

Research Article

An Uncertain Model for Analysis the Barriers to Implement Blockchain in Supply Chain Management and Logistics for Perishable Goods

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Accepted 16 Dec 2020*Keywords*Blockchain
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These days, with the development of advanced space, rising innovations, for example, the blockchain has made a decent open door for organizations to additionally improve the productivity of their supply arranges. Going with and orchestrating the supply chain with computerized advancements can prompt a huge increment in mechanical proficiency. At present, there is a crucial open door for the supply that binds the world over to amplify their profitability and productivity by utilizing and abusing blockchain innovation, man-made consciousness, and keen gear. In this research we proposed a hybrid method based on hesitant fuzzy made for ranking the barriers of implementation of blockchain on supply chain management in perishable goods. The result shows that Technological and security barriers are the most important barriers.

© 2021 *The Authors*. Published by Atlantis Press B.V.This is an open access article distributed under the CC BY-NC 4.0 license (<http://creativecommons.org/licenses/by-nc/4.0/>).**1. INTRODUCTION**

A system of people and organizations that centers around the creation and appropriation of a specific item or administration from the essential maker stage to the client and purchaser. A basic supply chain regularly incorporates food or unrefined material providers, makers, item delivering organizations, and at last retailers [1]. At present, the supply chain the board isn't compelling and isn't straightforward. Most supply and dispersion systems have issues dealing with these segments together [2]. In the present market model, it is extremely hard to make a constant supply chain and powerful administration, which influences the benefits of organizations and makers, yet additionally the last cost of the item [3]. A considerable lot of the issues of current supply chains can be fathomed through blockchain innovation; Because blockchain gives us extraordinary approaches to record, transmit, and share data [4].

Blockchain makes coordination, and there will be no difference in exchanges in the chain since all the elements that influence the chain to have a similar basic form of this computerized office. In the blockchain, everybody can see the supply chain of an advantage overall [4]. Records in blockchain can't be eradicated, and this is significant for the straightforwardness of a supply chain. With the utilization of this innovation, the supply chain the board gets more straightforward, and misfortunes in this chain are decreased [5].

Today, the intricacy of supply chains and the issues that exist in the administration of this chain prompts an exercise in futility and cash. Utilizing new innovations, for example, blockchain will improve quality and diminish costs. Since blockchains are structured as dissemination frameworks, they are impervious to information control and are entirely reasonable for supply and dispersion systems. A blockchain comprises of a progression of squares of data that are secured by cutting edge encryption strategies, and it is absurd to expect to alter or control the data put away on the squares [6].

A blockchain comprises of a progression of squares of data that are secured by cutting edge encryption procedures, and it is unimaginable to expect to change or control the data put away on the squares [7]. Be that as it may, there might be a few deterrents to the sending of the blockchain in the supply chain. Since blockchains are structured as dissemination frameworks, they are impervious to information control and are entirely appropriate for supply and conveyance systems [8].

From one viewpoint, transitory products have a restricted life expectancy, and then again, because of unsteady and variable stockpiling conditions during the transportation procedure, they are dependent upon the quality and worth decrease or even total defilement [9]. It makes, on the grounds that not focusing on the right transportation and conveyance of these items will cause staining and loss of allure and disappointment of clients of this classification of products [10]. Then again, the level of costs identified with conveying this classification of items until arriving at the last client

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comprises a noteworthy level of the expenses. Along these lines, the right development of the supply chain and its right activity in the supply chain of short-lived materials is of higher significance than different businesses [11].

Blockchains don't have a focal reference, and this is an extremely effective and growable component. Eventually, blockchain can build the profitability and straightforwardness of supply chains and influence everything from warehousing to installment [12]. The supply chain is basic for some things, the blockchain in the directing chain frames the primary head. The utilization of blockchain innovation in the supply chain can take care of huge numbers of the present issues in this world [13]. Blockchain additionally spares a great deal of additional time and cash that is squandered on this framework. It can pose every one of its inquiries in such manner in the remarks segment with the goal that we can answer them [13].

It should be noted that uncertainty about real-world decision-making issues, especially in performance appraisal issues, is natural because performance appraisal is about human judgment and human decisions are always vague. A hesitant fuzzy set (HFS), as a fuzzy set, attracted the attention of many experts in various scientific fields to deal with uncertainty. One of the most important applications of fuzzy sets is to solve decision problems. A HFS, introduced by Torra, in which the degree of membership of each member is defined as a set of possible values. HFSs are applied in a situation where we have a set of possible values. Especially in cases where there is a possibility of marginal error or probability distribution for possible values [33]. In the present study, a model to Analysis the Barriers to Implement Blockchain in Supply Chain Management and Logistics for Perishable Goods by using quantitative decision-making methods in hesitant fuzzy environment.

In this way, the current examination looks to research and break down the obstructions to the formation of the blockchain in the supply chain of short-lived materials and to rank these hindrances.

2. BLOCKCHAIN AND SUPPLY CHAIN

A blockchain arrangement contains records of information that are put away on different systems that focus on the blockchain. Each square relies upon a period stamp, and the time specification depends on a union convention between the gatherings in question, and the encryption calculation is ensured simultaneously. This disposes of the requirement for a confided in correspondences controller. Blockchain is a forlorn innovation and nobody possesses it. This innovation doesn't have a focal controller to confirm the exchanges made and acts in a self-administrative way [14].

Blockchain gives an extremely secure and dependable structure for transmitting data. At the beginning of blockchain, this innovation was just used to follow computerized money exchanges; But blockchain can be exceptionally valuable for ensuring a wide range of advanced data, and its utilization in the supply chain has numerous advantages. The Blockchain architecture and functioning mechanism is as Figure 1.

A portion of the advantages of Blockchain in the supply chain are as per the following:

1. **Record data in a straightforward and unchangeable way [5]**
Assume a few organizations and establishments cooperate and may utilize the blockchain to record proprietorship and capacity of their materials and items.

All individuals from this supply chain can screen the status of assets and items during their exchange starting with one organization then onto the next, and since data can't be messed with in blockchain, nobody is at fault if a mistake happens.

2. **Decrease costs [15]**
Because of the wastefulness of information transmission in the supply chain, a great deal of cash is squandered and this issue is progressively significant in ventures whose items are ruined and destroyed.

The utilization of straightforward and progressed blockchain innovation assists organizations with distinguishing financially savvy cases and use cost-sparing strategies.

Blockchain can likewise take out the expense of move charges through banks and other cash move strategies. The expense of these charges will be remembered for the figuring of the last cost and benefit of the items, and expelling them will expand the benefit and decrease the last expense for the client.

3. **Creation of intuitive data [4]**
One of the most critical issues with the present supply anchor is the powerlessness to incorporate and coordinate data for all individuals from the chain.

Blockchains are planned as a circulation framework that gives a reasonable and explicit extra room for data.

Every node adds new data to the blockchain and confirms its legitimacy.

This implies all individuals from the supply affix approach data in all organizations and stores and can confirm its legitimacy at any stage.

4. **Supplant electronic data trade [16]**
Numerous organizations use EDI to send business data to one another; However, this data is postponed and doesn't arrive at the organizations simultaneously as sending the items.

On the off chance that transportation is troublesome or costs keep on fluctuating, individuals from the supply chain will get this data in ensuing electronic information trade bundles.

With the assistance of blockchain, data is continually refreshed and can be moved to the organizations in the supply chain whenever.

5. **Computerized understandings and record sharing [17]**
Having just a single genuine duplicate is significant for sharing supply chain reports.

Important archives and agreements can be given blockchain and advanced mark framework; because of this activity, all accomplices approach the first form of the agreement and reports.

Blockchain guarantees that the agreement and understandings are unchangeable, and just if all accomplices agree, the details of the agreement will change.

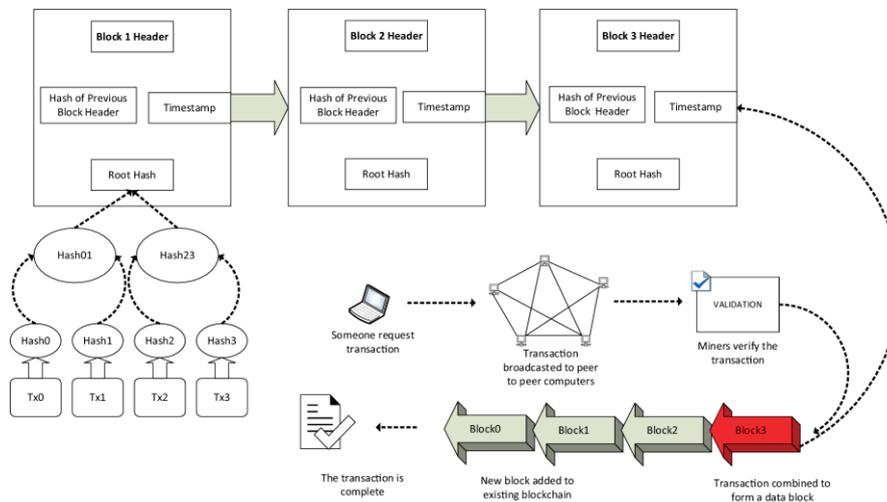


Figure 1 | Blockchain architecture and functioning mechanism [1].

Regardless of this framework, organizations and foundations invest less energy and cash on legal counselors and arrange, and a lot of administrative work is wiped out; therefore, organizations can invest additional time building up their items and developing their business.

3. BOUNDARIES TO THE FOUNDATION OF THE BLOCKCHAIN IN THE SUPPLY CHAIN

Lacking proportion and unsteadiness may happen in a supply affix framework because of shrouded layers and it is absurd to expect to follow the framework. There are noteworthy issues, particularly in transportation contracts, with meeting the necessities of supportability, forestalling awful gains and youngsters' business, and guaranteeing carbon outflow principles. Blockchain innovation might be a device to tackle every one of these issues [1]. Customer approval, particularly in social and ecological exercises, forces more obligations on organizations, which squeezes changes in corporate strategy and improves the work procedure. A procedure that can be constrained by savvy contracts includes making an increasingly effective supply chain framework [5]. Lower cost, higher security, and item data stream rely upon the capacity utilization of this innovation. Be that as it may, there are some innovative, money related, human, hierarchical, and social impediments and dangers engaged with incorporating the supply chain and supply chain [7]. On the off chance that these impediments and challenges are appropriately and sufficiently tended to, a more advantageous change from blockchain innovation to supply chain and acquisition can be created [17]. These issues can be considered in four classes: specialized and security hindrances; monetary and HR boundaries; hierarchical and singular obstructions; and social, natural, and social obstructions [18].

3.1. Specialized and Security Barriers

Blockchain innovation has numerous significant highlights, for example, straightforwardness, appropriated database, and security. Be that as it may, today there are different issues in utilizing

this innovation. Specialized and security imperatives structure the premise of these issues. In this segment, we characterize seven significant mechanical and security challenges [1].

3.1.1. Technical maturity shortage (C11)

Specifically, the youthfulness of blockchain innovation and the modest number of individuals who have encountered this innovation have prompted issues in adjusting and utilizing this innovation, prompting ambiguities in security vulnerabilities and the advantages of exact information. They pulverize. In this manner, current blockchain working frameworks are regularly alluded to as "tests." It welcomes unusual programming bugs from digital assailants because of the innovation's absence of innovation, and if these imperfections are distinguished, particularly in open blockchain working frameworks, genuine monetary misfortunes might be experienced [1].

3.1.2. Information security (C12)

Information security is another significant issue in blockchain innovation. Encryption is one of the most impressive highlights of blockchain working frameworks as far as controlling and making sure about information stacks in appropriated database frameworks. In spite of the fact that the cryptographic methodologies utilized in this field are incredible, there might be different shortcomings later on alongside signs of progress in territories, for example, quantum figuring [2]. Today, we are alluding to parallel frameworks where PCs can just work in 1 second and 0-second language. Be that as it may, there is a third case where 1 and 0 are utilized at the same time on quantum PCs, and this triple information is put away in structures called qubits. Contrasted with customary PCs, this sort of PC can perform incredible activities a large number of times, and along these lines, it may prompt security vulnerabilities in blockchain innovation in the coming years [1].

3.1.3. Usability (C13)

Another significant test in incorporating the blockchain innovation supply chain is that the framework isn't easy to use. The absence of

a particular plan standard and how it functions uniquely in contrast to existing frameworks represent a test for clients [1].

3.1.4. Multifaceted nature (unpredictability) (C14)

The intricacy of the blockchain framework is trickily contrasted with existing frameworks and the distinction between existing blockchain frameworks. The current innovation framework may not be sufficient to meet the mind-boggling and propelled high-lights of a blockchain framework. There is likewise proof that the blockchain framework will work with huge and complex information [1,3].

3.1.5. Cooperation (C15)

Current frameworks must have the option to work with blockchain innovation. There might be different issues with this mixing procedure. The similarity of the various blockchain working frameworks with one another and their capacity to exchange with one another is significant. There may likewise be different issues around there. On the off chance that the fundamental normalization isn't accomplished, specialized constraints will emerge. Intense methodologies should be created to forestall the issues that may emerge during this procedure of progress [1,9].

3.1.6. Forking (C16)

All members in a blockchain arrange are associated with the system utilizing programming that is continually refreshed by framework engineers. These updates are typically intended to improve organize abilities, highlights, and execution. Every client on a blockchain organize has a neighborhood adaptation of the system. In some remarkable cases, individuals who don't refresh their program in the wake of refreshing the product can just peruse the information in the open blockchain arrange, while individuals who have the product refreshed, can enter information into the blockchain organize. In such cases, the neighborhood variant of the blockchain of clients who don't refresh their product is not the same as the general structure of the blockchain, in light of the fact that the nearby form of the blockchain isn't refreshed. This can disturb different blockchain systems [1].

3.1.7. Execution and scalability (C17)

In spite of the fact that blockchain innovation may gain huge ground in many regions, it performs essentially lower than current frameworks (particularly for pictures or complete genomic informational indexes). For instance, albeit present-day charge card working frameworks would now be able to control 7,000 exchanges for every second, blockchain innovation can play out a normal of seven exchanges. Consequently, blockchain innovation isn't favored in high-volume works and exchanges and those that require high speeds (supply chain forms, banking tasks, and so forth.) [1,19]

3.2. Money Related and HR Barriers

3.2.1. IT staff deficiency (C21)

The absence of an adequate number of IT staff in the field of adequately prepared and concentrated blockchain innovation is one of the most significant hindrances to the mix of the supply chain. The need to have adequate information about supply chain procedures and ability in the utilization of blockchain prompts issues in finding prepared workers in the nation [1,18].

3.2.2. High venture costs (C22)

Blockchain innovation is an innovation with high venture costs, despite the fact that it offers intense advantages in diminishing expenses. Specifically, the deficiency of prepared labor to take a shot at open source working frameworks is one of the principal explanations behind the significant expense of blockchain innovation, The experimentation technique utilized in the establishment procedure sits around idly and builds costs [1,19].

3.2.3. Absence of research and development units (C23)

What's more, the absence of innovative work units and human asset strategies in organizations in such a manner hinders the advancement of blockchain innovation in different fields and delays the exchange of innovation. We accept that blockchain innovation is less notable and tried, which is a major obstacle for huge organizations to look into and build up this innovation [1,12].

3.2.4. Absence of technology infrastructure (C24)

In another innovative change, the framework foundation must be set as a need. There is a comparative circumstance with blockchain innovation. The current innovative foundation is one of the principal explanations behind the advancement of blockchain innovation [1,2,20].

3.2.5. Absence of financing for blockchain innovation (C25)

Likewise, government support for innovation is low since it is another innovation. The absence of government and political help forestalls the spread of blockchain innovation. Banks are at the core of conventional cash move frameworks, creation frameworks, or procedures, for example, supply chains. This implies they have been utilized for quite a while, are trusted by a great many people, and have been incorporated into conventional frameworks. Albeit effective and expensive, realized frameworks regularly oppose new frameworks. The states can't work alone on a worldwide scale because of their reliance on existing frameworks and their associations with one another. In spite of the fact that innovation is extending from the base to top, the general advancement relies just upon the way that blockchain innovation substantiates itself [1,5,21].

3.3. Organizational and Singular Obstructions

Explicit protection from adjustment to new advancements may show up in associations that oversee business forms. In this area, there are four authoritative and individual obstructions in executing blockchain innovation in the supply chain process [1].

3.3.1. Solid progressive structure and administration (C31)

Associations with a solid progressive structure and bureaucratic issues in these structures are among the greatest snags they face in incorporating blockchain innovation. Specifically, the chance of losing bureaucratic force in the hands of the individuals who work at elevated levels of hierarchical structure and the absence of information about new innovation are the primary purposes behind this opposition [1,11].

3.3.2. Precise managerial control (C32)

Obviously firms with severe administration structures will experience issues moving innovation to the blockchain, as these kinds of structures for the most part work remotely and are shut to advancement. Along these lines, they can't roll out mechanical improvements in an opportune way [1,8].

3.3.3. Data sharing barriers (C33)

Chain the executive's frameworks bolster the arranging of business exercises by giving data and investigation to organizations. Notwithstanding, there are deficiencies in data sharing that are the most significant factor in arranging exercises. This is a significant issue for organizations, in light of the fact that to do the correct arranging exercises, it is important to do the examination utilizing genuine information. Be that as it may, the asymmetric structure of data sharing between organizations in the conventional supply chain the board frameworks and the failure to screen changes in this structure influence the arranging procedure in organizations, which at last prompts expanded expenses. Nonetheless, enormous organizations don't need a portion of their data to be obvious for different reasons, for example, advertise rivalry data. To break the protection from blockchain innovation, this framework can be improved technically. In such a manner, organizations can give fundamental data and be urged to break this opposition [1,23].

3.3.4. Individuals' mindsets must change (C34)

Change, which is a difficult procedure since it changes numerous individual and hierarchical propensities, is pretty much consistently joined by the opposition. Numerous variables influence the course and level of this opposition, yet the qualities and characters of workers and hierarchical structure and the executives approach assume a significant job in such a manner. Open or inactive protection from mechanical and, therefore, hierarchical change disturbs the procedures of progress or change. The inability to make changes in a planned time may bring about lost authoritative assets [1,15].

3.4. Social and Natural Obstructions

3.4.1. Data sharing (natural and social angles) (C41)

Supply chain frameworks structure an extensive structure, frequently on a worldwide scale, that includes numerous business forms. It is exceptionally hard to control this structure as far as the economy, innovation, and security [26]. Likewise, there are concentrates on supply chain the executive's frameworks that look at their social and ecological viewpoints. Specifically, natural and social duties, which have been considered in the supply chain the executives, will be detectable to clients as of late because of expanded straightforwardness in organizations with blockchain innovation. Nonetheless, particularly those organizations that re-appropriate their work to auxiliaries may choose to maintain a strategic distance from their duties to the earth and people in general [25]. Accordingly, they may not be prepared for the idea of straightforwardness related to blockchain innovation. For instance, the craving of an organization in the more elite classes of the supply chain to keep its data secret or the dread of a temporary worker situated in the lower echelons of the supply chain is stuck in a troublesome circumstance because of the presence of its inadequacies (in natural terms). Furthermore, social makes protection from blockchain innovation. Alongside the idea of straightforwardness presented by blockchain innovation, we should focus on the protection from this improvement of innovation, which is in opposition to the interests of the individuals who are occupied with defilement in authoritative structures [1,3,5].

3.4.2. Lost assets (C42)

Blockchain innovation requires a lot of electrical vitality to perform computational estimations, particularly in mining forms. Thus, unfriendly ecological impacts may occur. In this sense, there is an advocated predisposition against blockchain innovation [1,26].

4. BACKGROUND

Biswas and Gupta [2] Developed a framework using DEMATEL technique for analyzing the barriers to block chain implementation in the industrial and service sectors of a supply chain. Nayak and Dhaigude [7] presented A model of sustainable supply chain management in SMEs using blockchain and Multiple-criteria decision-making. Colak et al. [3] presented a model based on HFS for performance evaluation of blockchain in supply chain management. Ar et al. [5] provided a decision framework for evaluating Blockchain feasibility in logistics operations and supply chain with integrates AHP and VIKOR methods under Intuitionistic Fuzzy Theory. Öztürk and Yildizbaşı [1] presented a numerical example for obstacles to block chain implementation in the supply chain with Fuzzy AHP and Fuzzy TOPSIS. However, this research focused on a numerical example in a particular industry and its application has not been studied in other industries such as perishable goods, which the timeline and transportation on it has the great importance. Therefore, in the present study, the barriers of implementation blockchain technology in the supply chain of perishable goods was studied by studying the dairy production and distribution companies located in the industrial areas of Modena in Italy. To solve the problem, the hesitant fuzzy decision method was used.

Table 1 Criteria and subcriteria for barriers of implementation blockchain technology in the supply chain.

Criteria	Subcriteria	References
Technological and security barriers (C1)	Lack of technological maturity (C11) Data security (C12) Usability (C13) Complexity (C14) Interoperability (C15) Forking (C16) Performance and scalability (C17)	[1,3,9,19]
Financial and human resources barriers (C2)	Lack of IT personnel (C21) High investment cost (C22) Lack of research and development Units (C23) Lack of funding technological infrastructure (C24) Lack of financial subvention for block chain technology (C25)	[1,19–24]
Organizational and individual barriers (C3)	Strong hierarchical structure and bureaucracy (C31) Strict administrative control (C32) Information sharing obstacles (C33) Mind set of people needs to be changed (C34)	[1,8,11,15,23]
Social and environmental barriers (C4)	Information sharing (environmental and social aspects) (C41) Wasted resources (C42)	[1,3,5,26]

This method is used to solve uncertainty problems. Ranking barriers to blockchain implementation in the supply chain of perishable goods are always associated with uncertainty due to their time sensitivity and deterioration. Our decision-making alternatives are following sections in a supply chain of perishable goods: health and quality control (A1), logistics and transportation (A2), production (A3), warehousing and storage (A4). By reviewing the research literature, 18 subcriteria and 4 criteria were identified that shows in Table 1.

5. RESEARCH METHODOLOGY

The decision-making with the Information uncertainty process is very difficult due to the intrinsic complexity of opinion and limited ability in humans. Fuzzy sets have been introduced by Zadeh to deal with the uncertainty of real-life decision problems. After the introduction of fuzzy logic by Zadeh in 1965, fuzzy sets became one of the most appropriate decision-making techniques. After that, as the gradual advancement of decision science, various suffixes of fuzzy sets were introduced. There is a new concept called HFSs introduced by Torra in 2011. MCDM under HFSs methods is used for the problem under uncertainty [29].

In solving some complex problems, uncertainty, and ambiguity in the problem as well as uncertainty in the opinion of experts may lead to errors. HFSs are useful ways to solve this problem and its ambiguity. hesitant Fuzzy MCDM methods are a new development of fuzzy methods [28,33]:

Suppose X is a reference set. Then, each HFS is a function of h:

$$h : X \rightarrow \varphi([0, 1]) \tag{1}$$

$\mu(x_i)$ and $\nu(x_i)$ are the membership function and the nonmembership function in the interval [0, 1] and are true in the following

condition for all values:

$$0 \leq \mu(x_i) + \nu(x_i) \leq 1 \tag{2}$$

Now we have $\pi_A(x_i) = 1 - \mu(x_i) - \nu(x_i)$ that $\pi_A(x_i)$ is the uncertainty value of x_i in the reference set A.

The point to be made here is that the number of HFE members can be Different [28,30,32].

Definition 1: A HFL, such as H in A, is a function in HFS that is defined as a subset of h when the reference set is applied to the interval [0, 1]. In fact, the HFS is the generalization of intuitionistic fuzzy sets. This set is defined by Xu and Xia for convenience as follows:

$$H = \{ \langle x_i, h(x_i) \rangle \mid x_i \in X \} \tag{3}$$

$h(x_i)$ is a set of different values in the interval [0, 1]. $h(x_i)$ is called the hesitant fuzzy element (HFE) in the set H.

Definition 2: For a reference set X, if $h(x) = \{ \gamma_1, \gamma_2, \dots, \gamma_l \}$ is a HFE with a set of possible values of with γ_k ($k = 1, 2, \dots, l$) and 1 is a value of $h(x)$ then the mean of $h(x)$ in the HFE is defined by the following formula:

$$\bar{h}(x) = \frac{1}{l} \sum_{k=1}^l \gamma_k. \tag{4}$$

To compare the rules of HFES, a definition of the value operator and also variance operator is needed:

Definition 3: For per HFE the value operator is as follows:

$$s(h) = \frac{1}{l_h} \sum_{\gamma \in h} \gamma \tag{5}$$

It is clear that for two HF elements such as h_1 and h_2 , if $s(h_1) > s(h_2)$ then $h_1 > h_2$ and if these two values are equal $s(h_1) = s(h_2)$ then $h_1 = h_2$.

Note: obviously, due to the fact that the value operator of the two values is the same, there is no superiority between these two HFEs [32]. Moreover, another concept called the variance operator is defined:

For both HFE elements such as h_1 and h_2 , if $v_1(h_1) > v_1(h_2)$ then $h_1 < h_2$ [28].

In Table 2 Linguistic variables for significant values of all criteria for hesitant fuzzy mcdm.

De Luca-Termini hesitant Entropy Method

This method is used for Weighing the criteria and its algorithm is as follow [28]:

Step 1: score matrix is compute with the hesitant fuzzy S_{ij} on the experts' opinions matrix by applying the following formula [27]:

$$s(h_E(x)) = \sum_{j=1}^{l(h_E(x))} h_E^{\sigma(j)}(x) / l(h_E(x)) \tag{6}$$

Step 2: normalized matrix S' computation based on the previous step:

$$s'_{ij} = s_{ij} / \sum_{i=1}^m s_{ij} \tag{7}$$

Step 3: By Using De Luca-Termini normalized entropy in the field of HFSS

$$E_j = -\frac{1}{m \ln 2} \sum_{i=1}^m \left(s'_{ij} \ln s'_{ij} + (1 - s'_{ij}) \ln (1 - s'_{ij}) \right), \tag{8}$$

$j = 1, 2, \dots, n,$

Step 4: The definition of the weight of the features is expressed by the following formula:

$$w_j = \frac{1 - E_j}{\sum_{j=1}^n (1 - E_j)}, j = 1, 2, \dots, n. \tag{9}$$

hesitant fuzzy VIKOR method

The steps in this algorithm are as follows:

Table 2 | Linguistic variables for significant values of all criteria.

Numbers	Linguistic Variables
(1)	Very low (VL)
(2)	Low (L)
(3)	Medium (M)
(4)	high (H)
(5)	very high (VH)

Step 1: creating a decision-making matrix named as H:

$$H = \begin{bmatrix} h_{C_1 C_1} & h_{C_1} & \dots & h_{\gamma \gamma C_1} \\ h_{\gamma \gamma C_1} & h_{\gamma \gamma} & \dots & h_{\gamma n} \\ \vdots & \vdots & \ddots & \vdots \\ h_{m C_1} & h_m & \dots & h_{\gamma m n} \end{bmatrix} \tag{10}$$

In which h_{ij} is the degree of membership for the options $A(A_1, A_2, \dots, A_m)$ according to the criteria $C(C_1, C_2, \dots, C_n)$, and in which $(j = 1, 2, \dots, m)$ and $(i = 1, 2, \dots, n)$.

Step 2: Determination of the value operator and variance operator will be calculated by using the formulas number (5) and (6). After that calculate the distance between two fuzzy elements through the following formula:

$$d(h_M, h_N) = \frac{1}{l} \sum_{k=1}^l |h_M^{\sigma(k)} - h_N^{\sigma(k)}| \tag{11}$$

After that, the positive and negative ideal values will be acquired:

Positive and negative ideals for positive criteria are as follows $h_j^- = \min_i h_{ij}$ and $h_j^* = \max_i h_{ij}$

This means the largest and smallest value in the positive criterion. As for negative criteria such as expense due to the inverse effect, the positive ideal has the smallest value while the negative one has the largest value [31]. The next step is to create the decision-making matrix and determine the best and worst value among the available values of each index for the decision-making matrix of the determined qualitative indices and the importance of each index has been computed by hesitant fuzzy concepts. For this purpose, firstly, the values of the hesitant fuzzy S function are calculated for managers by using Formulas (1) and (6). Then, the largest and smallest values are obtained with respect to the fact that all the criteria are positive [27,30].

Step 3: computation the value of S_i and R_j and the VIKOR indicator

The S_i criterion, R_j criterion in hesitant fuzzy VIKOR are calculated as follows, respectively:

$$\bar{S}_i = \bar{L}_{1,i} = \sum_{j=1}^n \omega_j \frac{d(h_j^*, h_{ij})}{d(h_j^*, h_j^-)} \tag{12}$$

$$\bar{R}_i = \bar{L}_{\infty,i} = \max_j \left(\omega_j \frac{d(h_j^*, h_{ij})}{h_j^*, h_j^-} \right) \tag{13}$$

$$\bar{Q}_i = v \frac{\bar{S}_i - \bar{S}^*}{\bar{S}^- - \bar{S}^*} + (1 - v) \frac{\bar{R}_i - \bar{R}^*}{\bar{R}^- - \bar{R}^*} \tag{14}$$

where $\omega_j (j = 1, 2, \dots, n)$ are the corresponding weights of criteria satisfying below condition:

$$0 \leq \omega_j \leq 1, j = 1, 2, \dots, n, \sum_{j=1}^n \omega_j = 1, \tag{15}$$

And $\tilde{S}^* = \min_i \tilde{S}_i, \tilde{S}^- = \max_i \tilde{S}_i, \tilde{R}^* = \min_i \tilde{R}_i, \tilde{R}^- = \max_i \tilde{R}_i$, also v is the weight of the strategy of the majority of criteria or the maximum overall utility. The larger the value of v , the preferences of the decision maker over different criteria will be more average. Without loss of generality, it also takes the value 0.5.

Step 4: ranking is based on S_i criterion, R_j criterion and the hesitant VIKOR fuzzy index.

This algorithm stops when:

The first condition: $Q(A^{(2)}) - Q(A^{(1)}) \geq \frac{1}{m-1}$ that $A^{(1)}$ and $A^{(2)}$ are the first and second options in arranged list.

The second: $A^{(1)}$ should be the best rank for S_i, R_i

The first condition is considered as an acceptable coefficient and the second condition is an acceptable stable condition. If both conditions are true for each case, the next step will commence. If the first condition is not true, the maximum will have computed by the following equation:

$$\tilde{Q}(A^{(M)}) - \tilde{Q}(A^{(1)}) < \frac{1}{m-1} \tag{16}$$

EXCEL 2014 software was applied to rank barrier of implementation of BT in supply chain.

Computing the values of R, S, and Q

R and S and Q are computed for all of them according to the values determined in previous step and the formula of parameter.

6. FINDINGS

6.1. Case Study

Modena is one of the main industrial realities at the European level; in fact, in the Modena area, there are many famous industries, both engineering and food, and the per capita income is one of the highest in Italy. The Emilian cuisine is renowned and many pacts are based on pork and, moreover, a very famous product that comes from Modena is balsamic vinegar, produced in large quantities in these areas.

Protecting excellence such as Balsamic Vinegar of Modena or the most exported Made in Italy agri-food product with Geographical Indication in the world is a duty because, being so widespread and famous, it is exposed to counterfeiting phenomena more than other products. The balsamic vinegar of Modena IGP has been landed on the blockchain to try to fight to counterfeit. In May of 2019, the Consortium for the Protection of Balsamic Vinegar of Modena PGI protagonist of the Blockchain Plaza project, the flagship event of Tuttofood 2019 that was held in Milan [34].

Modena Smart Life 2019 is the digital culture festival, a great event that was held by the Municipality of Modena from 27 to 29 September that involves the territory with activities aimed at making citizens, businesses, and institutions aware of what changes with the advent of digital technologies in the various fields of activity of mankind. During the three days, held numerous initiatives, conferences, and installations to concretely show how innovations change our life, work, and knowledge [35]. In the meantime, on 27 September, with the collaboration of the University of Modena,

a conference was held titled “Agri-food supply chains: blockchain technology to make traceability available to everyone” [36].

6.2. Analysis of Expert’s Data

In this section, data on expert from work experience and education are examined. Experts included supply chain executives and manager in the industrial areas of Modena in Italy who specialized in blockchain and have suitable work experience Tables 3–5.

Descriptive statistics indices were used to examine the demographic characteristics of the respondents. Frequency of respondents was surveyed based on gender, age, level of education, and experience.

Our study questionnaires were handed out at the entrances of the Modena Smart Life 2019 area from 27 to 29 September to potential respondents and were collected upon completion. Of the 60 delivered questionnaires, 58 were returned. However, 8 were incomplete and thus eliminated from further analysis. As a result, a total of 50 usable questionnaires were retained for the main analysis.

6.3. Gender

32% of the respondents (64.0%) are male and 18 (36.0%) are female.

6.4. Education

4 people or 8.0% of the respondents have associate degree. 16 persons or 32.0% of respondents have a bachelor’s degree. 21 persons equivalent to 42.0% of respondents have a master’s degree and 9 persons equal 18.0% of respondents have a doctorate degree.

Table 3 | Frequency distribution of respondents by gender.

Sum	%	Amount	Gender
64.0%	64.0	32	male
100.0%	36.0	18	female
	100	50	sum

Table 4 | Frequency distribution of respondents by education.

Sum	%	Amount	Education
80%	8.0	4	Diploma
40.0%	32.0	16	Bachelor
82.0%	42.0	21	Master
100.0%	18.0	9	P.H.D.
	100	50	Total

Table 5 | Frequency of respondents by work experience.

Sum	%	Amount	Work Experience
2.0%	2.0	1	<1
28.0%	26.0	13	3–5
78.0%	50.0	25	5–10
100.0%	22.0	11	>10
	100	50	entire

6.5. Work Experience

1 person means 2.0% of people have less than 1 year experience. Thirteen (26.0%) have between 3 and 5 years of experience. 25 people (50.0%) have between 5 and 10 years' experience and 11 people (22.0%) have more than 10 years' experience.

In the first step, the weight of the criteria and subcriteria were calculated using the entropy method. in Step 1 the score matrix is computed with the hesitant fuzzy S_{ij} on the experts' opinions matrix by formula (6).

then in Step 2 normalized matrix S' is computed by formula (7).

after that, we calculate the amount of E according to formula (8), and at the final step using formula (9) the weight is calculated. The amount of weight of the criteria and subcriteria is in Table 6:

It is show that the weight of Technological and security barriers is greater therefore the importance of it is more. Also for subcriteria Data security is the most important barriers for SC.

$$C1 > C2 > C4 > C1$$

After calculating the weight of criteria and subcriteria, the alternatives were ranked based on barriers on implementation of BT in supply chain using HF-VIKOR. in Table 7 the distance of the largest value from the other alternatives was Calculates.

After that follow the algorithm's third step and calculate the S, R, and Q of the hesitant fuzzy VIKOR index in Table 8.

Now we must investigate the condition of hesitant fuzzyVIKOR:

$$0/3828-0 \geq \frac{1}{4-1}$$

It is observed that the above relation is a correct relation, so the results of the method are correct so the ranking is as follow:

1. A2 - logistics and transportation
2. A3- production
3. A1- health and quality control
4. A4- warehousing and storage

Therefore, it is obvious that most section that logistics and transportation is the section where the barriers to blockchain are more prominent on it. Also Technological and security barriers is the most important barriers.

7. DISCUSSION AND CONCLUSION

The hybrid hesitant fuzzy entropy and hesitant fuzzy VIKOR methods made it more practical and suitable for the decision-makers to choose the best option from the implementation of blockchain into supply chain management.

Table 6 | Weight of the criteria and subcriteria.

Criteria	Weight	Subcriteria	Weight
Technological and security barriers (C1)	0.380952	Lack of technological maturity (C11)	0/195122
		Data security (C12)	0/219512
		Usability (C13)	0/121951
		Complexity (C14)	0/073171
		Interoperability (C15)	0/146341
		Forking (C16)	0/170732
		Performance and scalability (C17)	0/073171
Financial and human resources barriers (C2)	0.285714	Lack of IT personnel (C21)	0/269231
		High investment cost (C22)	0/346154
		Lack of research and development Units (C23)	0/192308
		Lack of funding technological infrastructure (C24)	0/153846
		Lack of financial subvention for block chain technology (C25)	0/038462
Organizational and individual barriers (C3)	0.095238	Strong hierarchical structure and bureaucracy (C31)	0/294118
		Strict administrative control (C32)	0/470588
		Information sharing obstacles (C33)	0/117647
		Mind set of people needs to be changed (C34)	0/117647
Social and environmental barriers (C4)	0.238095	Information sharing (environmental and social aspects) (C41)	0/4
		Wasted resources (C42)	0/6

Table 7 | Calculates the distance of the largest value from the other elements.

	C11	C12	C13	C14	C15	C16	C17	C21	C22
A1	0/0588	0/03395	0/022639	0/0226	0/01358	0/15168	0/05886	0/059391	0/032281
A2	0/005906	0/040538	0/02787	0/017735	0/007601	0/099649	0/040538	0/059391	0/032281
A3	0/005422	0/045668	0/038818	0/018267	0/009134	0/117308	0/045668	0/059391	0/032281
A4	0/005081	0/038337	0/029818	0/034078	0/010649	0/117963	0/038337	0/059391	0/032281
	C23	C24	C25	C31	C32	C33	C34	C41	C42
A1	0/007396	0/051691	0/057772	0/04561	0/012163	0/174632	0/057772	0/059391	0/032281
A2	0/004261	0/032281	0/027976	0/023672	0/01076	0/09895	0/032281	0/059391	0/032281
A3	0/005512	0/044607	0/035216	0/039911	0/021129	0/146375	0/044607	0/059391	0/032281
A4	0/00496	0/057504	0/031627	0/034502	0/014376	0/14297	0/057504	0/059391	0/032281

Table 8 | The amount of S, R, Q.

	R	S	Q
A1	0.0352	0.6174	0/58861
A2	0.0603	0.9148	0.0000
A3	0.0442	0.7418	0/3828
A4	0.0218	0.3217	1.0000

The highest weightage value used to consider the most important blockchain barriers which were represented such that $C1 > C2 > C4 > C1$ is given in Table 6. It is shown that technological and security barriers were the most important barriers for blockchain implementation which is similar to the result of [1].

HFSs have more preferences in comparison with classical ones. Finding a negligible blunder that caused issues on the membership values whereas applying classical strategies persuades us to center on faltering fluffy sets since this issue is unraveled by characterizing a set of conceivable values. It has shown that assigning an interval for an answer set for a reply set may have less exactness than a membership degree, which shows that the hesitant fuzzy decision-making methods are more precise than other strategies [27].

In the present study, due to the presence of scattered data and ranking of subscales on a scale of nine, normal hesitant entropy was used to determine the weights of this method. The reason for this was that the opinion of experts may be skeptical, and because the amount of hesitation is given to each indicator, it gives us a more accurate weight for ranking. In fact, entropy is the measure of uncertainty. The more random the data, the higher the entropy value, and the less random it is, the smaller the value. The point here is that the less random an event is, the more information it provides at the time of the event. If one event is more likely to occur than the other, viewing that event contains less information. Conversely, observing rarer events provides more information at the time of the event. In other words, the main idea of the entropy method is that the higher the scatter in the values of an index, the more important that index is, and the higher its weight.

The last step is to use the hesitant fuzzy VIKOR method to rank net strategies. The advantage of using the hesitant fuzzy VIKOR method was that it was a useful tool, especially when decision-makers could not easily apply their preferences to the problem due to the existence of many conflicting indicators and doubted their decision. The basis of the fuzzy VIKOR method is skeptical of decision-makers because it maximizes the utility of the group

shown by the S index and minimizes the effects of individual opinions shown by R. Due to factors such as lack of accurate and incomplete information, subjectivity and linguistics, which are more or less involved in real life, decision-making is a difficult process. These factors indicate that the decision-making process is in a HESITANT fuzzy environment and fuzzy logic.

For future research it is recommended that the solutions for blockchain barriers in the supply chain were Analyze and rank. These barriers can also be categorized by new classification methods like flowsort or BWMSort.

CONFLICTS OF INTEREST

The authors declare of no conflicts of interest.

AUTHORS' CONTRIBUTIONS

Conceptualization, P.S.; methodology, P.S.; software, P.S.; formal analysis, P.S.; investigation, P.S.; resources, P.S.; writing—original draft preparation, P.S.; writing—review and editing, P.S.; visualization, P.S.

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