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RESEARCH ARTICLE

Increasing Efficiency through Tokenization of Digital Assets in an Exporting Company 4.0

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Abstract: Digital assets have been introduced to the global market as one of the innovations with the potential. Even though their impact on the traditional economy is impossible to measure. Security tokens (ST) are the ones that stand out due to the preference they have from producers and consumers. The former obtains financial resources efficiently for their specific projects. While the latter look for STs in global digital platforms of trust and security. Which are regulated by public securities sales offices. The research proposes a method under the fuzzy logic theory and its applied models. It highlights the use of the triangular fuzzy numbers, the Fuzzy Delfi, Expertons, Hamming Distance, and the fuzzy inference system (FIS). The benefits and limitations of the proposal were highlighted when the proposal was used in an agro-export company. The route or algorithm of the value system to be followed in the execution of the investments stands out. Therefore, the research fulfills its objective and is very useful for small and medium export 4.0 companies. Since they are eager to obtain cash flow to improve their technical efficiency and to be able to export their artifacts to global markets. That is to say, the producer of goods can obtain an unprecedented benefit in an agile and efficient way in the context of Industry 4.0.

Keywords: STO, ST, SME, Industry 4.0, Asset tokenization

1. Introduction

In the third decade of the 21st century, the predominant economy is global and includes; the traditional economy that is sustained by the use of physical or tangible money and the digital economy. Likewise, it is well known that an economy is studied through two types of agents: producers, who have the individual production set, and consumers; who have the consumption of their preferences. In the scenario described above, the fourth industrial

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revolution or Industry 4.0 arrived and disruptively introduced digital technologies and boosted the digital economy due to consumer preferences for the tokenization of assets to replace tangible assets.

A digital asset or virtual asset is understood as any digital representation of value that can be in the form of digital tokens (digital payment tokens, utility tokens, or security tokens), any other virtual product, crypto assets, or assets of essentially the same nature [1]. Tokens can be non-fungible tokens (NFT), which are indivisible and non-exchangeable. While, fungible tokens (FT) are characterized by being divisible and exchangeable, but both are underpinned by blockchain technology. However, the research interest is limited to FTs and specifically to security tokens (ST), which offer rights quite similar to traditional but reach a wider audience, eliminating bureaucracy and slowness. At the same time, their cost is much lower than having to list shares [1]. Consumers with preferences for STs find supply in security token offerings (STO) that are managed by specialized and regulated agents.

It is necessary to clarify that STs, STOs, like Initial Coin Offering (ICO), is developed on a digital platform under blockchain technology. It is a data structure whose information is grouped in blocks to which meta-information related to other blocks of the previous chain is added in a timeline, so that, with cryptographic techniques, the information contained in a block can only be edited by modifying all subsequent blocks [2]. Its origin dates back to 2008 when Satoshi Marramaos published the Withepaper "Bitcoin: a pear-to-pear electronic cash systems" and in 2009 appeared the first cryptoasset with blockchain technology called; Bitcoin. While in 2015 the Ethereum platform was presented; with its cryptoasset Ether, smart contracts protocol, and ERC20 [2]. The latter is a protocol that allows authorizing the execution and transactions of third-party tokens [3]. Meanwhile, smart contracts allow people to do business with strangers, over the Internet, without the need to use a trusted intermediary. The software automates much of the process, allowing contractual promises to be enforced without human involvement [4]. Smart contracts represent a highly estimable advantage, as they provide reliability and security that traditional contracts do not possess, as well as a very high speed of execution.

However, the relevance of the research is located on the side of the producer who has suffered the obsolescence of its fixed and intangible assets (knowledge) due to the digital and disruptive technology of Industry 4.0 [5]. That is, producers who do not adopt the efficient use of digital technology are stagnating in their efficiency, productivity, and competitiveness. Therefore, the relevance of the research lies in providing, especially to export 4.0 companies, a model that allows them to improve their efficiency by using digital asset tokenization, but in turn, improving the efficiency of use of digital assets.

Based on the above, the current state of the art defines two components; (i) the tokenization of digital assets through the security token (ST) and the security token offering (STO), and (ii) the fulfillment of requirements that export companies must have to obtain liquid resources from the ST and STO. Technically, an ST can be; assets, shares, debt, and investment funds. The TS offering process is known as STO [6]. It usually has the following process; (i) economic and commercial feasibility analysis, (ii) token design, (iii) legal and tax structure for launching the STO through a public offering, (iv) digitization of the asset respecting market requirements, investor rights and warranties, (v) marketing and communication campaign design to encourage STO conversion, and (vi) STO launch. This is executed through a multi-channel platform, but the company is only responsible for preparing the economic and commercial feasibility analysis.

Consequently, the research aims to propose an efficient evaluation method to generate a digital asset and its tokenization. The method is executed using fuzzy logic and allows to build in an agile and innovative way a digital asset through the participation of its experts. That accepts the uncertainty of international trade and Industry 4.0. Also, the method introduces the use of digital technology scaling (DTS) under modus ponens reasoning. By which the use of digital technologies or input variables (EV) is evaluated, and reduced to three intermediate variables (IV). Then the fuzzy inference system (FIS) is built and the export efficiency is obtained as output variable (OV). Then the evaluation of the useful investment is elaborated to develop the corresponding tokenization of the digital asset. In the end, the research meets its objectives by a robust method in a low-information uncertainty environment and based on expert knowledge. Only care with the semantic bias of the EV and IV variables are required.

2. Materials and Method

In the context of uncertainty to which export 4.0 companies are subjected, an innovative method is proposed that allows the tokenization of assets in an agile and reliable way under the theory of fuzzy logic and the opinion of business experts.

2.1 Research Materials

1) Fuzzy logic. The evaluation of digital assets and not

a measurement is developed [7]. For this purpose, Fuzzy Set theory [8], triangular fuzzy numbers (TFN) [7], Fuzzy Delfi [9], Expertones [10], Hamming Distance [11], fuzzy inference system (FIS) [12] are used. Very useful to explain the economic and commercial analysis of the asset.

2) The company and its experts. Fuzzy logic is applied to the exporting company 4.0 which is interested in improving its technical efficiency but does not have the financial resources. The company delivers the efficiency data for the last three years, a minimum of eight experts (from the production), five counter-experts (from the administrative), and the people in charge of the jobs in the value chain.

3) The digital technology scale (DTS). It was designed under the modus ponens reasoning and validated by the researcher to evaluate the use of digital technologies (td). Where; additive manufacturing = td_1, Internet of things = td_2, 3D printing = td_3, augmented reality = td_4, virtual reality = td_5, collaborative work = td_6, data mining = td_7, artificial intelligence = td_8, robotics = td_9, blockchain = td_{10}, cloud = td_{11}, big data = td_{12}, cybersecurity = td_{13}, agile project = td_{14}, social networks = td_{15}. Each td is an input variable (EV).

4) The RAMI 4.0. It is the model [13] used by Industry 4.0 to reduce the conglomerate of EVs to three intermediate variables or axes of RAMI 4.0; life cycle (IV_1), hierarchical level (IV_2), and digital synchronization (IV_3).

5) The FIS. The fuzzy inference system (FIS) is built using Mamdani's reasoning in the Matlab - Fuzzy Logic Toolbox software. The intermediate variables are introduced in the FIS, with their corresponding degrees of membership, and the output variable (OV) is obtained. This is defined as export efficiency (EE).

2.2 Research Method

1) Selection of the company. The first process corresponds to the selection of exporting companies to be intervened. For this, the If-Then reasoning is used under the *modus tollens.*

2) Valuation using the DTS. The selected company has introduced the use of the documentary measurement instrument defined as the digital technology scale (DTS). It allows the valuation of the use of digital technology at each job in the value chain. That is, employing the DTS, the Hamming Distance (HD) is obtained for each job position in the columns, and the intermediate variables (IV_1, IV_2, IV_3) are grouped in the rows according to the three axes of the RAMI. Each axis represents the use [Low Medium High] of digital technologies.

3) Construction of the FIS. With each intermediate variable (IV) and the fuzzy rules defined by the researcher, the fuzzy inference system (FIS) is developed in the Matlab-Fuzzy Logic Toolbox software. It provides the output variable (OV) or export efficiency (EE) for each valuation point (N, Year 0, Year 1, Year 2, Year 3). EE is a value [Low Medium High] for each evaluation point.

4) Construction of the value system. With the EE data, obtained through the FIS, the graph and the algorithm of the value system. The algorithm represents the most effective route to increase efficiency. It allows the monitoring of export efficiency (EE).

5) Valuation of the investment. Although the value system allows an increase in the efficiency of the exporting company, it, in turn, requires an investment. The investment value is calculated using the triangular fuzzy numbers, Delfi Fuzzy and Experton. The amount obtained is voiced in thousands of USD. It is the benchmark for asset tokenization.

In summary, the proposed method uses the DTS to make the valuation of the input variables (EV) and gets the intermediate variables (IV) which are introduced in the FIS (Mamdani) and to obtain the OV or EE. See Figure 1.

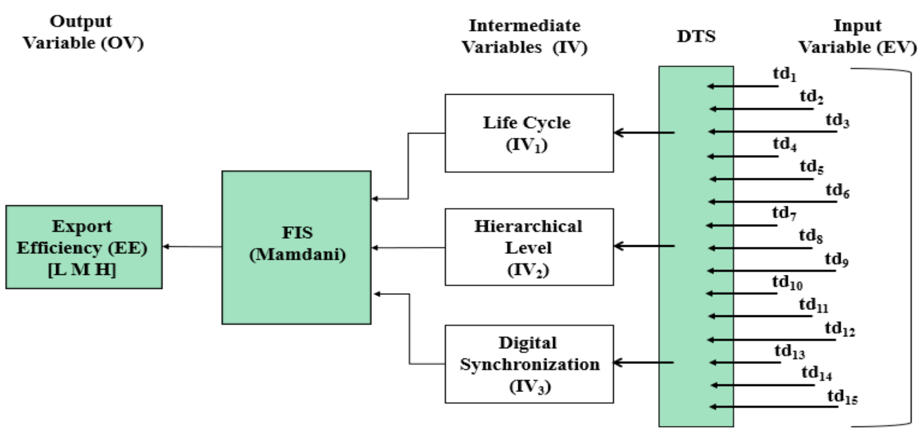

Figure 1. Graphic representation of the method.

3. Results

3.1 Selection of the Goods Exporting Company

First, a pre-selection of 10 exporting companies was carried out, to which the If-Then reasoning was applied virtually under the modus tollens.

Test 1.

If td_1, ... and td_5 are used efficiently, then the life cycle is high.

Fact: The life cycle (IV_1) is not high.

Consequence: Therefore, td_1, ... and td_5 are not used efficiently.

Test 2.

If td_6, ... and td_{10} are used efficiently, then the hierarchy level is high.

Fact: The hierarchy level (IV_2) is not high.

Consequence: Therefore, td_6, ... and td_{10} is not used efficiently.

Test 3.

If td_{11}, ... and td_{15} are used efficiently, then the digital synchronization is high.

Fact: The digital synchronization (IV_3) is not high.

Consequence: Therefore, td_{11}, ... and td_{15} is not used efficiently.

Therefore, the fresh blueberry agro-exporting company selected has a cultivation area of 700 hectares and its value chain includes; R+D+i, design, supply, production manager, logistic, marketing, facilities, ICTs, human talent, and general management. The predominant blueberry varieties are Emerald, Ventura, and Biloxy, whose agronomic adaptation allows harvesting during January, February, March, and April. A harvest and export window to the U.S. allows you to obtain prices above the annual average.

3.2 Results of the Use of the DTS

A virtual interview of approximately two hours was conducted with each response of the workplace PT1, PT2, ... and PT10, with the objective of evaluating the use of the fifteen digital technologies (td_1, td_2, ... td_{15}). The valuation corresponds to the initial situation that the agro-exporting company has, which is called point N. Then the researcher makes the evaluation of improvement, according to his experience and knowledge, of Year 0, Year 1, Year 2, and Year 3. Where, Year 0 is the period between the initial evaluation and the improvement, which can be achieved without investment, only through the best use of available resources. Year 1 is the first year of investment, Year 2 is the second year of investment, and Year 3 represents the third year of investment.

1) Valuation of point N. In the first column we have the valuation of PTI (R+D+i = research, development and innovation) with Hamming Distance = HD = 0.65. It continues with the value of HD for the ten jobs and highlights the value furthest from the ideal; PT7 = 0.75 and the value closest to the ideal; PT6 = 0.49. The average value of the ten jobs = PT (N) = 0.63. While, in the ranks: life cycle (IV_1) a valuation [Low] = IV_1 = 0.314, hierarchy level (IV_2) a valuation [Low] = IV_2 = 0.318 and digital synchronization (IV_3) a valuation [Medium] = IV_3 = 0.472. Where agile project has the lowest value = 0.19 and the highest value is cybersecurity = 0.44. See Figure A1.

2) Valuation of year 0. In the first column we have the valuation of PTI (R+D+i = research, development and innovation) with a Hamming Distance = HD = 0.61. It continues with the value of HD for the ten jobs and highlights the value furthest from the ideal; PT7 = 0.71 and the value closest to the ideal; PT6 = 0.45. The average value for the ten jobs = PT (Year 0) = 0.59. A far cry from the ideal value of 1. Meanwhile, in the ranks: life cycle (IV_1) a [Low] = IV_1 = 0.314, hierarchy level (IV_2) a [Low] = IV_2 = 0.352, and digital synchronization (IV_3) a [Medium] = IV_3 = 0.564. Improvements that are achieved with available resources. That is, without investment. See Figure A2.

3) Valuation of year 1**.** In the first column we have the valuation of PTI (R+D+i = research, development and innovation) with a Hamming Distance = HD = 0.52. It continues with the value of HD for the ten jobs and highlights the value furthest from the ideal; PT7 = 0.61 and the value closest to the ideal; PT6 = 0.39. The average value for the ten jobs = PT (Year 1) = 0.52. A far cry from the ideal value of 1. Meanwhile, in the ranks: life cycle (IV_1) a [Medium] = IV_1 = 0.470 valuation, hierarchy level (IV_2) a [Low] = IV_2 = 0.404 valuation, and digital synchronization (IV_3) a [Medium] = IV_3 = 0.564 valuation. Improvements to be achieved by investing in the Internet of Things (IoT). See Figure A3.

4) Valuation of point year 2. In the first column we have the evaluation of PTI (R+D+i = research, development and innovation) with a Hamming Distance = HD = 0.45. Likewise, the value of HD for the ten jobs highlights the value furthest from the ideal; PT7 = PT10 = 0.51, and the value closest to the ideal; PT6 = 0.37. The average value of the ten jobs = PT (Year 2) = 0.45. While, in the ranks: life cycle (IV_1) a [Mean] valuation = IV_1 = 0.470, hierarchy level (IV_2) a [Medium] valuation = IV_2 = 0.548, and digital synchronization (IV_3) a [Medium] valuation = IV_3 = 0.628. Improvements are achieved through investment in IoT and Big Data. See Figure A4.

5) Valuation of point year 3. In the first column we have the valuation of PTI (R+D+i = research, develop-

ment and innovation) with a Hamming Distance = HD = 0.29. Likewise, the value of HD for the ten jobs highlights the value furthest from the ideal; PT10 = 0.35 and the value closest to the ideal; PT6 = 0.25. The average value of the ten jobs = PTx (Year 3) = 0.29. While in the ranks; life cycle (IV_1) a valuation; [High] = IV_1 = 0.688, hierarchy level (IV_2) a valuation; [High] = IV_2 = 0.668 and digital synchronization (IV_3) a valuation; [High] = IV_3 = 0.766. Improvements are achieved through investment in IoT, VR, collaborative work, data mining, Blockchain and cybersecurity. See Figure A5.

3.3 Construction and Use of the FIS

The construction of the FIS is developed with three inputs: (i) IV_1 = life cycle, (ii) IV_2 = hierarchical level, and (iii) IV_3 = digital synchronization. Each input (IV_1, IV_2 and IV_3) has three trapezoidal types [Low Medium High] degrees of membership. See Figure B1, B2, B3, and B4. Also, the export efficiency (EE-FIS) has three degrees of membership [Low Medium High]. See Figure B5. Then the construction of the fuzzy If-Then rules is done. See Figure B6. The values of the membership functions are defined by the researcher based on his experience. To the FIS the values of IV_1, IV_2 and IV_3 are introduced for the different landmarks; (i) for point N: IV_1 = 0.314, IV_2 = 0.315, IV_3 = 0.472 then the value of EE = 0. 241 (see Figure B7), (ii) for Year 0: IV_1 = 0.314, IV_2 = 0.352, IV_3 = 0.564 then the value of EE = 0.277 (see Figure B8), (iii) for Year 1: IV_1 = 0. 470, IV_2 = 0.404, IV_3 = 0.564 then the value of EE = 0.500 (see Figure B9), (iv) for Year 2: IV_1 = 0.470, IV_2 = 0.548, IV_3 = 0.628 then the value of EE = 0.500 (see Figure B10) and (v) for Year 3: IV_1 = 0.688, IV_2 = 0.668, IV_3 = 0.766 then the value of EE = 0.755 (see Figure B11). All values respond to the fuzzy rule established for the EE-FIS and develop the fuzzy surface, as shown in Figure B12.

3.4 Value System Construction

The value of the export efficiency (EE) or output variable is associated with the data obtained in the Hamming Distance employing the DTS, and Table 1 is constructed. It is shown that milestone N has a red color: since the value of the Hamming Distance = 0.63 and the output variable = 0.2. While milestone Year 3 has a green color: due to the value of Hamming Distance = 0.29 and output variable = 0.755. Where the Hamming Distance is inversely proportional to the output variable. Therefore, the curve of the output variable or EE is defined as the system value of the investigation. It represents the most efficient route for increasing the efficiency of the exporting company under investigation. Even though, there could be other routes. However, according to the opinion of the experts and counter-experts, the export efficiency increases from 0.241 [Low] to 0.755 [High]. An increase in efficiency allows it to be rescued as an intangible asset to present in the Whitepaper for its corresponding tokenization.

Table 1. Association of values of HD and EE

Milestone	Export Efficiency (EE)				
	HD	IV_1	IV_2	IV_3	OV
N	0.63	0.314	0.318	0.472	0.241
Year 0	0.59	0.314	0.352	0.564	0.277
Year 1	0.52	0.470	0.404	0.564	0.500
Year 2	0.45	0.470	0.548	0.628	0.500
Year 3	0.29	0.688	0.668	0.776	0.755

Note: Red color is "Low" degree of belonging, gray color is "Medium" degree of belonging and green color is "High" degree of belonging.

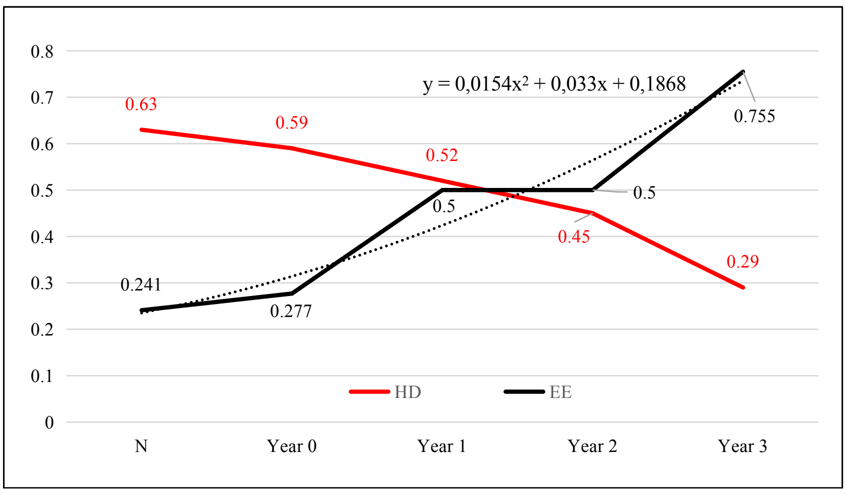

Figure 2. Milestone, HD, and export efficiency (EE).

3.5 Valuation of the Investment of the Value System.

The valuation of the investment required to execute the value system or digital asset covers the expectations detailed in the valuation of milestone; N, Year 0, Year 1, Year 2, and Year 3 (described in sections; 3.2). The Delfi Diffuse and Expertones method is used for the valuation. Utilizing three activities.

Activity 1.

Valuation of the experts concerning the investment. The eight experts are brought together to get their opinions on three questions about the project's investment.

i. Estimate the minimum investment for the project?

ii. Estimate the most presumed investment for the project?

iii. Estimate the maximum investment for the project?

The answers are collected in Table C1.

Activity 2.

Counter-expert method. Five counter-experts are assembled to do the expert evaluation between the extremes [594, 825]. Table C2 shows the counter-expert questions. Table C3 shows the responses of the counter-expert according to the levels of assumption and with the data obtained the absolute frequency, relative frequency, and inverse cumulative frequency are developed. See Table C4.

Activity 3.

Calculation of the R + – Experton of the investment. The authors Kaufmann and Gil Aluja (1993) explain that the R+ -Experton is obtained utilizing Equation 1:

$$R\text{+– } Experton = Ai + (As - Ai) * Experton. \quad (1)$$

Where: Ai = 594 and As = 825 (from Table C1). It is replaced in Equation 1

R+– Experton = 594 + (825 – 594) * Experton.

$$R\text{+– } Experton = 594 + 231 * Experton. \quad (2)$$

Therefore, by means of Equation 2 the R+- Experton of the investment is constructed and shown in Table C5 and the lower and upper interval is obtained:

Li = ((825.0 + 825.0 + 825.0 + 825.0 + 778.8 + 640.2 + 594.0 + 594.0 + 594.0 + 594.0 + 594.0) / 10)

Li = 686.4

Ls = ((825.0 + 825.0 + 825.0 + 825.0 + 825.0 + 825.0 + 825.0 + 825.0 + 825.0 + 732.6 + 594.0) / 10)

Ls = 792.6

That is, the R + -Experton for the inversion has the extremes [Li Ls] = [686.4, 792.6] and its mean value is = 739.5. By which the TFN = [686.4, 739.5, 792.6] is constructed. Therefore, the amount of investment is equal to the mean value of USD 739500.

4. Discussion

In the economy and the traditional market for financial resources, export companies have the option of obtaining financing for their projects through Initial Public Offerings (IPO). Through the IPO, companies are incorporated into the stock market and from where they issue different financial assets to attract public capital. A very recent option is the security token (ST) whose offer is executed through the security token offering (STO) and is characterized because they require less time, are cheaper, secure, with the technology base of blockchain, smart contracts, and the ERC20 protocol. However, export companies still do not take advantage of these new financial instruments due to two reasons. Are few countries have regulations on STs and companies authorized for the public issuance of STOs, and export 4.0 companies do not always know how to prepare the documentation for asset tokenization. With the caveat that in today's digital economy any company from one country can make issues in another, fulfilling sometimes very slight requirements.

In addition to the above, tokenization itself often means a significant increase in the efficiency of the asset-liability in question, since it usually provides access to a secondary market that provides very interesting additional liquidity, so that if a holder of token wishes to dispose of the asset-liability represented, it has the option of offering it to a very broad universe that exceeds that of traditional investors. And we will also have a reference price. Thus, if a token has a certain expected behavior (Te) that can be represented in fuzzy triangular or trapezoidal numbers easily, then when we know the actual behavior of the token (Tr) we obtain in this way a measure of the effectiveness of that token. Where the value of Tr > Te. See Figure 3.

The reason why the research proposes an agile method to select the exporting company, apply the DTS, build the EE and proceed with the diagnosis of point N, which represents the current state of the company concerning the efficient use of digital technologies. Then, manipulating the increase in the use of technologies in the different workplaces (PT), and efficient growth path is built. A path is defined as the system value and tokenization of the asset. That is, machines and equipment are tangible assets, but the construction of the token represents a translation of a financial asset-liability or equity to the digital world, so its efficiency does not depend only on the use of technologies, but also on the evolution of the asset-liability it represents and normally the evolution of a market.

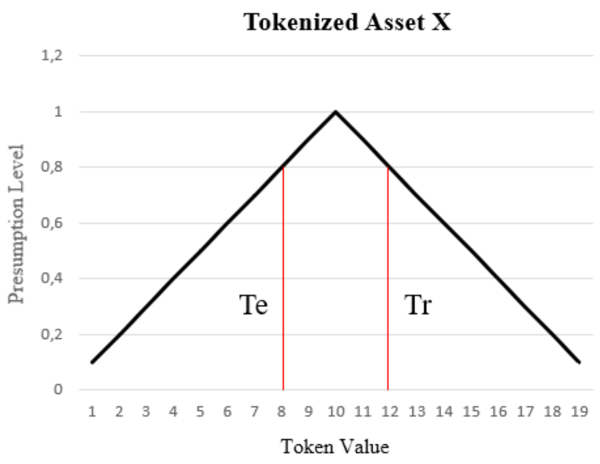

Figure 3. Tokenized asset X

The research is developed under the fuzzy logic by which the digital asset is built. An accurate and clear valuation and not the measurement of the digital asset. This constitutes an innovation in Industry 4.0, but the proposal will have to overcome the regulations of the countries and entities that issue STOs. That is to say, it will be necessary to experiment if the consumers of the ST accept the economic and commercial viability analysis under fuzzy logic. Consequently, the document that is addressed to the future token holders is a technical report, also known as Withepaper, which should answer all the questions, therefore, its structure at least includes; (i) introduction, (ii) legal notice, (iii) table of contents, (iv) description of the market and the problem, (v) description of the product and how it will solve the problem, (vi) tokens: how many, why, how, when, (vii) how the funds raised will be used, (viii) working team, and (ix) roadmap. The document will need to be produced neatly for the preference of future ST holders because fuzzy or fuzzy reasoning is very close to human reasoning [14].

Future research should be a model that allows the monitoring and control of the ST holder's compliance with the Whitepaper. That is, the ST holder, through the use of virtual reality and its respective avatar, could be mobilized in the exporting company 4.0 verifying compliance with the Whitepaper. An innovation that would make it possible to control the fulfillment of promises to consumers.

5. Conclusions

Blockchain will spearhead the next generation of financial market infrastructure, and ST are a digitized from of tradicional ownership certificates. Then blockchain and ST will disrupt the investment industry by providing cheaper and faster financial market solution [15]. Based on the premise; that technology does not knock on the door or ask for permission [16] came the tokenization of digital assets under blockchain technology and crossed directly to the financial markets. That is, the global listed trading volume of STs is expected to grow to $162.7 trillion by 2030 and according to the most optimistic analysts consider them to be the crypto asset class of the next decade [17] due to consumer preference. Preferences that are supported by: (i) smart contracts whereby people do business between strangers, over the Internet, securely and reliably, and (ii) the ERC20 protocol. While producers obtain significant liquidity outside traditional markets, but above all the underlying assets are protected, especially in inflationary environments. All of which generates an increase in efficiency in the exporting company 4.0 underlying the use of digital technology, the tokenization of assets, and indirectly a complementary efficiency due to the secondary market of the ST.

Consequently, the method proposed, innovative, agile, and robust, allows accepting the uncertainty of the context of the digital economy, Industry 4.0 and international trade drawbacks, as well as the subjectivity in the evaluation of experts. It also allows to build a digital asset in person or virtually. Finally, it allows closeness with the token holder, who knows the benefits of digital technologies. In summary, the research meets its objectives and provides small and medium-sized enterprises with another option [18,19] to obtain fresh resources and improve efficiency, productivity, and competitiveness in the complex and uncertain international trade.

Authors' Contributions

The authors worked jointly on the research.

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Appendix A

Table A1. Valuation with DTS of Milestone N.

Input Variable (EV)		Hamming Distance Per Job (PT) - Milestone N.										Ideal	Average	Intermediate Variable (IV)		
Item	Digital Technology	PTI	PT2	PT3	PT4	PT5	PT6	PT7	PT8	PT9	PT10	Profile	Per (td)	Value	[L M H]	Exes-RAMI
1	Additive Manufacturing	0,1	0,3	0,3	0,1	0,1	0,5	0,1	0,1	0,1	0,2	1,0	0,19			
2	Internet Of Things	0,6	0,1	0,5	0,2	0,1	0,3	0,1	0,1	0,1	0,3	1,0	0,24		High	
3	3D Printing	0,5	0,7	0,5	0,3	0,1	0,5	0,5	0,7	0,3	0,3	1,0	0,44	0,314	Medium	Life Cycle
4	Aumented Reality	0,3	0,6	0,2	0,1	0,3	0,5	0,2	0,3	0,1	0,5	1,0	0,31		Low	
5	Virtual Reality	0,5	0,8	0,1	0,1	0,4	0,5	0,2	0,3	0,5	0,5	1,0	0,39			
6	Collaborative Work	0,4	0,1	0,1	0,3	0,7	0,2	0,1	0,2	0,5	0,1	1,0	0,27			
7	Data Mining	0,2	0,2	0,6	0,3	0,7	0,7	0,1	0,3	0,5	0,2	1,0	0,38		High	
8	Artificial Intelligence	0,2	0,2	0,5	0,4	0,6	0,5	0,1	0,3	0,5	0,2	1,0	0,35	0,318	Medium	Hierarchical Level
9	Robotics	0,3	0,5	0,3	0,3	0,2	0,4	0,3	0,3	0,1	0,2	1,0	0,29		Low	
10	Blockchain	0,1	0,1	0,3	0,3	0,3	0,7	0,1	0,5	0,3	0,3	1,0	0,30			
11	Cloud	0,6	0,3	0,6	0,6	0,8	0,6	0,1	0,5	0,7	0,1	1,0	0,49			
12	Big Data	0,2	0,1	0,5	0,3	0,3	0,5	0,3	0,7	0,7	0,2	1,0	0,38		High	
13	Cibersecurity	0,4	0,5	0,7	0,6	0,4	0,7	0,7	0,9	0,7	0,5	1,0	0,61	0,472	Medium	Digital Synchronization
14	Agile Project	0,1	0,1	0,2	0,2	0,5	0,3	0,3	0,3	0,3	0,1	1,0	0,24		Low	
15	Social Networks	0,7	0,8	0,7	0,4	0,7	0,8	0,5	0,6	0,7	0,5	1,0	0,64			
	Hamming Distance Per PT	0,65	0,64	0,59	0,70	0,59	0,49	0,75	0,59	0,59	0,72					
	Average of HD Per PT					0,63						HD = Low > 0.6		0.6 > HD = Medium > 0.3		HD = High < 0.3

Note: PT1 = R+D+i, PT2 = design, PT3 = supply, PT4 = production manager, PT5 = logistic, PT6 = Marketing, PT7 = facilities, PT8 = ICTs, PT9 = human talent, and PT10 = general manager.

Table A2. Prospective Year 0 milestone using DTS.

Input Variable(EV)		Hamming Distance Per Job (PT) - Milestone Year 0										Ideal	Average	Intermediate Variable (IV)		
Item	Digital Technology	PTI	PT2	PT3	PT4	PT5	PT6	PT7	PT8	PT9	PT10	Profile	(td)	Value	[L M H]	Exes-RAMI
1	Additive Manufacturing	0,1	0,3	0,3	0,1	0,1	0,5	0,1	0,1	0,1	0,2	1,0	0,19			
2	Internet Of Things	0,6	0,1	0,5	0,2	0,1	0,3	0,1	0,1	0,1	0,3	1,0	0,24		High	
3	3D Printing	0,5	0,7	0,5	0,3	0,1	0,5	0,5	0,7	0,3	0,3	1,0	0,44	0,314	Medium	Life Cycle
4	Aumented Reality	0,3	0,6	0,2	0,1	0,3	0,5	0,2	0,3	0,1	0,5	1,0	0,31		Low	
5	Virtual Reality	0,5	0,8	0,1	0,1	0,4	0,5	0,2	0,3	0,5	0,5	1,0	0,39			
6	Collaborative Work	0,4	0,4	0,4	0,4	0,7	0,4	0,4	0,4	0,5	0,4	1,0	0,44			
7	Data Mining	0,2	0,2	0,6	0,3	0,7	0,7	0,1	0,3	0,5	0,2	1,0	0,38		HIgh	
8	Artificial Intelligence	0,2	0,2	0,5	0,4	0,6	0,5	0,1	0,3	0,5	0,2	1,0	0,35	0,352	Medium	Hierarchical Level
9	Robotics	0,3	0,5	0,3	0,3	0,2	0,4	0,3	0,3	0,1	0,2	1,0	0,29		Low	
10	Blockchain	0,1	0,1	0,3	0,3	0,3	0,7	0,1	0,5	0,3	0,3	1,0	0,30			
11	Cloud	0,6	0,3	0,6	0,6	0,8	0,6	0,1	0,5	0,7	0,1	1,0	0,49			
12	Big Data	0,2	0,1	0,5	0,3	0,3	0,5	0,3	0,7	0,7	0,2	1,0	0,38		High	
13	Cibersecurity	0,4	0,5	0,7	0,6	0,4	0,7	0,7	0,9	0,7	0,5	1,0	0,61	0,564	Medium	Digital Synchronization
14	Agile Project	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	1,0	0,70		Low	
15	Social Networks	0,7	0,8	0,7	0,4	0,7	0,8	0,5	0,6	0,7	0,5	1,0	0,64			
	Hamming Distance Per PT	0,61	0,58	0,54	0,66	0,57	0,45	0,71	0,55	0,57	0,66					
	Average of HD Per PT					0,59							HD = Low > 0.6		0.6 > HD = Medium > 0.3	HD = High < 0.3

Table A3. Prospective Year 1 milestone using DTS.

Input Variable (EV)		Hamming Distance Per Job (PT) - Milestone Year 1										Ideal	Average	Intermediate Variable (IV)		
Item	Digital Technology	PTI	PT2	PT3	PT4	PT5	PT6	PT7	PT8	PT9	PT10	Profile	(td)	Value	[L M H]	Exes - RAMI
1	Additive Manufacturing	0,1	0,3	0,3	0,1	0,1	0,5	0,1	0,1	0,1	0,2	1,0	0,19			
2	Internet Of Things	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	1,0	0,70		High	
3	3D Printing	0,5	0,7	0,5	0,3	0,1	0,5	0,5	0,7	0,3	0,3	1,0	0,44	0,470	Medium	Life Cycle
4	Aumented Reality	0,3	0,6	0,2	0,1	0,3	0,5	0,2	0,3	0,1	0,5	1,0	0,31		Low	
5	Virtual Reality	0,7	0,8	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	1,0	0,71			
6	Collaborative Work	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	1,0	0,70			
7	Data Mining	0,2	0,2	0,6	0,3	0,7	0,7	0,1	0,3	0,5	0,2	1,0	0,38		High	
8	Artificial Intelligence	0,2	0,2	0,5	0,4	0,6	0,5	0,1	0,3	0,5	0,2	1,0	0,35	0,404	Medium	Hierarchical Level
9	Robotics	0,3	0,5	0,3	0,3	0,2	0,4	0,3	0,3	0,1	0,2	1,0	0,29		Low	
10	Blockchain	0,1	0,1	0,3	0,3	0,3	0,7	0,1	0,5	0,3	0,3	1,0	0,30			
11	Cloud	0,6	0,3	0,6	0,6	0,8	0,6	0,1	0,5	0,7	0,1	1,0	0,49			
12	Big Data	0,2	0,1	0,5	0,3	0,3	0,5	0,3	0,7	0,7	0,2	1,0	0,38		High	
13	Cibersecurity	0,4	0,5	0,7	0,6	0,4	0,7	0,7	0,9	0,7	0,5	1,0	0,61	0,564	Medium	Digital Synchronization
14	Agile Project	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	1,0	0,70		Low	
15	Social Networks	0,7	0,8	0,7	0,4	0,7	0,8	0,5	0,6	0,7	0,5	1,0	0,64			
	Hamming Distance Per PT	0,57	0,52	0,47	0,57	0,51	0,39	0,61	0,47	0,50	0,60					
	Average of HD Per PT					0,52							HD = Low > 0.6		0.6 > HD = Medium > 0.3	HD = High < 0.3

Table A4. Prospective Year 2 milestone using DTS

Input Variable (EV)		Hamming Distance Per Job (PT) - Milestone Year 2										Ideal	Average	Intermediate Variable (IV)		
Item	Digital Technology	PTI	PT2	PT3	PT4	PT5	PT6	PT7	PT8	PT9	PT10	Profile	(td)	Value	[L M H]	Exes - RAMI
1	Additive Manufacturing	0,1	0,3	0,3	0,1	0,1	0,5	0,1	0,1	0,1	0,2	1,0	0,19			
2	Internet Of Things	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	1,0	0,7		High	
3	3D Printing	0,5	0,7	0,5	0,3	0,1	0,5	0,5	0,7	0,3	0,3	1,0	0,44	0,470	Medium	Life Cycle
4	Aumented Reality	0,3	0,6	0,2	0,1	0,3	0,5	0,2	0,3	0,1	0,5	1,0	0,31		Low	
5	Virtual Reality	0,7	0,8	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	1,0	0,71			
6	Collaborative Work	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	1,0	0,7			
7	Data Mining	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	1,0	0,7		High	
8	Artificial Intelligence	0,2	0,2	0,5	0,4	0,6	0,5	0,1	0,3	0,5	0,2	1,0	0,35	0,548	Medium	Hierarchical Level
9	Robotics	0,3	0,5	0,3	0,3	0,2	0,4	0,3	0,3	0,1	0,2	1,0	0,29		Low	
10	Blockchain	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	1,0	0,70			
11	Cloud	0,6	0,3	0,6	0,6	0,8	0,6	0,1	0,5	0,7	0,1	1,0	0,49			
12	Big Data	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	1,0	0,70		High	
13	Cibersecurity	0,4	0,5	0,7	0,6	0,4	0,7	0,7	0,9	0,7	0,5	1,0	0,61	0,628	Memdium	Digital Synchronization
14	Agile Project	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	1,0	0,70		Low	
15	Social Networks	0,7	0,8	0,7	0,4	0,7	0,8	0,5	0,6	0,7	0,5	1,0	0,64			
	Hamming Distance Per PT	0,47	0,41	0,42	0,49	0,46	0,37	0,51	0,43	0,46	0,51					
	Average of HD Per PT					0,45							HD = Low > 0.6		0.6 > HD = Medium > 0.3	HD = High < 0.3

Table A5. Prospective Year 3 milestone using DTS

Input Variable(EV)		Hamming Distance Per Job (PT) - Milestone Year 3										Ideal	Average	Intermediate Variable (IV)		
Item	Digital Technology	PT1	PT2	PT3	PT4	PT5	PT6	PT7	PT8	PT9	PT10	Profile	(td)	Value	[L M H]	Exes - RAMI
1	Additive Manufacturing	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	1,0	0,5			
2	Internet Of Things	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	1,0	0,90		High	
3	3D Printing	0,5	0,7	0,5	0,3	0,1	0,5	0,5	0,7	0,3	0,3	1,0	0,44	0,688	Medium	Life Cycle
4	Aumented Reality	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	1,0	0,70		Low	
5	Virtual Reality	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	1,0	0,90			
6	Collaborative Work	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	1,0	0,90			
7	Data Mining	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	1,0	0,90		High	
8	Artificial Intelligence	0,2	0,2	0,5	0,4	0,6	0,5	0,1	0,3	0,5	0,2	1,0	0,35	0,668	Medium	Hierarchical Level
9	Robotics	0,3	0,5	0,3	0,3	0,2	0,4	0,3	0,3	0,1	0,2	1,0	0,29		Low	
10	Blockchain	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	1,0	0,90			
11	Cloud	0,6	0,3	0,6	0,6	0,8	0,6	0,1	0,5	0,7	0,1	1,0	0,49			
12	Big Data	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	1,0	0,90		High	
13	Cibersecurity	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	1,0	0,90	0,766	Medium	Digital Synchronization
14	Agile Project	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	1,0	0,90		Low	
15	Social Networks	0,7	0,8	0,7	0,4	0,7	0,8	0,5	0,6	0,7	0,5	1,0	0,64			
	Hamming Distance Per PT	0,29	0,27	0,27	0,31	0,28	0,25	0,34	0,28	0,29	0,35					
	Average of HD Per PT					0,29							**HD = Low > 0.6**		**0.6 > HD = Medium > 0.3**	**HD = High < 0.3**

Appendix B

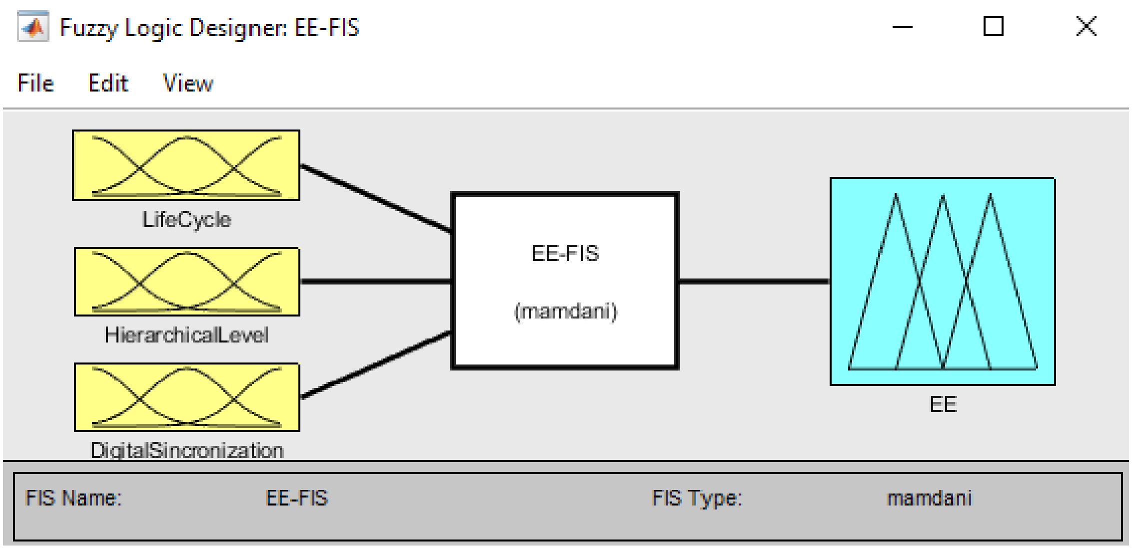

Figure B1. Fuzzy Inference system (FIS) diagram

Note: IV_1 = Life Cycle, IV_2 = Hierarchical Level, IV_3 = Digital Sincronization, and OV = EE = Export Efficiency. Executed in Matlab - Fuzzy Logic Toolbox 2020a.

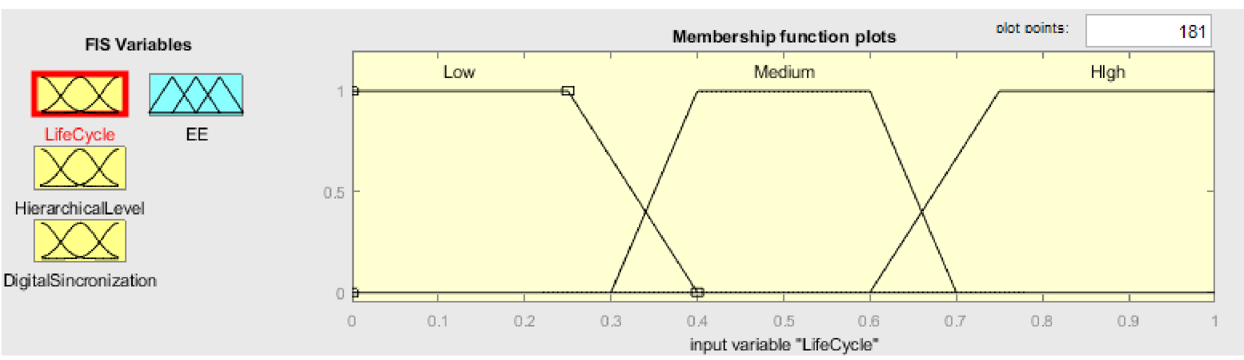

Figure B2. Life cycle membership function.

Note: Membership function: Low; Trapmf [0 0 0.25 0.4], Medium; Trapmf [0.3 0.4 0.6 0.7], and High; Trapmf [0.6 0.75 1 1].

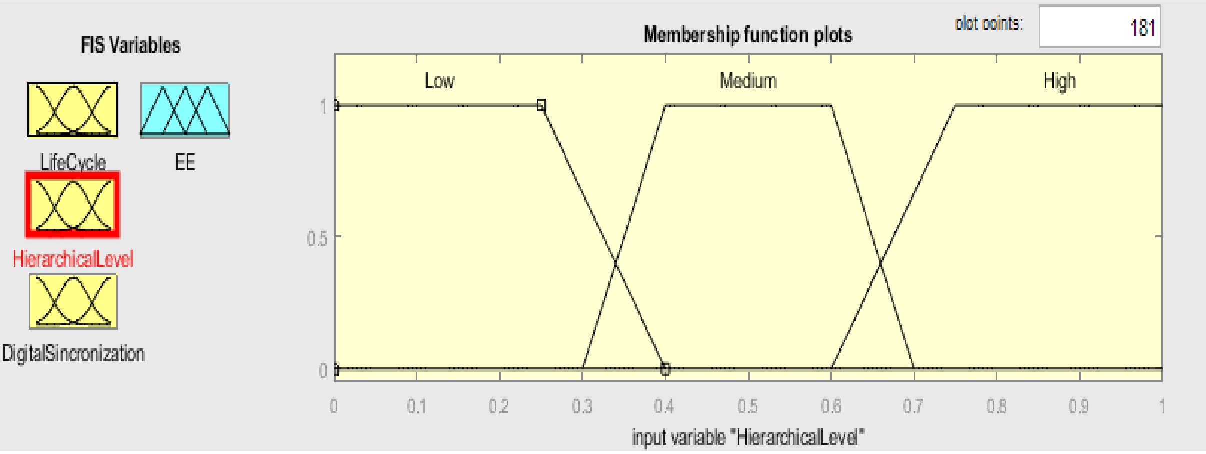

Figure B3. Hierarchical level membership function.

Note: Membership function: Low; Trapmf [0 0 0.25 0.4], Medium; Trapmf [0.3 0.4 0.6 0.7], and High; Trapmf [0.6 0.75 1 1].

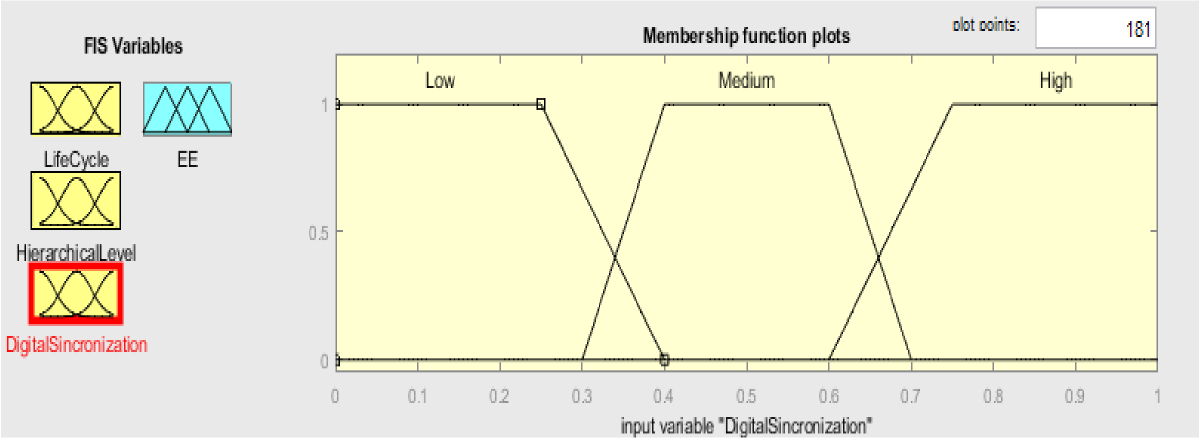

Figure B4. Digital synchronization membership function

Note: Membership function: Low; Trapmf [0 0 0.25 0.4], Medium; Trapmf [0.3 0.4 0.6 0.7], and High; Trapmf [0.6 0.75 1 1].

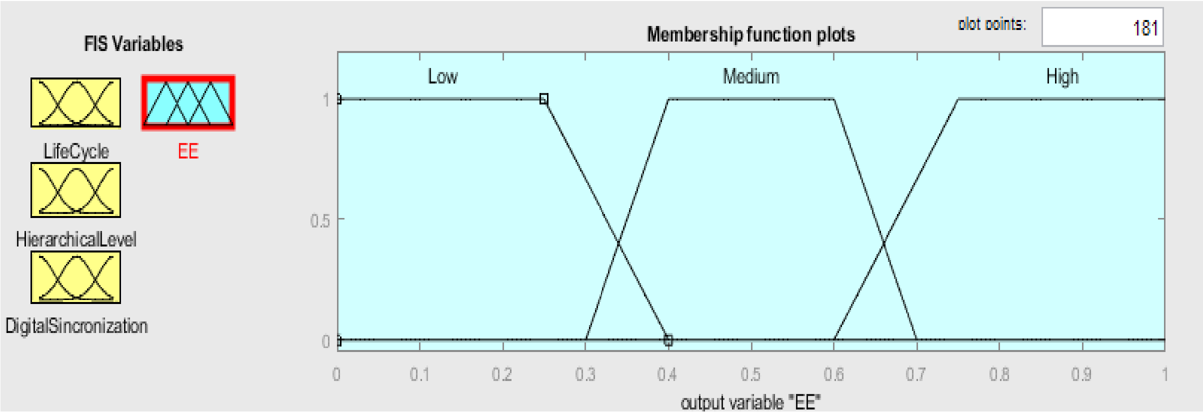

Figure B5. EE membership function.

Note: Membership function: Low; Trapmf [0 0 0.25 0.4], Medium; Trapmf [0.3 0.4 0.6 0.7], and High; Trapmf [0.6 0.75 1 1].

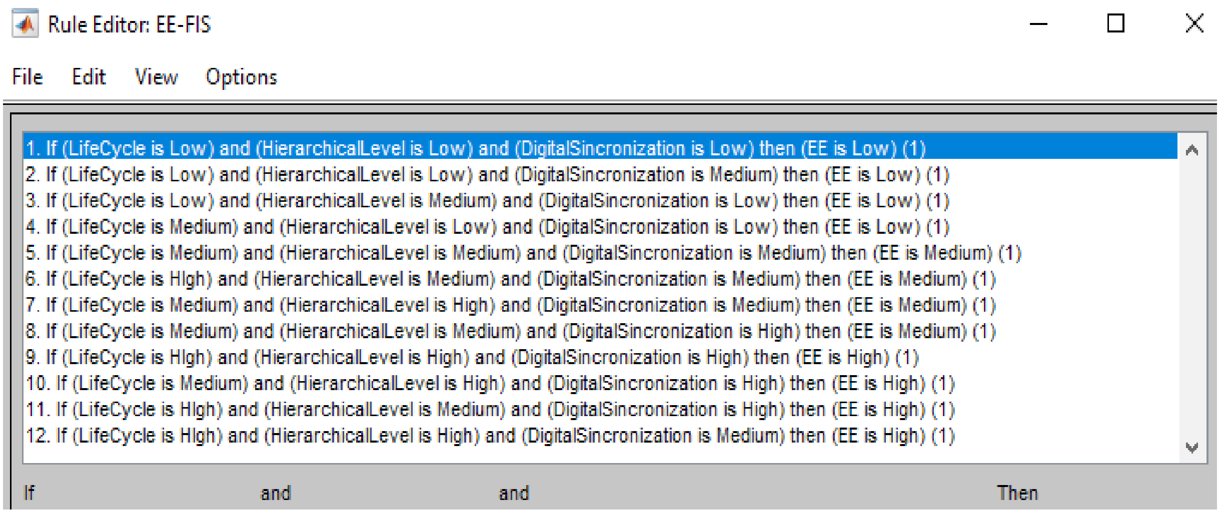

Figure B6. Rule editor of EE-FIS.

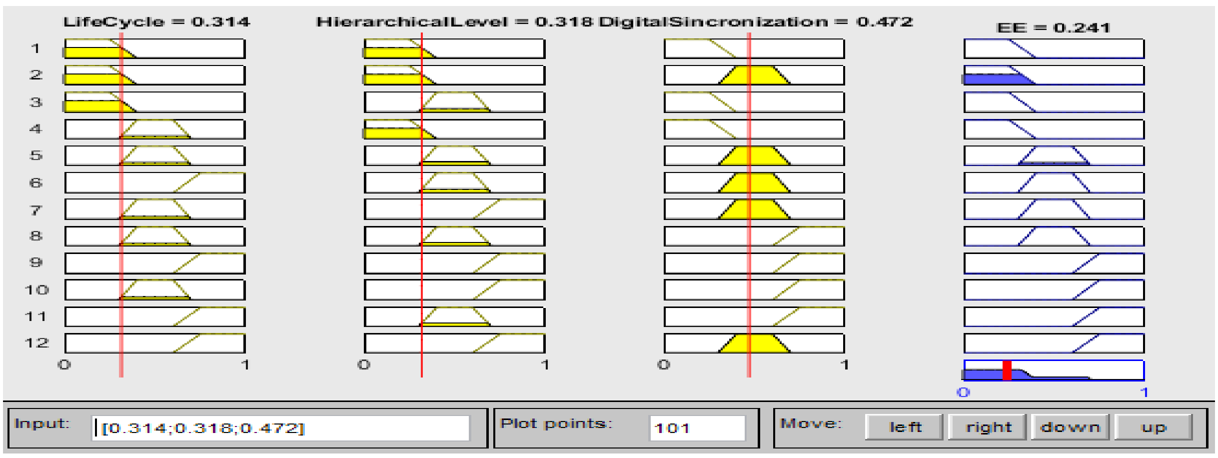

Figure B7. EE valuation for milestone N.

Note: The value of life cycle, hierarchical level, and digital sincronization are from Table A1.

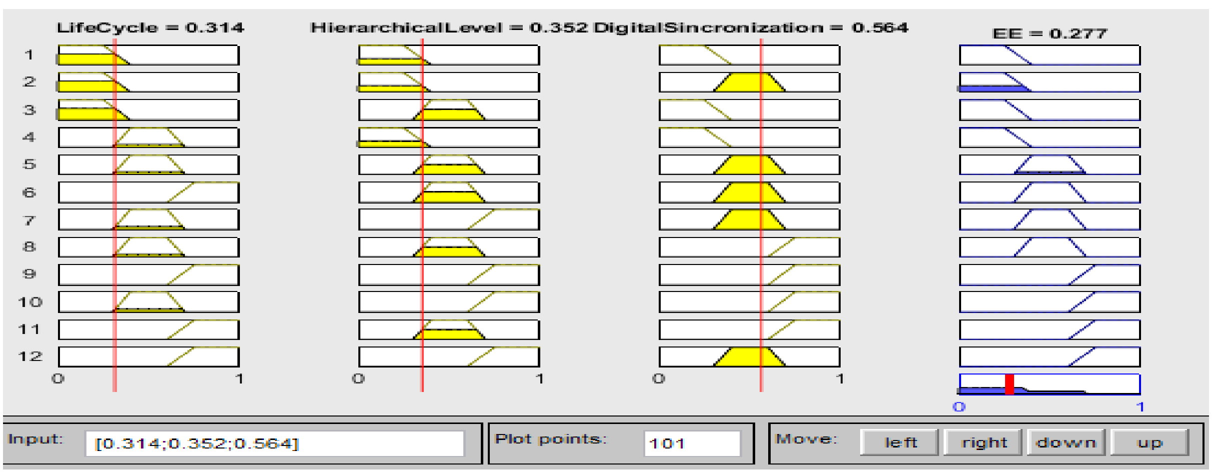

Figure B8. EE valuation for milestone Year 0.

Note: The value of life cycle, hierarchical level, and digital sincronization are from Table A2.

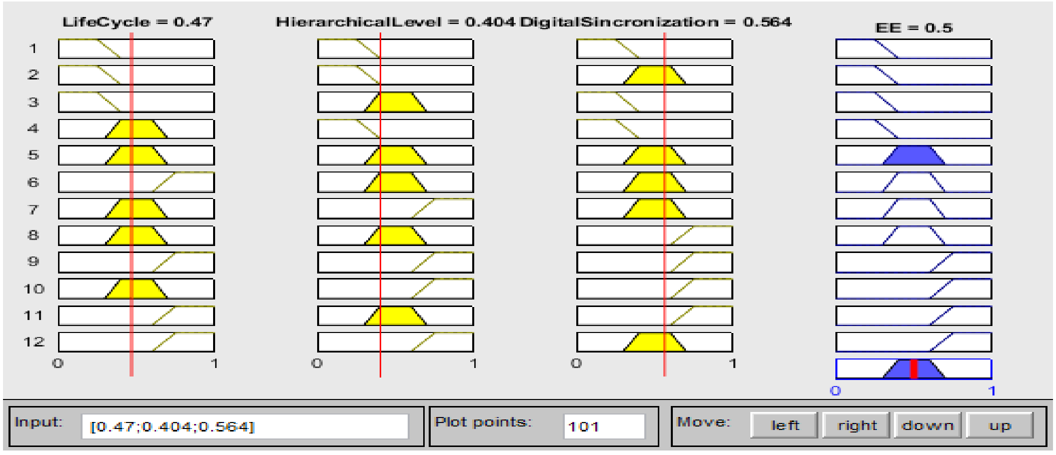

Figure B9. EE valuation for milestone Year 1.

Note: The value of life cycle, hierarchical level, and digital sincronization are from Table A3.

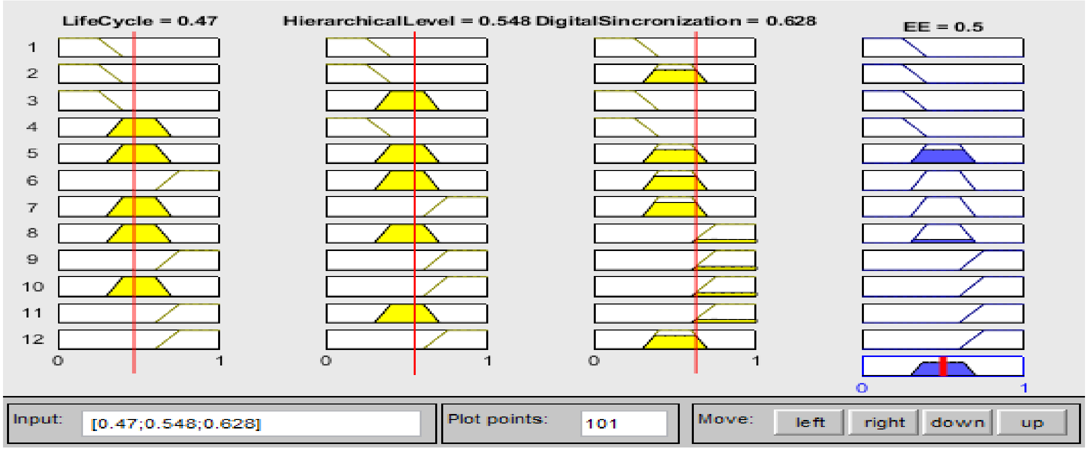

Figure B10. EE valuation for milestone Year 2.

Note: The value of life cycle, hierarchical level, and digital sincronization are from Table A4.

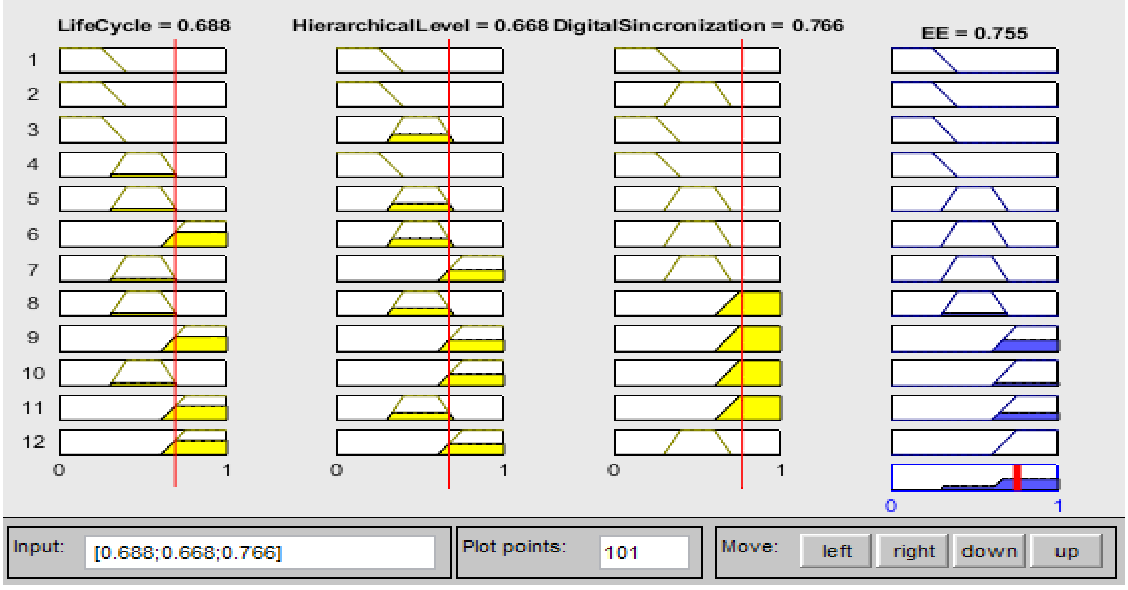

Figure B11. EE valuation for milestone Year 3.

Note: The value of life cycle, hierarchical level, and digital sincronization are from Table A5.

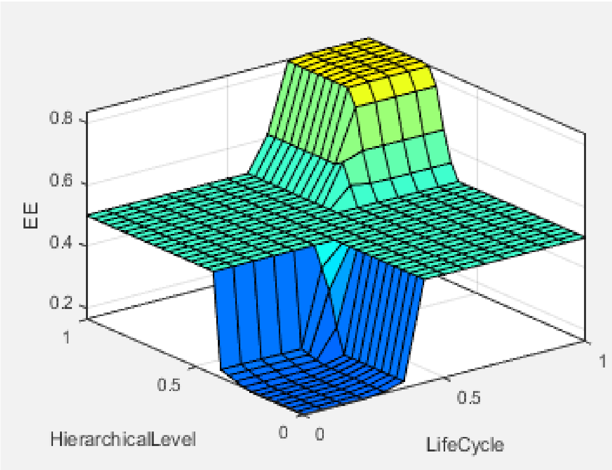

Figure B12. Diffuse surface of EE

Appendix C

Table C1. Expert opinion.

Number of Experts	Investment For Blueberry Line Value in Thousands of USD		
	Minimum	Greater Presumption	Maximum
1	450	600	800
2	750	850	950
3	500	600	700
4	450	650	750
5	650	750	850
6	700	800	900
7	550	650	750
8	700	800	900
	594	**713**	**825**

Table C2. Counter expertise questions.

Presumption Level	Semantic Description
0.0	Execution investment to 594
0.1	Execution investment practically 594
0.2	Execution investment almost 594
0.3	Execution investment close to 594
0.4	Execution investment closer to 594 than 825
0.5	Execution investment as close to 594 as 825
0.6	Execution investment closer to 825 than 594
0.7	Execution investment close to 825
0.8	Execution investment almost 825
0.9	Execution investment practically 825
1.0	Execution investment to 825

Table C3. Opinion of counter experts.

Number Of Counter Experts	Opinion Of Counter Experts
1	[0.5, 0.6, 0.7]
2	[0.4, 0.6, 0.8]
3	[0.4, 0.5, 0,6]
4	[0.4, 0.6, 0.9]
5	[0.3, 0.5, 0.7]

Table C4. Absolute, relative, and inverse accumulated frequency.

Presumption Level	Absolute Frequency		Relative Frequency		Inverse Accumulated Frequency	
	Li	Ls	Ls	Ls	Li	Ls
0.0					1	1
0.1					1	1
0.2					1	1
0.3	1		0.2		0.8	1
0.4	3		0.6		0.2	1
0.5	1		0.2		0	1
0.6		1		0.2	0	0.8
0.7		2		0.4	0	0.4
0.8		1		0.2	0	0.2
0.9		1		0.2	0	0
1.0					0	0

Table C5. R+ - Experton of investment.

Presumption Level	Inverse Accumulated Frequency Formula		R^+ - Experton - Investment		
				Li	Ls
0.0	1	1	R+ - M Experton = [594 + (231*Experton)]	825.0	825.0
0.1	1	1		825.0	825.0
0.2	1	1		825.0	825.0
0.3	0.8	1		778.8	825.0
0.4	0.2	1		640.2	825.0
0.5	0	1		594.0	825.0
0.6	0	1		594.0	825.0
0.7	0	1		594.0	825.0
0.8	0	0.6		594.0	732.6
0.9	0	0		594.0	594.0
1.0	0	0		594.0	594.0

Note: The R + -Experton for the inversion has the extremes [Li Ls] = [686.4, 792.6] and its mean value is = 739.5. By which the TFN = [686.4, 739.5, 792.6] is constructed. Therefore, the amount of investment is equal to the mean value of USD 739500.