M(U,P) \le G_M(J,P) \\ if\ C\ is\ neutrosophic\ set\ in\ Y \\ and\ U \subseteq J \subseteq P. \end{gathered}$$

Definition 7.

$$\begin{gathered} Let\ Y = \{y_1, y_2, \ldots., y_{nm}\} be\ the\ universe\ of\ discourse. \\ Let\ \ U = \{y_a, Tr_U(y_a), FL_U\,(y_a)) : y_a \in Y\} \\ and\ J = \{y_a, Tr_J(y_a), FL_J\,(y_a) : y_a \in Y\} \\ be\ two\ intuitionistic\ fuzzy\ sets. \\ Then, the\ distance\ measure\ between\ U\ and\ J\ can\ be\ defined\ as: \end{gathered}$$
$$dis_{IFS}(U,J) = \frac{2}{m}\sum\nolimits_{a=1}^{m} \frac{sin\left\{\frac{\pi}{6}|Tr_U(y_a) - Tr_J(y_a)|\right\} + sin\left\{\frac{\pi}{6}|FL_U\,(y_a) - FL_J\,(y_a)|\right\}}{1 + sin\left\{\frac{\pi}{6}|Tr_U(y_a) - Tr_J(y_a)|\right\} + sin\left\{\frac{\pi}{6}|FL_U\,(y_a) - FL_J\,(y_a)|\right\}}$$

Definition 8.

$$\begin{gathered} The\ distance\ measures\ for\ intuitionistic\ fuzzy\ set\ dis_{IFS}(U,J) \\ satisfies\ the\ following\ properties: \\ 0 \le dis_{IFS}(U,J) \le 1; \\ dis_{IFS}(U,J) = 0\ if\ and\ only\ if\ U\ =\ J; \\ dis_{IFS}(U,J) = dis_{IFS}(J,U); \\ dis_{IFS}(U,P) \le dis_{IFS}(U,J) \\ and\ dis_{IFS}(U,P) \le dis_{IFS}(J,P) \\ if\ P\ is\ intuitionistic\ fuzzy\ set\ in\ Y\ and \\ U \subseteq J \subseteq P. \end{gathered}$$

Doi : https://doi.org/10.54216/IJNS.180426
Received: March 28, 2022 Accepted: July 10, 2022

Definition 9.

$$LLet\ Y = \{y_1, y_2, \ldots, y_{nm}\} be\ the\ universe\ of\ discourse.$$
$$Let\ \ U = \{y_a, Tr_U(y_a), FL_U\ (y_a)) : y_a \in Y\}$$
$$and\ J = \{y_a, Tr_J(y_a), FL_J\ (y_a) : y_a \in Y\}$$
$$be\ two\ neutrosophic\ sets.$$
$$Then, a\ new\ distance\ measure\ can\ be\ defined\ as:$$

$$dis_{New}^{M}(U,J) =$$

$$\frac{2}{m}\sum_{a=1}^{m} \frac{sin\left\{\frac{\pi}{10}\left|\begin{matrix}Tr_U\ (y_a) - \\ Tr_J\ (y_a)\end{matrix}\right|\right\} + sin\left\{\frac{\pi}{10}\left|\begin{matrix}Ind_U\ (y_a) - \\ Ind_J\ (y_a)\end{matrix}\right|\right\} + sin\left\{\frac{\pi}{10}\left|\begin{matrix}FL_U\ (y_a) - \\ FL_{UJ}(y_a)\end{matrix}\right|\right\}}{1 + sin\left\{\frac{\pi}{10}\left|\begin{matrix}Tr_U\ (y_a) - \\ Tr_J\ (y_a)\end{matrix}\right|\right\} + sin\left\{\frac{\pi}{10}\left|\begin{matrix}Ind_U\ (y_a) - \\ Ind_J\ (y_a)\end{matrix}\right|\right\} + sin\left\{\frac{\pi}{10}\left|\begin{matrix}FL_U\ (y_a) - \\ FL_J\ (y_a)\end{matrix}\right|\right\}}$$

Proposition 1.

$$The\ distance\ measures\ dis_{New}^{M}(U,J)\ \ for\ neutrosophic\ sets$$

$$U\ and\ J\ comply\ with\ the\ following\ properties:$$
$$0 \le dis_{New}^{M}(U,J) \le 1;$$
$$dis_{New}^{M}(U,J) = 0\ if\ and\ only\ if$$
$$U\ =\ J;$$
$$dis_{New}^{M}(U,J) = dis_{New}^{M}(J,U);$$
$$dis_{New}^{M}(U,P) \le dis_{New}^{M}(U,J)$$
$$and\ dis_{New}^{M}(U,P) \le dis_{New}^{M}(J,P)$$
$$if\ P\ is\ neutrosophic\ set\ in\ Y\ and$$
$$U \subseteq J \subseteq P.$$

Proof:

$$0 \le dis_{New}^{M}(U,J) \le 1.$$
$$As\ we\ know\ the\ degree\ of\ truth, indeterminacy, and\ falsity\ membership$$
$$for\ neutrosophic\ set\ is$$
$$0 \le Tr_U(y), Ind_U(y), FL_U(y) \le 1.$$
$$This\ implies\ for\ U = \{y_a, Tr_U(y_a), Ind_U\ (y_a), FL_U\ (y_a)) : y_a \in Y\}$$
$$and\ J = \{y_a, Tr_J(y_a), Ind_J\ (y_a), FL_J\ (y_a) : y_a \in Y\}$$

$$0 \le \left|Tr_U(y_a) - Tr_J(y_a)\right| \le$$
$$1, 0 \le \left|Ind_U\ (y_a) - Ind_J\ (y_a)\right| \le 1,$$
$$\text{and } 0 \le \left|FL_U\ (y_a) - FL_J\ (y_a)\right| \le 1$$
$$\Rightarrow 0 \le sin\left\{\frac{\pi}{10}\left|Tr_U(y_a) - Tr_J(y_a)\right|\right\} \le \frac{1}{3},$$

Doi : https://doi.org/10.54216/IJNS.180426
Received: March 28, 2022 Accepted: July 10, 2022

$$0 \le sin\left\{\frac{\pi}{10}\left|Ind_U(y_a) - Ind_J(y_a)\right|\right\} \le \frac{1}{3},$$
$$and$$
$$0 \le sin\left\{\frac{\pi}{10}\left|FL_U(y_a) - FL_J\,(y_a)\right|\right\} \le \frac{1}{3}$$

$$\Rightarrow 0 \le sin\left\{\frac{\pi}{10}\left|Tr_U\,(y_a) - Tr_J\,(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|Ind_U(y_a) - Ind_J(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|FL_U\,(y_a) - FL_J\,(y_a)\right|\right\} \le 1$$

$$\Rightarrow 0 \le 1 + sin\left\{\frac{\pi}{10}\left|Tr_U\,(y_a) - Tr_J(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|Ind_U(y_a) - Ind_J(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|FL_U\,(y_a) - FL_J\,(y_a)\right|\right\} \le 2$$

$$\Rightarrow 0 \le 2.\frac{sin\left\{\frac{\pi}{10}\left|Tr_U(y_a) - Tr_J(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|Ind_U(y_a) - Ind_J(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|FL_U\,(y_a) - FL_J\,(y_a)\right|\right\}}{1 + sin\left\{\frac{\pi}{10}\left|Tr_U(y_a) - Tr_J(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|Ind_U(y_a) - Ind_J(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|FL_U\,(y_a) - FL_J\,(y_a)\right|\right\}} \le 1$$

$$\Rightarrow 0 \le \frac{2}{m}\sum_{a=1}^{m}\frac{sin\left\{\frac{\pi}{10}\left|Tr_U(y_a) - Tr_J(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|Ind_U(y_a) - Ind_J(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|FL_U(y_a) - FL_J(y_a)\right|\right\}}{1 + sin\left\{\frac{\pi}{10}\left|Tr_U(y_a) - Tr_J(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|Ind_U(y_a) - Ind_J(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|FL_U(y_a) - FL_J(y_a)\right|\right\}} \le 1$$

$$\Rightarrow 0 \le dis^M_{New}(U,J) \le 1.$$

$dis^M_{New}(U,J)) = 0$ if and only if
$U = J$.

$$If\ U = J, then\ Tr_U\,(y_a) = Tr_J\,(y_a), Ind_U\,(y_a) = Ind_J\,(y_a),$$
$$and\ FL_U\,(y_a) = FL_J\,(y_a)\ which\ states\ that$$
$$\left|Tr_U\,(y_a) - Tr_J\,(y_a)\right| = 0, \left|Ind_U\,(y_a) - Ind_J\,(y_a)\right| = 0,$$
$$and\ \left|FL_U\,(y_a) - FL_J\,(y_a)\right| = 0. Hence,$$
$$sin\left\{\frac{\pi}{10}\left|Tr_U\,(y_a) - Tr_J\,(y_a)\right|\right\} = 0,$$
$$sin\left\{\frac{\pi}{10}\left|Ind_U\,(y_a) - Ind_{UJ}(y_a)\right|\right\} = 0,$$
$$and\ sin\left\{\frac{\pi}{10}\left|FL_U\,(y_a) - FL_J\,(y_a)\right|\right\} = 0.$$
$$Thus, dis^M_{New}(U,J)) = 0.$$

$$Conversely,$$

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Received: March 28, 2022 Accepted: July 10, 2022

$$dis_{New}^{M}(U,J)) = 0$$

$$\frac{2}{m}\sum_{a=1}^{m} \frac{sin\left\{\frac{\pi}{10}\left|Tr_U\,(y_a) - Tr_J\,(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|Ind_U\,(y_a) - Ind_J\,(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|FL_U\,(y_a) - FL_J\,(y_a)\right|\right\}}{1 + sin\left\{\frac{\pi}{10}\left|Tr_U\,(y_a) - Tr_J\,(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|Ind_U\,(y_a) - Ind_J\,(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|FL_U\,(y_a) - FL_J\,(y_a)\right|\right\}} = 0$$

$$\frac{sin\left\{\frac{\pi}{10}\left|Tr_U\,(y_a) - Tr_J\,(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|Ind_U\,(y_a) - Ind_J\,(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|FL_U\,(y_a) - FL_J\,(y_a)\right|\right\}}{1 + sin\left\{\frac{\pi}{10}\left|Tr_U\,(y_a) - Tr_J\,(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|Ind_U\,(y_a) - Ind_J\,(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|FL_U\,(y_a) - FL_J\,(y_a)\right|\right\}} = 0$$

$$sin\left\{\frac{\pi}{10}\left|Tr_U\,(y_a) - Tr_J\,(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|Ind_U\,(y_a) - Ind_J\,(y_a)\right|\right\} + sin\left\{\frac{\pi}{10}\left|FL_U\,(y_a) - FL_J\,(y_a)\right|\right\} = 0,$$

$$sin\left\{\frac{\pi}{10}\left|Tr_U\,(y_a) - Tr_J\,(y_a)\right|\right\} = 0,\quad sin\left\{\frac{\pi}{10}\left|Ind_U\,(y_a) - Ind_J\,(y_a)\right|\right\} = 0,\quad \text{and } sin\left\{\frac{\pi}{10}\left|FL_U\,(y_a) - FL_J\,(y_a)\right|\right\} = 0$$

$$\left|Tr_U\,(y_a) - Tr_J\,(y_a)\right| = 0,\quad \left|Ind_U\,(y_a) - Ind_J\,(y_a)\right| = 0,\quad \text{and } \left|FL_U\,(y_a) - FL_J\,(y_a)\right| = 0$$

$$Tr_U\,(y_a) = Tr_J\,(y_a), Ind_U\,(y_a) = Ind_J\,(y_a), \text{and} FL_U\,(y_a) = FL_J\,(y_a)$$

$$\Longrightarrow A = B$$

$dis_{New}^{M}(U,J) = 0$ if and only if $U = J$.

$$dis_{New}^{M}(U,J) = dis_{New}^{M}(J,U).$$

$$Tr_U\,(y_a) - Tr_J\,(y_a) \neq Tr_J\,(y_a) - Tr_U\,(y_a),$$

$$Ind_U\,(y_a) - Ind_J\,(y_a) \neq Ind_J(y_a) - Ind_U\,(y_a),$$

and $FL_U\,(y_a) - FL_J\,(y_a) \neq FL_J\,(y_a) - FL_U\,(y_a)$.

$$\left|Tr_U\,(y_a) - Tr_J\,(y_a)\right| = \left|Tr_J\,(y_a) - Tr_U\,(y_a)\right|,$$

$$\left|Ind_U\,(y_a) - Ind_J\,(y_a)\right| = \left|Ind_J\,(y_a) - Ind_U\,(y_a)\right|,$$

and $\left|FL_U\,(y_a) - FL_J\,(y_a)\right| = \left|FL_J\,(y_a) - FL_U\,(y_a)\right|$

Doi : https://doi.org/10.54216/IJNS.180426
Received: March 28, 2022 Accepted: July 10, 2022

$$dis_{New}^{M}(U,J)=\frac{2}{m}\sum_{a=1}^{m}\frac{\sin\left\{\frac{\pi}{10}\left|Tr_U(y_a)-Tr_J(y_a)\right|\right\}+\sin\left\{\frac{\pi}{10}\left|Ind_U(y_a)-Ind_J(y_a)\right|\right\}+\sin\left\{\frac{\pi}{10}\left|FL_U(y_a)-FL_J(y_a)\right|\right\}}{1+\sin\left\{\frac{\pi}{10}\left|Tr_U(y_a)-Tr_J(y_a)\right|\right\}+\sin\left\{\frac{\pi}{10}\left|Ind_U(y_a)-Ind_J(y_a)\right|\right\}+\sin\left\{\frac{\pi}{10}\left|FL_U(y_a)-FL_J(y_a)\right|\right\}}$$

$$=\frac{2}{m}\sum_{a=1}^{m}\frac{\sin\left\{\frac{\pi}{10}\left|Tr_U(y_a)-Tr_J(y_a)\right|\right\}+\sin\left\{\frac{\pi}{10}\left|Ind_U(y_a)-Ind_J(y_a)\right|\right\}+\sin\left\{\frac{\pi}{10}\left|FL_U(y_a)-FL_J(y_a)\right|\right\}}{1+\sin\left\{\frac{\pi}{10}\left|Tr_U(y_a)-Tr_J(y_a)\right|\right\}+\sin\left\{\frac{\pi}{10}\left|Ind_U(y_a)-Ind_J(y_a)\right|\right\}+\sin\left\{\frac{\pi}{10}\left|FL_U(y_a)-FL_J(y_a)\right|\right\}}$$
$$=dis_{New}^{M}(J,U).$$

($dis_{New}^{M}(U,P)\le dis_{New}^{M}(U,J)$ and $dis_{New}^{M}(U,P)\le dis_{New}^{M}(J,P)$ *if P is a neutrosophic set in Y and* $U\subseteq J\subseteq P$.

Consider $P=\{y_a,Tr_P(y_a),Ind_P(y_a),FL_P(y_a)):y_a\in Y\}$ *is a neutrosophic set in Y and let* $U\subseteq J\subseteq P$.

$$Tr_U(y)\le Tr_J(y)\le Tr_P(y),\ Ind_U(y)\le Ind_J(y)\le Ind_P(y),\ FL_U(y)\le FL_J(y)\le FL_P(y)$$

for every $y_a\in Y$. Then, we will have the following relations:

$$|Tr_U(y_a)-Tr_P(y_a)|\le\left|Tr_U(y_a)-Tr_J(y_a)\right|,$$
and $$|Tr_U(y_a)-Tr_P(y_a)|\le\left|Tr_J(y_a)-Tr_P(y_a)\right|$$
$$|Ind_U(y_a)-Ind_P(y_a)|\le\left|Ind_U(y_a)-Ind_J(y_a)\right|,$$
and $$|Ind_U(y_a)-Ind_P(y_a)|\le\left|Ind_J(y_a)-Ind_P(y_a)\right|$$
$$|FL_U(y_a)-FL_P(y_a)|\le\left|FL_U(y_a)-FL_J(y_a)\right|,$$
and $$|FL_U(y_a)-FL_P(y_a)|\le\left|FL_J(y_a)-FL_P(y_a)\right|$$

Then,

$$\sin\left\{\frac{\pi}{10}|Tr_U(y_a)-Tr_P(y_a)|\right\}\le\sin\left\{\frac{\pi}{10}\left|Tr_U(y_a)-Tr_J(y_a)\right|\right\}$$ and
$$\sin\left\{\frac{\pi}{10}|Tr_U(y_a)-Tr_P(y_a)|\right\}\le\sin\left\{\frac{\pi}{10}\left|Tr_J(y_a)-Tr_P(y_a)\right|\right\}$$

$$\sin\left\{\frac{\pi}{10}|Ind_U(y_a)-Ind_P(y_a)|\right\}\le\sin\left\{\frac{\pi}{10}\left|Ind_U(y_a)-Ind_J(y_a)\right|\right\}$$ and
$$\sin\left\{\frac{\pi}{10}|Ind_U(y_a)-Ind_P(y_a)|\right\}\le\sin\left\{\frac{\pi}{10}\left|Ind_J(y_a)-Ind_P(y_a)\right|\right\}$$
$$\sin\left\{\frac{\pi}{10}FL_U(y_a)-FL_P(y_a)\right\}\le\sin\left\{\frac{\pi}{10}FL_U(y_a)-FL_J(y_a)\right\}$$ and
$$\sin\left\{\frac{\pi}{10}|FL_U(y_a)-FL_P(y_a)|\right\}\le\sin\left\{\frac{\pi}{10}\left|FL_J(y_a)-FL_P(y_a)\right|\right\}$$

Then,

$$\sin\left\{\frac{\pi}{10}|Tr_U(y_a)-Tr_P(y_a)|\right\}+$$

Doi : https://doi.org/10.54216/IJNS.180426
Received: March 28, 2022 Accepted: July 10, 2022

$$sin\left\{\frac{\pi}{10}|Ind_U(y_a) - Ind_P(y_a)|\right\} + sin\left\{\frac{\pi}{10}|FL_U(y_a) - FL_P(y_a)|\right\} \le sin\left\{\frac{\pi}{10}|Tr_U(y_a) - Tr_J(y_a)|\right\} + sin\left\{\frac{\pi}{10}|Ind_U(y_a) - Ind_J(y_a)|\right\} + sin\left\{\frac{\pi}{10}|FL_U(y_a) - FL_J(y_a)|\right\}.$$

and

$$sin\left\{\frac{\pi}{10}|Tr_U(y_a) - Tr_P(y_a)|\right\} + sin\left\{\frac{\pi}{10}|Ind_U(y_a) - Ind_P(y_a)|\right\} + sin\left\{\frac{\pi}{10}|FL_U(y_a) - FL_P(y_a)|\right\} \le sin\left\{\frac{\pi}{10}|Tr_J(y_a) - Tr_P(y_a)|\right\} + sin\left\{\frac{\pi}{10}|Ind_J(y_a) - Ind_P(y_a)|\right\} + sin\left\{\frac{\pi}{10}|FL_J(y_a) - FL_P(y_a)|\right\}.$$

Hence,

$$\frac{2}{m}\sum_{a=1}^{m}\frac{sin\left\{\frac{\pi}{10}|Tr_U(y_a) - Tr_P(y_a)|\right\} + sin\left\{\frac{\pi}{10}|Ind_U(y_a) - Ind_P(y_a)|\right\} + sin\left\{\frac{\pi}{10}|FL_U(y_a) - FL_P(y_a)|\right\}}{1 + sin\left\{\frac{\pi}{10}|Tr_U(y_a) - Tr_P(y_a)|\right\} + sin\left\{\frac{\pi}{10}|Ind_U(y_a) - Ind_p(y_a)|\right\} + sin\left\{\frac{\pi}{10}|FL_U(y_a) - FL_P(y_a)|\right\}}$$

$$\le \frac{2}{m}\sum_{a=1}^{m}\frac{sin\left\{\frac{\pi}{10}|Tr_U(y_a) - Tr_J(y_a)|\right\} + sin\left\{\frac{\pi}{10}|Ind_U(y_a) - Ind_J(y_a)|\right\} + sin\left\{\frac{\pi}{10}|FL_U(y_a) - FL_J(y_a)|\right\}}{1 + sin\left\{\frac{\pi}{10}|Tr_U(y_a) - Tr_J(y_a)|\right\} + sin\left\{\frac{\pi}{10}|Ind_U(y_a) - Ind_J(y_a)|\right\} + sin\left\{\frac{\pi}{10}|FL_U(y_a) - FL_J(y_a)|\right\}}$$

and

$$\frac{2}{m}\sum_{a=1}^{m}\frac{sin\left\{\frac{\pi}{10}|Tr_U(y_a) - Tr_P(y_a)|\right\} + sin\left\{\frac{\pi}{10}|Ind_U(y_a) - Ind_P(y_a)|\right\} + sin\left\{\frac{\pi}{10}|FL_U(y_a) - FL_P(y_a)|\right\}}{1 + sin\left\{\frac{\pi}{10}|Tr_U(y_a) - Tr_P(y_a)|\right\} + sin\left\{\frac{\pi}{10}|Ind_U(y_a) - Ind_p(y_a)|\right\} + sin\left\{\frac{\pi}{10}|FL_U(y_a) - FL_P(y_a)|\right\}}$$

Doi : https://doi.org/10.54216/IJNS.180426
Received: March 28, 2022 Accepted: July 10, 2022

$$\leq \frac{2}{m}\sum_{a=1}^{m} \frac{\begin{array}{c} sin\left\{\frac{\pi}{10}\left|Tr_U(y_a) - Tr_J(y_a)\right|\right\} + \\ sin\left\{\frac{\pi}{10}\left|Ind_U(y_a) - Ind_J(y_a)\right|\right\} + \\ sin\left\{\frac{\pi}{10}\left|FL_U(y_a) - FL_J(y_a)\right|\right\} \end{array}}{\begin{array}{c} 1 + sin\left\{\frac{\pi}{10}\left|Tr_U(y_a) - Tr_J(y_a)\right|\right\} + \\ sin\left\{\frac{\pi}{10}\left|Ind_U(y_a) - Ind_J(y_a)\right|\right\} + \\ sin\left\{\frac{\pi}{10}\left|FL_U(y_a) - FL_J(y_a)\right|\right\} \end{array}}$$

$$\Rightarrow dis_{New}^{M}(U,P) \leq dis_{New}^{M}(U,J) \text{and } dis_{New}^{M}(U,P) \leq dis_{New}^{M}(J,P).$$

3. Results

During the pandemic, we want to determine the relative weights of IIoT problems to make well-informed choices for supply chain restructuring. It is for this reason that seven experts from academia and business have been brought in. A hierarchical weighting system is used to evaluate the relative value of expert opinions after the epidemic.

The Internet of Things (IIoT) has advantages, hazards, and limitations, just like every other new technology. Management must understand how to prioritize each of these difficulties to effectively prepare their firms for IIoT activities, notwithstanding earlier studies outlining the dangers and hurdles. However, interruptions like COVID-19, which has created an unprecedented disruption, might change the priority ordering of these concerns. Our findings may help identify the organization's weak areas to handle the IIoT problems while also considering the pandemic. The main result shows that Network-related is the highest rank followed by Ecological and Organisational.

4. Conclusion

Nearly all facets of our life have been affected, including businesses and supply networks, by the COVID-19 outbreak. There have been supplied shortages and flow disruptions due to traditional supply networks' problems. To solve these problems, IIoT is making use of its untapped potential and already-implemented capabilities. Its execution, on the other hand, comes with a host of difficulties, some of which have been documented in previous studies. Research in this area is aimed at determining how the pandemic has affected the weights assigned to the various issues of the Internet of Things (IIoT).

For a single-value neutrosophic set, a distance measure based on similarity is proposed by this study. Adopting the new measure formula in the course of medical diagnostic demonstrates its efficacy. We discovered that it's tested on the basis is compatible with the 3 existing distance measurements, i.e. normalized Hamming, extended Hausdorff, and normalized Euclidean.

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Doi : https://doi.org/10.54216/IJNS.180426
Received: March 28, 2022 Accepted: July 10, 2022