Supplier Evaluation by using Trust Scores in a Blockchain Platform

Shameek Banerjee[1], Yashomandira Kharde[2]

[2] Assistant Professor,

[1,2] Symbiosis Institute of Operations Management, Nashik, Symbiosis International (Deemed University), Pune, India

[1] shameek.banerjee@siom.in, [2] yashomandira.kharde@siom.in

ABSTRACT

Supplier Evaluation plays a pivotal role in any organization as it helps to reduce cost, improve quality of product and improve the efficiency of a supply chain thereby increasing customer satisfaction.For any industry it is important to have a trusted relationship with your suppliers as it will yield more value for the business and will ultimately lead to a more responsive supply chain. Before selecting a supplier there are numerous key factors that needs to be considered by the consumer in order to create trust in the mind of the consumer.In this paperthe Key factors and their importance (on a scale from 1 to 5) were collected via telephonic conversation with managers and executives from manufacturing, FMCG, IT and E-commerce industries. The weights were calculated using AHP. Furthermore, we have used the output of this AHP analysis as input for a TOPSIS analysis to assigna value called trust score to different suppliers.Based on this, we have devised a modelby usingthe Blockchain platform to assign trust scores. This is done because Blockchain creates a mutual trust among the transacting parties and also helps to improve the trackability and traceability of products in a supply chain.This model will help consumers to evaluate various suppliers based on Key Performance Indicators and finally arrive at a decision to select the most appropriate supplier.

Keywords

Supplier Evaluation,Trust Score, AHP, TOPSIS, Blockchain, Smart Contracts.

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Introduction

For any industry, supplier selection is one of the key value drivers in the procurement cycle. Supplier selection is preceded by supplier evaluation which is a processrequiringproper insights, in depth analysis and profound knowledge. To carry out this process the most important factor is the source and the quality of the data that is being used to evaluate the supplier. (Narasimhan et al.,2001)

While there has been extensive research on various methods for supplier evaluation but the quality of the data that is being used is still a concern. With the advent of technology, there has been a proliferation of various unethical practices like false price comparisons, withholding important conditions of sale, not honouring warranty claims, selling defective products etc (Sihem 2013). The information that is being gathered needs to be from a verified source. To ensure the trustworthiness of the data we have used the blockchain platform. Blockchain ensures Confidentiality, Integrity and Authenticity for the data thereby improving data quality. Furthermore, the cryptographic algorithm that is used for network security ensures a mutual trust between both the transacting party (Miraz et al.,2018)

We have also used the concept of trust scores which provides a value to a supplier based on the performance of the supplier on these weighted key factors, which will ultimately act as a single source of truth and will help the consumer to make a better decision.

This paper is intended to give a holistic view on all the factors that can be considered for supplier evaluation and how we can arrive at a better decision by using these factors and leveraging the concept of trust scores in blockchain platform.

The paper commences by analyzing the literature for the key factors of supplier evaluation, the unethical practices that are done to mislead business decisions and summarization of the use of trust scores so far. Thereafter the methodology is discussed where Trust score is calculated in the Blockchain platform by using smart contracts in two steps: -

a) The weights of the key factors are determined using AHP. Here we have used a survey to determine the importance of these factors.

b) The output of the AHP analysis i.e. the weight of the key factoris then fed as input for the TOPSIS Analysis to do a pairwise comparison among various suppliers. Finally, the output of the TOPSIS analysis is a performance score which is used as a trust score.

Finally, the implementation feasibility and the risk aversion for the model has been discussed.

Literature Review:

Supplier selection

According to (Sollish et al.,2007) supplier evaluation and selection are fundamental activities handled by the procurement department. As per (Thiruchelvamet al.,2011) this is an important process in supply chain. Supplier Selection involves decision making with numerous criteria via a focus on the qualitative and the quantitative factors (Cengiz et al., 2017). Ensuring proper supplier selection would reduce purchase cost, increase profit, reduce lead time of product, increase consumer satisfaction and improve the competitiveness (Frej et al., 2017). Thus, identifying the key factors in order to select the right supplier is necessary for driving the growth of the firm. Moreover, having numerous suppliers provides more flexibility to the organization as the requirement of the organization is diversified and this also invokes competitiveness among different suppliers (Pal et al.,2013). Below listed are some

of the criteria that can be used for supplier selection. (Taherdoost et al.,2019)

a) Quality: This include features like type of material, dimension, material design, life of material, different types of material, machinery, quality system, technique for manufacturingand improvement measures.

b) Delivery: Supplier capability to adhere to defined delivery schedules that include lead time, timely performance, fill-rate, location, return management, logistics and incoterms.

c) Performance history: The performance history of supplier in economic, finance, organizational and social area.

d) Warranties: Honouring the specified documented guarantee to replace and repair the product within a given time period

e) Production capacity: Services or products that can be created by the supplier with current resources in hand.

f) Price: This include unit price, exchange rates, taxes, pricing terms and discount

g) Technology Capability: Supplier ability to acquire technology and resources for R&D

h) Mutual Trust and easy communication: The trust level on the quality of work done by the supplier. Easy communication implies the simplicity with which information is exchanged between the two parties.

i) Communication System: Information on orders via the supplier communication system

j) Reputation and Position in Industry*:*Reputation and Ranking of a product, company or brand in comparison to competitors (in terms of sales volume)

k) Profile of Supplier: Superiority of the supplier's status, finance, certificates, past performance and references

l) Management*:* Reputability of management team of supplier and their ability to take decisionin order to resolve issues.

m) Repair Service*:* Supplier ability to repair something which is faulty or damaged

n) Attitude: Confidence and politeness of the supplier when you are in contact with them

o) Risk Factor*:* It is a measure of the elements that can affect the asset value such as market price, exchange rate and interest rate

p) Commercial plan and structure*:* Statement of business goals of supplier and infrastructure plan to achieve them

q) Labour relations record*:* Relationship between workforce and management in the supplier's organization

r) Geographical Location*:*Thelocation of the supplier

s) Reliability*:* Reliability of the supplier in terms of response of buyer, financial stability, current and past customers, cultural awareness and ownership diversity.

t) Service*:*Ability of supplier to provide customization (OEM, label service, design, shape), industry knowledge, flexibility and communication (language, response time, information)

u) Professionalism: Skill expected from a professional

v) Product development*:* Supplier ability to modify or form a new product that satisfy customer requirement

w) Environmental and social responsibility*:* Ability to use resources carefully, reduce damage and ensuring the availability of resource for future generation

x) Process improvement: Supplier ability to improve business process in order to meet new standards.

y) Cost: This refers to material, time, resources, effort, risks incurred, utilities consumed and opportunity cost.

Advertisement frauds

Unfortunately, with the advent of technology, advertising frauds have also proliferated. According to (Nuseir et al.,2018) there are three components of false advertisements which are Fraud, Falsity and Misleading. The main aim of Fraud advertisement is to deceive consumers. Falsity refers to inconsistency in claimed facts and Misleading refers to creating an impression of product that is untrue or about product features that does not exist. All this can affect the buying process of a consumer and can change the perception of consumer about a product or service. As per (Khanet al.,2014) the falsehood of misleading advertisement to manipulating consumers cannot be easily detected. According to (Hasan et al., 2011) false advertisement claims are related to inconspicuous information, lack of attribute information, expansion implications and truth. As per the Consumer Protection from Unfair Trading Regulations (Hoek et al.,1985) an advertisement is misleading if it is presented to a person in a deceptive way and has monetary benefit or is intended to overcome other competitors in the market. Thus, it is very important from a business or a consumer's perspective to understand the false claims before making their purchasing decision. But this task is indeed a very complicated task as there are a plethora of data sources and it is difficult to check the authenticity of each of this data sources.

Trust models

There have been numerous trust models that has been suggested from time to time. Normally in the internet trust is managed by a Trust Management System (TMS). A dynamic trust model suggested by Anuoluwapo Adewuyiwhich was used for collaborating different applications in the Internet of Things.

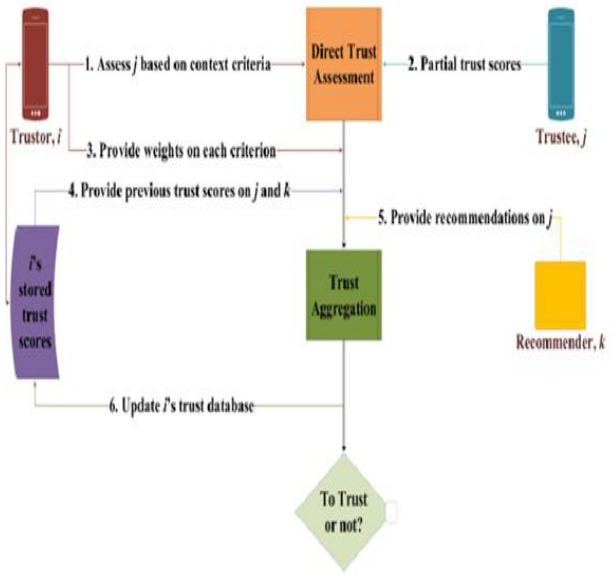

Figure 1: Trust Model for Collaborating different applications in IOT (Source: Adewuyi et al.,2019)

In 2020 a trust score model was also suggested by Ramesh and Sai Sri Sathya which stated how to create an initial trust score based on proximity and incoming data.

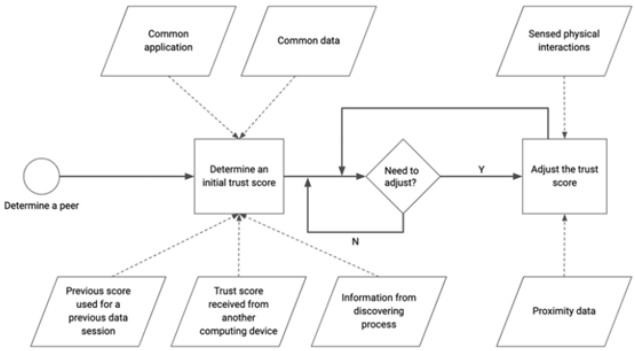

Figure 2: Trust Score based on Proximity and incoming data (Source: Sathya et al.,2020)

Although there are numerous models on trust scores but the quality and the source of the data always remains a question.

Trust Score in Blockchain

The definition of trust can be challenging as it combines morals, ethics, values, emotions and a variety of other fields. As per(Luhmann 2017) Trust is a useful mechanism to diminish complexity and risk. It has been seen that trust plays an important role when the user tries to assess the believability of the information present online. Users will not participate in a transaction with whom they lack trust.
Trust Score is not a new concept. E-commerce giants like Amazon and E-bay are already using trust score for review ratings. Apart from this we also have (Ahnet al.,2018) who suggested a model to derive trust on e-Payment based system which used Blockchain. The model derives trust value between users via psychological factors. (Shala et al.,2019) also stated a trust evaluation system for trust between peers in a machine to machine application services via Blockchain. Trust Score models have also been suggested in decentralized IOT platform (Shala et al., 2020). The advantage of trust score in blockchain is that it provides a single value which is derived based on certain predefined criteria which has already been decided and due to the trust mechanism of blockchain platform we can be reasonably sure that the data is indeed authentic.
The pieces of literature that has been collected helps us to identity some of the key supplier selection criteria and also the *gaps* in the data quality that is required to perform an effective analysis for supplier selection. In the subsequent sections we will be using a model where we use the concept of trust score in blockchain which will aid the supplier selection processby addressing the data quality issue thereby providing a *gap fit* to the problem.

Methodology

Below are the steps via which the model was devised
Step 1(Identify the supplier selection criteria): - The criteria for the supplier selection was identified as per the literature on Supplier Selection. There was a total of 25 criteria.
Step 2(Identify the weights of the criteria): - A questionnaire was formed to determine the importance of each criteria. In the questionnaire the respondent had to provide the importance of each of the 25 criteria in an ordinal Scale (For example: - Rate Quality between 1 to 5 where 1 signified least importance and 5 signified most important). The respondents were managers and executives from different industries like consulting, pharmaceutical, e-commerce, IT, manufacturing and more. Based on the response, the weightage of each criteria was calculated using Analytical Hierarchical Processing (AHP). After this we chose the top 5 criteria for our analysis.
Step 3(Calculate performance score of suppliers)*:* Next we chose 3 companies: - Bosch, Hyundai Mobis and Valeo (n number of companies can be chosen). All these companies are suppliers of global OEM parts. Another questionnaire was formed to evaluate these three companies based on the top 5 criteria from the earlier step. In this caseTOPSIS was used to calculate the performance score of each supplier.
Step 4(Assign Trust Score to Supplier using Smart Contracts): The logic for Step 2and Step 3 is written in the Smart Contract. The performance score is then normalized to get the trust score value for each supplier, which is then assigned to corresponding supplier.

Data Analysis:

The total value (obtained by adding the total response value i.e. if a criteria received 50 responses with values like 5,4,5,…,n then we simply add all the values for the criteria to arrive at the total value of the criteria) for each of the criteria is shown in the table below:

Criteria	Total Value
Quality	237
Delivery	231
Service	229
Reliability	226
Price	218
Professionalism	214
Cost	211
Risk Factor	210
Warranties and Claim Policies	209
Mutual Trust and Easy Communication	209
Repair Service	209
Attitude	208
Performance History	206
Communication System	205
Supplier's profile	204
Process Improvement	204
Management and organization	203
Technology and Capability	199
Production Capacity	198
Product Development	198
Reputation and Position In industry	195
Environmental and Social Responsibility	188
Commercial Plans and Structure	185
Geographical Location	185
Labour relations record	182

Table 1: Value of Each Supplier Selection Criteria (Source: Author's Creation)

From here we have chosen the top 5 criteria for our AHP Analysis
As per the AHP analysis these were the weights of the top 5 criteria

Criteria	Weights
Quality	20.77%
Delivery	20.24%
Service	20.07%
Reliability	19.8%
Price	19.12%

Table 2: Weight of Top 5 criteria using AHP(Source: Author's Creation)

Now these weights were used as input for the TOPSIS Analysis. In this case comparison was done between 3OEM manufacturing companies i.e. Bosch, Hyundai Mobis and Valeo based on the top 5 criteria. The performance score for the 3 companies based on TOPSIS analysis are:

Company	Performance Score
Bosch	0.7592463388
Hyundai Mobis	0.7006185918
Valeo	0.6620344931

Table 3: Calculating Performance Score of Companies using TOPSIS(Source: Author's Creation)

Next, we arrive at the trust score by normalizing the values

Company	Trust Score
Bosch (Most Favourable supplier)	37
Hyundai Mobis	33
Valeo	30

Table 4: Calculating Trust Score of Companies using TOPSIS (Source: Author's Creation)

Results

The overall model can be illustrated in the following way:

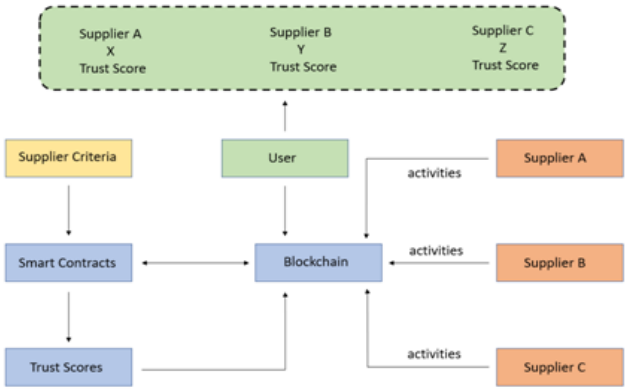

Figure3: Model for Supplier Evaluation using Trust Score in Blockchain (Source: Author's creation)

Initially the identification of the supplier evaluation criteria is decided by the business. Thereafter the weight calculation of the criteria is done in the smart contract. In this paper we have used AHP for determining the weights. Next all the activities that are done by the supplier are recorded in the blockchain. Based on this activity we apply TOPSIS and the performance score is also calculated in the smart contract by using the weights of the evaluation criteria that was previously calculated. In the previous section as an example we have shown how the trust score is getting affected based on the supplier activities. The performance scores are then normalized to derive the trust score which is given to each supplier in the blockchain platform. When a business user accesses the blockchain platform he/she can see the trust scores for each of the suppliers and accordingly take the buying decision.The key assumption of this model is that all the suppliers should be a part of the blockchain network.

Conclusion

In this study we considered 10 criteria for supplier evaluation, but this number is fully at the discretion of the business. Moreover, the model is highly dynamic as more criteria can be added by the business as they deem fit. The business simply needs to update the smart contract with the new criteria. The programming in smart contracts can be done in such a way so as to allow addition of new variables. Here we have used AHP followed by TOPSIS to calculate the performance score which was then normalized to arrive at the trust score but there are numerous other multi criteria decision making methods out there for determining the weights of the supplier evaluation criteria. Any method can be chosen by the business. Only the corresponding programming for the new method needs to be written in the smart contract.

There are few challenges to this model which include cost of Blockchain implementation, finding subject matter expert for smart contract coding and convincing stakeholders to use blockchain can also be a hurdle. But the main goal of ensuring the authenticity of the information and ensuring trust about the supplier can be achieved without any difficulty and furthermore, the time taken to evaluate the supplier and ultimately arriving at a buying decision will decrease drastically.

Future Scope

This paper primarily focused on how trust scores can be used to evaluate a supplier. Here we focused on AHP and TOPSIS to derive the weights of the supplier criteria. Further research can be done on how to arrive at the weights of the supplier selection criteria. The 25 criteria that has been used is not an exhaustive one, further criteria can be explored. The model can be particularly explored in the E-commerce sector(B2B and B2C) for exploring the products (in this case products can be assigned with a trust score). Furthermore, the concept of trust score can play a key role for decentralized identity (actual identity will not be shared, the trust score will act as the identity of the user thereby improving data privacy)

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